Community Access Point in Indonesia:
Improving Access to Quality Information and Promoting Local Potentials

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Abstract

The social, cultural, economical and geographical diversity of the country of Indonesia recognized in its motto: "Unity in Diversity", is both an opportunity and a challenge for the development of an Indonesian information society. It is an opportunity as it is a natural source of riches for a vibrant development. It is a challenge as distribution, heterogeneity and autonomy makes the integration of information and services more complex at all levels of the national information infrastructure. One particularly critical aspect of this complexity is the disparity between big cities and remote rural areas, largely due to the unbalance in resources. In this paper, we propose the Community Access Point (CAP). CAP is a peer-to-peer architecture for a digital library that can serve as a platform for the interoperation of distributed, heterogeneous and autonomous information sources and services. The features of CAP make it a suitable and economical solution suited to the needs and capacity of remote and economically challenged communities.

Keywords: Community Access Point, digital divide, access to information, peer-to-peer system, distributed system

1. Introduction

Indonesia is composed of 17.508 islands grouped in 33 provinces. Such geographical distribution naturally comes with significant cultural, social and economical diversity. Yet such diversity is both an opportunity and a challenge for the development of an Indonesian information society. It is an opportunity as it is a natural source of riches for a vibrant development. It is a challenge as distribution, heterogeneity and autonomy makes the integration of information and services more complex at all levels of the national information infrastructure. One particularly critical aspect of this complexity is the disparity between big cities and remote rural areas, largely due to the unbalance in resources.

For instance, only small and mostly urban portion of the Indonesian population has access to higher education. A survey by the Directorate General of Higher Education of the Republic of Indonesia in 2003 showed that the higher education sub sector consists of 82 public higher educational institutions (HEI) and more than 2.236 private HEI. Public HEI accommodate about 1 million undergraduate students while private HEI about 2 millions. In addition, 200.000 students study in religious educational institution and in professional training institutions. Consequently, the level of access to higher education is about 12.8%, which is low even among developing countries such as the Philippines (32%) and Thailand (30%)[1]. Clearly, increasing access to higher education is an expensive task that requires time, effort and durable political will. Alternative solutions must be sought to bring scientific and technological knowledge to these geographically, socially or economically isolated large portions of the population.

In this paper, we are concerned with exploiting the opportunities offered by the developments of information and communication and, in particular, the Internet. The autonomous, distributed, and best effort nature of the Internet infrastructure as well as the recent wireless development seem to fit the needs and requiremaemt of a country like Indonesia with its geographical, cultural, social and economical challenges. Beside the technical argument, we motivate our proposal from the simple observation of the exponential growth of Internet adoption. A survey by Asosiasi Penyelenggara Jasa Internet Indonesia (APJII) shows (cf. Table 1) that there is a significant increase in the number of users of the Internet. Does this trend suggest that the Internet is an effective means to provide equal access to information?

Table 1: Quantity Enhancement of Customer and User (cumulative) [2]

Year	Amount of Customer	Amount of User
1998	134.000	512.000
1999	256.000	1.000.000
2000	400.000	1.900.000
2001	581.000	4.200.000
2002	667.002	4.500.000
2003	865.706	8.080.534
2004	1.087.428	11.226.143
2005	1.500.000	16.000.000

However, we shall not ignore that the information infrastructure (access to information technologies and Internet) itself suffers from geographical, social and economical challenges of Indonesia. Cleary, Internet users mostly reside in big cities whereas remote rural areas where do not enjoy the most needed access to information and knowledge. Clearly, developing a fair information infrastructure is also an expensive task that requires time, effort and durable political will.

In front of such challenges, we decided to investigate an economical solution suited to the needs and capacity of remote and economically challenged communities.

