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Design of Integrated Pharmacy Information Systems using Service Oriented Architecture

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***Abstract*—Pharmacy information systems that exist today, many of them are designed and built just to manage a single specific pharmacy. In terms of ordering medications, the pharmacies most still use the manual method, such as send a letter of reservation or make a reservation by phone. The database is built as a back-end of the pharmacy information system, also use the software most diverse database. Currently, from the customer side, to obtain the presence information of a drug product, customers need to go to every pharmacy one by one to find the product you are looking for drugs. This, of course, will add to the cost and is very inefficient in economic terms. This study aims to develop an integrated pharmacy information system by utilizing Service Oriented Architecture. Method of system development approach is built with Systems Development Life Cycle (SDLC). Plans are being implemented by the Unified Modeling Language (UML). The programming language used in this study is PHP with CodeIgniter framework, Visual Basic. NET (VB.NET), and Java 2 Mobile Edition (J2ME). The results of this research are the production of an integrated pharmacy information system with other pharmacy information system and other applications, both in terms of different languages and different development in the database used. With the integration of the system, it can be used for broader uses, such as ordering goods between different pharmacy systems. In addition, it also produced mobile and desktop-based applications to access information drug stocks. These mobile applications are expected to be able to close the pharmacy with a customer who would have an impact on customer relationships and the pharmacies are getting close.**

Keywords-Pharmacy Information Systems; UML; PHP; Visual Basic. NET; J2ME

I. INTRODUCTION

The current pharmacy information system, mostly designed and built only to manage one particular pharmacy. In terms of ordering drugs, most pharmacies still use manual methods, such as sending order letters or ordering via telephone. The database is built as a back-end of the pharmacy information system, also mostly using diverse database software.

Viewed in terms of efficiency, of course, it will be more efficient if a system that bridges between pharmacies is made to order each other drugs easily, can make direct orders or direct orders to other pharmacies that have different pharmacy information systems in both programming and database languages that are used. By using the business to business (B2B) ordering concept, savings can be made in financial terms.

Service Oriented Architecture (SOA) is an architectural model for engineering software using services found on the network. Software engineering components in SOA are loose coupling, so they can be reused. Applications on SOA are built on service, which is an implementation of business functions that are clearly defined and can be consumed by clients on various business applications or processes [1].

An implementation of SOA to model the integration of higher education information systems. Along with the development of information technology, causing applications and platforms used by departments and supporting units in universities to be diverse. This results in the availability and needs of data and information from each supporting unit in tertiary institutions that need to be properly processed so as to facilitate the provision and exchange of data and information needed by stakeholders. In addition, various applications and platforms cause unity (cohesion) between the services provided, the lower and incompatibility between data and information in universities [2].

CRM applications using a SOA method by utilizing Web Service technology and application design using Service Oriented Architecture Design (SOAD) based on Enterprise Architecture to create harmony between business and information technology for company needs [3].

Information systems using Web service technology using PHP, SQL Server databases and Access which are implemented in goods distribution management systems at a pharmacy that has several branches. This research produces an information system that is able to integrate applications and platforms from all branches [4].

This health care application, SOA makes it easy for patients to browse the medical records of all hospitals that have been visited without the need to visit one by one of the hospitals. Patients will also find it easier to get the health information and facilities needed without the need to visit one by one the existing hospital websites [5].

II. SERVICE ORIENTED ARCHITECTURE

Service Oriented Architecture, or abbreviated as SOA, is generally defined as an application architecture where all functions, services are defined using a language that is encrypted and can access interfaces called to carry out business processes. Every interaction is independent of others. Because the interface is independent of the platform, every client from any device can use the service provided. SOA connects various operating systems and is able to automate the business processes of an organization internally or enterprise [2].

SOA is a strategic technology framework that allows all important systems, both inside and outside the organization, to open and access well-defined services, and limit information on those services, which might further summarize the process layer and composite applications for developing solutions. In essence, SOA adds aspects of capabilities to the architecture, allowing it to relate to system changes using a configuration layer that is better than continuing to redevelop the system [6].