In this paper, we propose the Community Access Point (CAP) as a solution to provide quality information and promote the riches of each area in Indonesia. CAP will function as access point where people can enjoy the information. It acts as public digital library where the people can search any information they need. Our contribution can be divided into threefold:

- Designing the architecture of CAP considering the investment capability of the government. We propose the use of peer-to-peer technology as a solution to create robust architecture with less expensive infrastructure investment.
- Implementation of application that will be used on top of CAP infrastructure
- Strategy of the implementation of CAP in Indonesia.

The rest of the paper is organized as follow. In section 2 we present related works. In section 3 we describe the technological background of our solution. In section 4 we explain our proposed solution of the CAP architecture. In section 5 we explain our strategy to implement CAP in Indonesia and assess the impact of implementation of CAP. In the last section we briefly conclude and outline future work.

2. Related Works

One common problem faced by many countries in the world is information gap. The problem is affected by some factors, mostly due to socioeconomic factors such as race, income, education and geography [3]. The initiatives for reducing the problem have been conducted through several projects. E-learning, training in rural areas and public digital libraries are common mechanisms to solve such problem.

One project conducted by Bill & Melinda Gates Foundation [3] showed that public digital library is an effective mean to reduce the digital divide and well suited for basic skill development. Support for investment is continuously increasing in America as the public policy makers realize the needs for such technology.

Another project to reduce the digital divide is DISA that was aimed for South Africa [4]. The focus of DISA project is providing digital content especially digital image for e-Learning as part of lifelong learning. A sober assessment of both the strengths and weaknesses of the current state of digital imaging technology in South Africa has resulted in a modest, but feasible, digital library model with due consideration to ethical issues and social context.

One of the most popular applications today is peer-to-peer (P2P) application. It grows very fast with millions users join and share their documents. One of the advantages of P2P applications is they do not require high resource computer to participate in the network. The users with any computer specification share the files they have and exchange the files they interested. The technology has created large networked communities with the same interest. Napster [5] and Kazaa [6] are examples of successful P2P application for file music and video sharing.

Combining the technology of digital library and peer-to-peer technology could be very promising for challenging country such as Indonesia. The hybrid of the technology can be a potential tool for bridging the information gap in Indonesia, which has varying ICT infrastructure capability in each area.

3. Digital Library and Peer-to-Peer System

In this section we will describe the technological aspect behind our proposed solution. First we will explain the digital library as the main application that will be run on our CAP infrastructure. Second we will explain the peer-to-peer system as the infrastructure architecture of our proposed solution and its advantages that lead us to choose this architecture.

3.1 Digital Library

Digital library is an application that acts as conventional library. The users can search, read and borrow the collection it has. The main difference with the conventional library is all its collections in form of digital content instead of printed-paper.

Digital library is equipped with the capabilities of managing the collections as in traditional library including procurement process, circulation, etc. Digital library basically is a collection of separate system but logically connected and interacted with each other. However, the definition of digital library is continuously evolving as the information technology grows. Below are some definitions of digital library from several resources:

1. Based on *Digital Library Federation* (DLF)

   The working definition of digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities [7]."

2. Based on Wikipedia

   A digital library is a library in which a significant proportion of the resources are available in machine-readable format (as opposed to print or microform), accessible by means of computers. The digital content may be locally held or accessed remotely via computer networks. In libraries, the process of digitization began with the catalog, moved to periodical indexes and abstracting services, then to periodicals and large reference works, and finally to book publishing [8].

3. Based on Ismail Fahmi as team member of Bandung Institut of Technology library.

   Digital library is a vast collection of entities stored and maintained by multiple information sources including databases, image banks, file systems, email systems, the Web, and applications providing structured or semi-structured data [9].

The digital library used in the CAP application uses the definition of digital library by Ismail Fahmi. Digital library will share the responsibility between librarians and computers in order to manage the collection. For instance in the data entry process, the librarian has responsibility to input the data whereas the computer is dedicated to process the input and save it to the database.

3.2 Distributed System and Peer-to-Peer Technology

Distributed system and peer-to-peer technology enable resources in the network to communicate each other. The characteristic of peer-to-peer technology is resource sharing either in bandwidth, computing power, space, etc. Such characteristic is very important, as it is not requiring each resource involved having good performance. Thus the technology makes the knowledge becoming borderless. It enables many parties participate in it; small, medium and big institutions even individual person can join the system and collaborate each other. Some researches on peer-to-peer system can be seen in [10], [11], and [12].

People defines peer-to-peer system in many ways, one of them is defined by Intel Working Group [13] *"The sharing of computer resources and services by direct exchange between systems"*. In peer-to-peer system, each computer named node/peer behaves both as client and server. Each peer should pay its participation in the network by providing access to its resources that are usually in form of bandwidth, space or computing power. In our case, each peer should allocate its contents to be shared to other peers with any mechanisms.

Based on above definition, peer-to-peer system has some principles below:

- Resource sharing: each peer shares its resources to other peers. The resource maybe in form of physical resources such as disk space and bandwidth or logical resources such as services and knowledge.
- Decentralization: this principle is the consequence of resource sharing. The system does not operate in centralized manner to avoid single point of failure or performance bottleneck.
- Self-organization: when peer-to-peer system fully operated in decentralized manner, no peer can control the system centrally. Therefore the system is requested to organize itself based on available information.

4. Design of Community Access Point

Community Access Point is an application system that has been designed to accommodate the needs for accessing useful information. As we will provide the information to many remote areas, investment capability then becomes one of main consideration when implementing such system. To build such system, we need 4 main components: distributed network infrastructure and peer-to-peer technology, digital library, digital content and network of focal points.

Distributed and peer-to-peer technology is chosen as its nature that does not require high investment cost. This advantage is very suitable for Indonesia condition that has been in economical crisis since 1997. By providing system which is suited with the investment budget, they still can participate in the CAP system. Thus this will increase the possibility for the Indonesian to enjoy quality information.

The digital library is the key technology for providing equal access to high quality information. It will be placed in public area where everybody can easily come to use it. The digital library has been proven [3] as an effective media to improve the knowledge of its users as part of lifelong learning. It also can be extend to more robust system by incorporating Internet and wireless technology that makes it accessible anytime and anywhere.

Digital content is an important component as it is the core of information. There are two aspects concerned in digital content which are technical

specification and type of content. From technical specification perspective, in order to make the digital content can be shared, the content should be created using XML format. From the type of content perspective, we prioritize the contents which are very important for community development and promote the local potential.

With the vast geographical areas of Indonesia, it is almost impossible to launch such endeavor single-handedly. The establishment and empowerment of focal points are critical aspects of this initiative. Focal point can be viewed as independent organization that will run the application and manage the operational of the system. Incorporating the system to the government organization, which frequently accessed by citizen will accelerate the transfer of technology and knowledge from "information rich" area to "information poor" area. Furthermore, it will lessen the gap of digital divide among areas in Indonesia.

4.1 Architecture of Digital Library in CAP

Figure 1 shows the technical diagram of digital library in the CAP system and its connection to other CAPs. The digital library architecture consits of three components: library information system, information retrieval system, and communication system. Each component is connected to each other and dedicated to particular function. All components are developed using free and open source technologies to reduce the software investment cost. Combination of Linux as operating system, MySQL as database technology, PHP and web browser technology would be suitable solution. Web browser is easy to use and we can train easier the new user using this technology.

The library information system acts as a component that provides back office application for the librarians to manage the collections. The component provides functionality as in conventional library including sirculation, procurement, fine, reporting, etc. Data about books and other resources are stored in relational database which is MySQL.

The information retrieval system acts as a component that will help the users searching the collections that match their needs. This component is context sensitive and having capability to search information based on its content. We use boolean model and vector space model as our technique for retrieval process. Index is generated from abstract of the contents.