An organization can describe and publish their services to directories, choose the right service, and after that involve service. In the e-services paradigm, it is divided into service providers, requesters, and yellow pages shown in Figure 1.

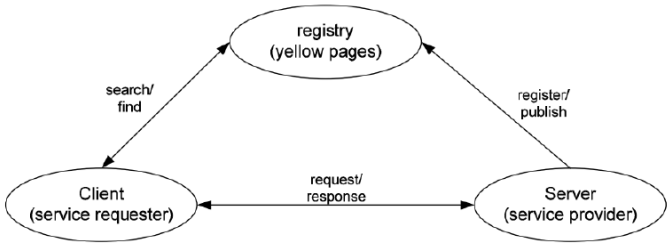

Figure 1. The basic idea of service oriented architecture

In addition, SOA is also defined as a term used to describe a way to implement enterprise architecture. SOA starts with business analysis, to identify and structure individual business areas and processes. This allows defining services, which are implemented in the individual area of business functionality. In SOA, technical services are the same as business specialists or business process functionality [1].

III. SYSTEM DEVELOPMENT

System development methods used in the development of integrated pharmacy information systems refer to the stages in the provisions of SDLC (Systems Development Life Cycle) using the waterfall model or Linear Sequential Model [7]. The waterfall model in Figure 2 approaches systematically and sequentially from the stage of system requirements and then goes to the stages of analysis, design, coding, testing, and maintenance.

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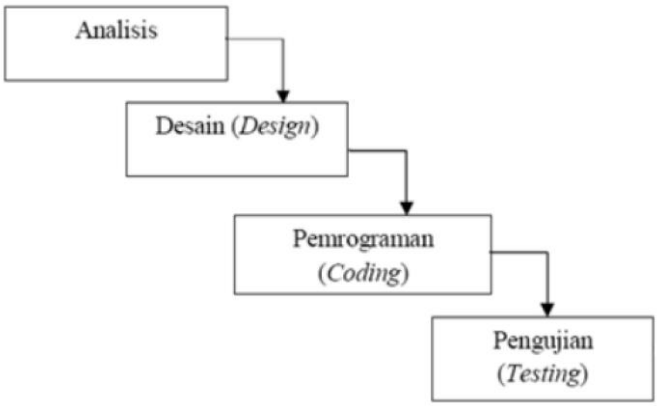

Figure 2. Waterfall model

The explanation of the stages of the method of developing this system is:

A. Requirement Analysis

This study intends to obtain an overview of information about pharmacies and drugs. The analysis is done to obtain a description of the system that will be made. Stages of analysis are divided into two, namely functional analysis and non-functional analysis.

B. Design

This integrated pharmacy information system was developed with a functional approach model. In this case, the system design begins with creating a system architecture to be built, then proceeding with the design of the UML (Unified Modeling Language) and the design of the user interface.

C. Coding

Programming is an implementation process of system design and modeling. The design must be translated into a language that can be understood by computers using a programming language. Programming is done using the PHP language with the Code Igniter framework, J2ME, and VB.NET. The database used is PostgreSQL and MySQL.

D. Testing

Tests in this study are testing web service services and functional testing systems using black-box testing techniques. Web service testing is done by using web service testing tools, soapUI software. Testing this web service is done by entering input parameters and seeing the results displayed whether they are as expected. Furthermore, the next test is the black-box testing technique that focuses on the information domain of the software, by carrying out a test case by partitioning the input from a program by providing in-depth testing coverage.

IV. System Requirements Analysis

At the stage of the system requirements analysis, an analysis of information has been obtained from various existing information systems. The functional analysis is an analysis of system functionality described in UML. A complete explanation of system functionality as follows:

- The system provides facilities for ordering drugs in an integrated manner.
- The system provides booking confirmation facilities.
- The system provides booking payment facilities.
- The system provides payment confirmation facilities.
- The system provides order delivery facilities.
- The system provides booking reporting facilities.
- The system provides integrated drug stock check facilities.
- The system provides a facility for member registration.
- The system provides member management facilities.