The last component acts as a system integrator that provides services to communicate with other CAPs. It is also equipped with the capabilty of searching digital content in distributed system. The technology we used in implementing such system is web service technology (Apache Axis) that enables
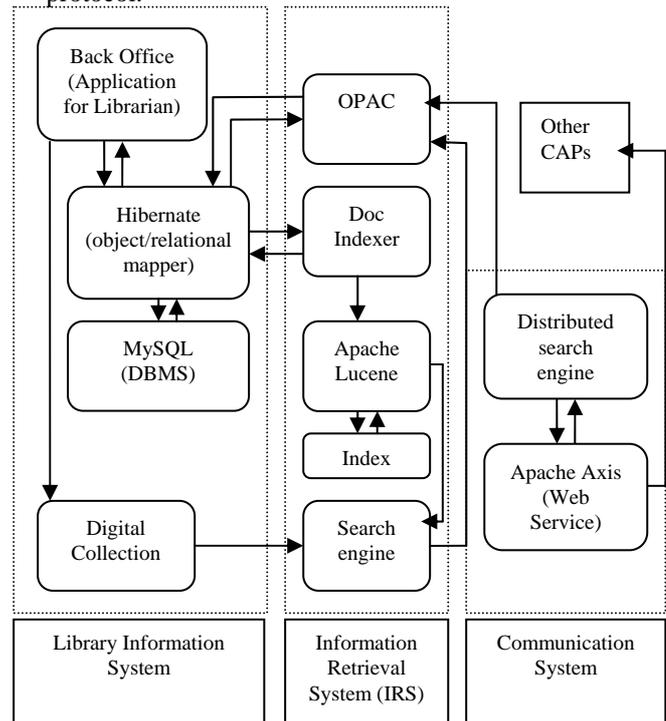
system to communicate each other using http protocol.

Figure 1. Architectural design of the CAP system

4.2 Infrastructure Architecture of CAP

One of the important issues in implementing CAP is the design of infrastructure. Each focal point in CAP can be viewed as a node in peer-to-peer system. Thus in which level of government organization we will choose as CAP's focal point becomes important issue that we should solve. Government hierarchy in Indonesia consists of some level. The top level of organization resides in Jakarta as the capital of Indonesia. In the second level, we have province that usually has a big cities such as Surabaya as its capital. The third level is Kabupaten that covers tents of smaller areas. Each area in each level has autonomy to manage its resources. Number of province in Indonesia is 33 provinces whereas number of Kabupaten is around 800 kabupaten.

One of considered aspects when choosing the focal point is the availability of the ICT infrastructure. Most of Kabupatens have been equipped with ICT infrastructure. This opportunity leads us to choose province and Kabupaten as the focal point by incorporating the CAP application on top of existing system and infrastructure. It would lessen the budget for investment. Figure 2 shows how we can implement the CAP application by utilizing focal point in the level of province or Kabupaten.

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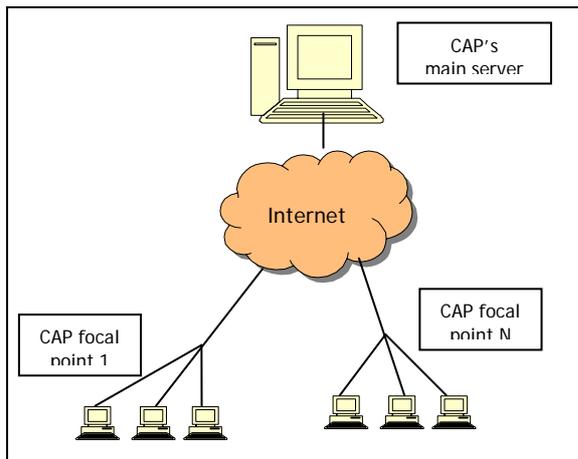

Figure 2. Focal points distributions

Based on figure 2, we consider three alternative solutions that basically can be implemented in Indonesia. The three alternatives are:
1. Centralized Network Architecture
2. Distributed Network Architecture without replication
3. Distributed Network Architecture with replication

4.2.1 Centralized Network Architecture

The first solution is the typical solution that usually taken by any organization that has capability to invest enough money for their infrastructure. The central server can be placed in Department of Communication and Information as an agency, which is responsible to utilize the ICT in Indonesia. In this architecture, each focal point in province or kabupaten only acts as an access provider. All documents will be stored in the central server. The librarian of the CAP in focal point must connec to Internet when they are adding or updating content they are interested. Figure 3 shows the centralized architecture of our proposed solution.