Furthermore, non-functional analysis is an analysis used to find out the elements that interact with the current system. The non-functional analysis of the system, namely users, is the party that uses system facilities. There are three users, namely visitors, members, and administrators.

V. System Architecture

Integrated pharmacy information system software is a pharmacy information system that is integrated with various different systems development platforms. These differences include used programming languages and databases that are used as back-end development. In this study, the system was implemented based on the web, desktop, and mobile. The web-based system is used by members as a media for ordering drugs between connected pharmacies. The desktop-based system is used by members to view drug stocks. A mobile-based system is used by visitors who want to see drug stocks in all connected pharmacies. An overview of the integrated pharmacy information system is presented in Figure 3

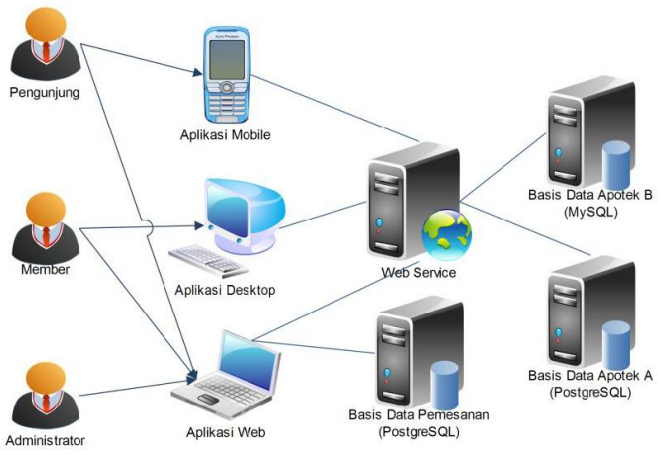

Figure 3. Interaction between user and application

The database owned by the pharmacy member is integrated with the medium of the web service. The web-based system uses PostgreSQL. Furthermore, the web-based system

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consumes a web service to retrieve drug data and stock in each connected pharmacy database.

VI. CLASS DIAGRAM

Class diagrams or class diagrams describe the structure of the system in terms of defining the classes that will be created to build the system. Classes have attributes and methods. Attributes are variables owned by a class. Operations or methods are functions that belong to a class.

In this system, there are several classes that are related to one another. The class structure of this integrated pharmacy information system in detail and in more detail is presented in Figure 4

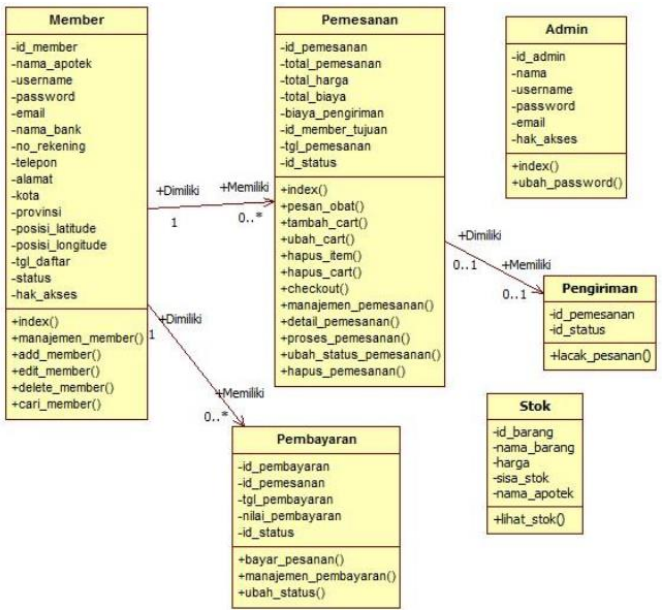

Figure 4. Class diagram of an integrated pharmacy information system

VII. INTERFACE DESIGN

In this section, we will display the design of the integrated pharmacy information system application interface. The application created has three interface models, namely the web-based application interface, desktop-based application interface, and mobile-based application interface.