The advantage of this approach is the simplicity and easiness of maintenance process, as we only need to manage one server in the central office.

However, this architecture also has the disadvantages, which are:
- Access from CAP to the central server requires high bandwidth to satisfy the user.
- If the system is disconnected or slow then the focal point cannot access the central server.
- The central server should have high performance server specification which is expensive.
- Content organization is quite difficult as the owner does not have autonomy to manage the content.

Thus the requirement of this architecture is each focal point should have ICT infrastructures and good internet connection. This solution is quite expensive for Indonesia as the geographical condition of Indonesia that is very complex and not all areas have robust ICT infrastructure.
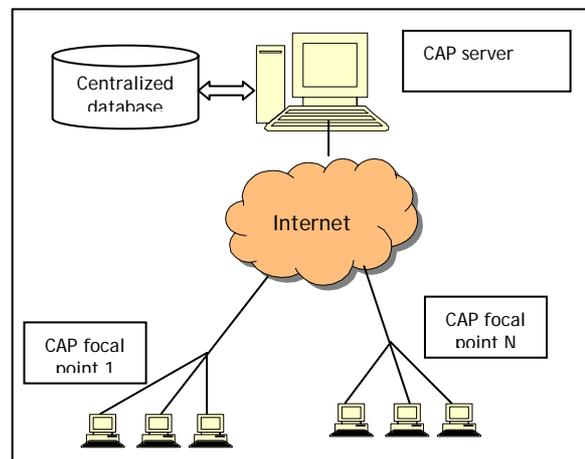

Figure 3. Centralized network architecture of CAP

4.2.2 Centralized Network Architecture without Replication

Second proposal is dedicating a server in each focal point. The server is not necessarily having super computing capabilities; instead we can use a personal computer and dedicate it as a server. We consider that each focal point only will manage the collection it has, and if users search for more information which the focal point does not have, the system will contact other focal points. Therefore each focal point needs to exchange its index with other focal points to be used as information in routing process. Such index exchange can be found in [12]. By using this architecture, every client in the CAP focal point does not need to be always connected to the Internet. When the connection is slow or even they do not have fixed installation, the users still can enjoy the information stored in the

focal point server. Figure 4 shows the architecture for this solution.

This kind of architecture has advantages in increasing the system availability. When the focal point has problem with the Internet connection, its users still can access the content locally. But of course, this architecture still requires the system to connect to central server when they need more general contents or contents that they don't have. The trade off of this approach is the need for human resources that will take care of the system, but it doesn't matter since it will develop the capacity building of the focal point. By maintaining such system, one of our aims which are empowering focal point will be achieved.
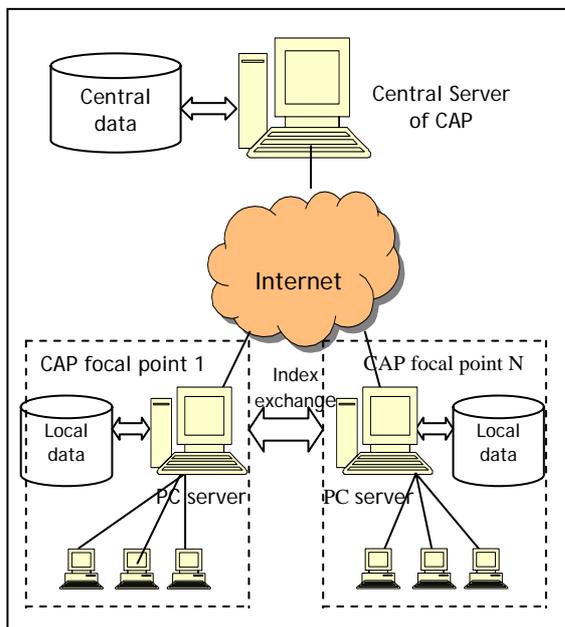

Figure 4. Distributed network architecture of CAP without replication

4.2.3 Centralized Network Architecture with Replication

The architecture of this model is quite similar with the second approach. The only difference is the content organization which requires the content of the focal point being replicated to other focal point CAPs instead of only its index. Each computer in focal point will act as a real server as it will store almost all of documents from the whole system. Therefore, when client search for information, it only needs contacting the server in focal point. Figure 5 shows the architecture of the CAP using this approach.

This approach does not need internet connection for information searching. The information needed will be satisfied by the focal point server. However the internet connection is still required for information exchanging between focal point CAPs. But of course it needs less time and invisible in the point of view of its clients.

One of disadvantages of this architecture is it needs higher server specification rather than the second approach. We still can reduce the cost of investment by creating hierarchical system for content organization. Focal point in the Kabupaten level only needs to replicate contents belonging to any focal points in the same province (as Kabupaten is under control of province in the government hierarchy). Thus when investing server for focal point, we can differentiate the specification of server for focal point in Kabupaten level and province level. We can choose server specification for province one level higher than Kabupaten.

This approach also requires large data exchange. But it can be scheduled so that it would not disturb the performance of the system. The architecture also needs the large data storage in each focal point, but it does not matter since the price of such space is quite cheap today.
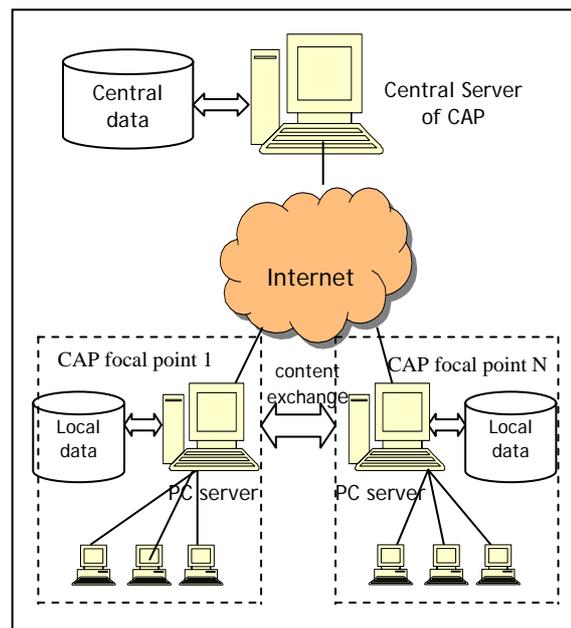

Figure 5. Distributed network architecture of CAP with replication

5. Strategy for Successful Implementation of Community Access Point and Its Impact

In this section we will explain the strategies of implementing CAP in Indonesia and its impacts.

5.1 Strategies of Implementation of CAP

To achieve the success of the initiative, it should be designed some stages that will assure the feasibility of the proposed architecture. We proposed three phases that should be conducted in order to make the initiative works smoothly, which are piloting, expanding and collaborating.

Piloting

This is the first phase that should be taken in order to plan the strategy of implementation for national level. We can choose contrasting areas in term of the capability of the human resources and the availability of ICT infrastructure. Jakarta is not a good choice as it already has the modern ICT Infrastructure. Smaller cities near to Jakarta will be good choices as they have equipped with ICT infrastructure although not as good as facilities in Jakarta. But it is more representing the characteristic of almost of developing city in Indonesia. Other cities that should be chosen as the pilot of focal point are the remote areas such as the cities in the east part of Indonesia. Those areas represent most of cities in Indonesia which have limited ICT infrastructure and Internet access. We can select 2 or 3 cities for each type of area.