The web-based application interface is accessed by means of a web browser. The desktop-based application interface is accessed through a desktop application. While the mobile-based application interface is accessed from J2ME applications from mobile phones that support Java mobile technology.

The interface design of web-based applications is presented in Figure 5. The web-based application design interface consists of headers, navigation, counters, and footers. Navigation is located on the left while displaying content is on the right. In the header section, the logo is placed on the system.

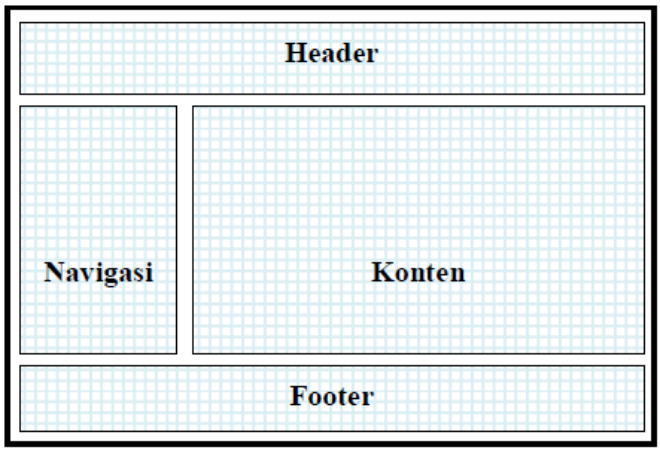

Figure 5. Web-based application interface design

The display of interface design for desktop-based drug search applications is presented in Figure 6.

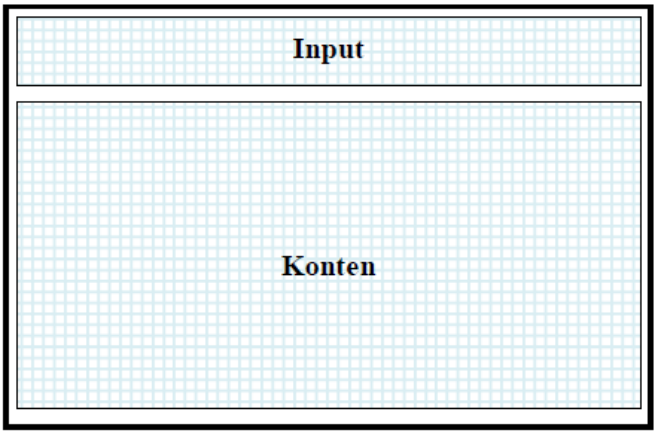

Figure 6. Desktop application interface design for members

In VB.NET-based desktop applications that are used by members to search for drugs, there are two main parts, namely the input section to enter drug search parameters and the content section to display drug search results. This application will use a web service to search the database member information system integrated pharmacy.

In J2ME-based mobile applications that visitors use to access drug information and stock information, there are three main parts, namely the input section, the content section, and the navigation section. This application will use a web service to access drug stock information. The display of interface design for mobile applications is presented in Figure 7.

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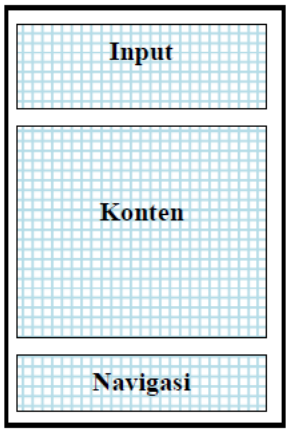

Figure 7. Mobile application interface design for visitors

VIII. System Implementation

The results of the design and design of an integrated pharmacy information system, implemented through web, desktop and mobile applications using the Windows 7 32 bit operating system, Mozilla Firefox 5.0.1 web browser, Apache 2.2.14 web server, PHP 5 programming language, Visual programming language Basic .NET, Java 2 Micro Edition programming language, PostgreSQL database, MySQL database. The next stage for the implementation of an integrated pharmacy information system, the database must be active. Furthermore, if the PostgreSQL database service is active, a status message will appear that looks like in Figure 8.