During the piloting phase, we can assess what kind of aspect that should be taken for other areas that have similar characteristic to the pilot areas. The aspects include type of training, strategy for content organization and creation, working habit of the personnel that will run the system, the existing ICT infrastructure etc.

Our first experience on implementing CAP system in Palembang and Serang (both of them are in the level of province) showed that we need a bit effort as the condition in remote areas (even in the level of province) that need more investments and training in term of human resources and ICT and internet facilities.

Expanding

Second phase to achieve the success of the initiative is the expanding phase. In this phase, we can implement CAP in other areas. As we have experienced with the pilot areas, we can choose more appropriate strategy to implement the CAP system. The implementation should be done gradually based on some priority. To fasten the growth of the CAP, we have to treat each area equally as they will be our agents to attract other areas to join the community.

Collaborating

This is the last step to enrich the content of CAP system. In each area, usually it also has other resources of information such as local library, government, local university, etc. Such resources basically can be integrated as long as they meet the standard and protocol we used. Fortunately, we have technology such as web services that has the capability to bridge the communication between systems. However, our CAP system has been equipped with such technology so that any systems can join with CAP system easily. They just need to call the services provided by CAP system and easily retrieve the data given. One of our initial collaboration is established between University of Indonesia, Serang and Palembang that involves data from library of University of Indonesia, data from CAP Palembang and Serang, and local library in Serang.

In term of Internet infrastructure, there are some prospectus government agencies that can be relied on. One of them is PT POS (postal office), which has a network called Wasantara Net. The Wasantara Net covers almost of area until level of Kabupaten.

Beside three phases that should be implemented, there are some aspects that should be considered:

- The CAP system should be placed in the location that is accessible by the community. Some public place such as postal office is a good candidate as almost of citizens especially in the remote areas usually visit the office for sending mail or pay some bills.
- The CAP system should be easy to use as most of the users are novice in term of computer usage.
- Information provided should be up to date that makes the users curious to find new information
- Richness of the contents. Each focal point needs to enrich its contents to attract more peoples to come.
- The sustainability of the CAP system. This very important as CAP system needs human resource to maintain it. One mechanism that can be applied by focal point is by determining particular price when the users try to download the content. The price should be reasonable as more than half of Indonesian peoples fall into poor category.

5.2 Impacts of the Implementation

Implementation of CAP system in Indonesia is very important to open people mind, particularly who lives in remote areas. According study by United Nation on September 5th, 2003, Indonesia's Human Development Index (HDI) is ranked 122th among 175 countries. The HDI is measured by adult literacy, education enrollment ratio, Gross Domestic Product per capita, and life expectancy. The CAP system, however, provide many information that perhaps can be useful for the users to improve their knowledge.

Furthermore, one of side effect of the use of CAP system is information exchange. This process indirectly will promote the riches of each area in Indonesia. Such process we hope can encourage the people to do many things including research based on information they get from the CAP system. The mechanism perhaps also reduces the double research in Indonesia as they can use or collaborate with other peoples or institutions with the same interest.

6. Conclusion and Discussion

In this paper, we have presented the Community Access Point system that we have designed to meet the requirements and address the challenges of the development of an information infrastructure for the geographically, socially, culturally and economically diverse Indonesian society. We proposed variant architectures for the system, each of which has its own advantages and disadvantages that we discuss. Yet, the most promising architecture seem to be the one leveraging a peer-to-peer architecture as it seems the most economical in terms of both initial investment and operational cost, as well as it sees to fit well some of the infrastructural constraints imposed by the country's geography.

We are currently implementing the principles of the peer-to-peer version of the system as part of the inter-university digital library system Lontar (see [14]) developed and deployed by the computer science department of the University of Indonesia.

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