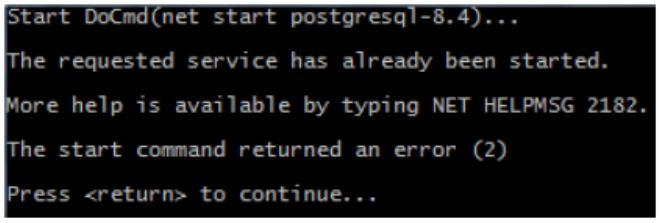

Figure 8. Information on the PostgreSQL service is active

Furthermore, if the MySQL database service is active, a status message will appear that looks like in Figure 9.

Figure 9. Information service of in an active MySQL

IX. Web Service Implementation

Integrated pharmacy information system uses a web service with the name "Integrated Farm Pharmacy Service Like". Details of the web service services that have been implemented are presented in Figure 10.

Figure 10. Integrated pharmacy service web service

A. Login Implementation

In the MVC design (Model View Controller), the controller file is first called, which then calls the model file displayed with the view file. The login page is the first page displayed to users when accessing a web-based integrated pharmacy information system. This page is used for system user authentication processes. There are two pages for login, namely a page for member logins and a page for administrator logins. The following is the listing code of the page for member logins as shown in Figure 11.

```
class C_Login_Member extends CI_Controller {

    function __construct() {
        parent::__construct();
        $this->load->model('m_login', '', TRUE);
    }

    function index() {
        if (($this->session->userdata('login') == TRUE) AND
            ($this->session->userdata('hak_akses') == 'member')) {

            redirect('c_awal_member');
        }
        else {
            $this->load->view('login_member');
        }
    }
```

Figure 11. Listing Code Login Member

The display of the member login page as presented in Figure 12.

Figure 12. Display member login

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B. Order Implementation

The process to display the ordering submenu is located in application/controller section/c_pemayaran.php. The ordering submenu provides drug ordering facilities. Before being allowed to use message_action function, the system first checks whether the user has a member status. If it is true, the user can use the message function <medication. In the order process, the system calls a web service. The function that is called is getInfoObatPilihLokasi (). The following is the listing code of the page for ordering drugs as presented in Figure 13.

```
function pesan_obat() {
    if (($this->session->userdata('login') == TRUE) AND
       ($this->session->userdata('hak_akses') == 'member')) {

    $data['h2_title'] = 'Pesan Obat';
    $data['main_view'] = 'member/pemesanan/pemesanan';
    $data['form_action'] = site_url('c_pemesanan/pesan_obat');

    require_once(BASEPATH.'libraries/nusoap/nusoap'.EXT);
    $alamat_service="http://localhost/apotek_services/layanan_obat.php";
    $klien=new soapclient($alamat_service);
```

Figure 13. Listing code pesan_obat Function

The order page display as presented in Figure 14.

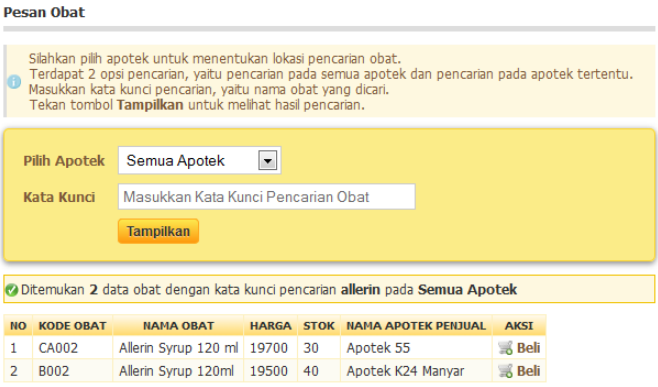

Figure 14. Display of drug messages

C. Implementation of Order Confirmation

The process to display the order confirmation submenu page is located in application/controller section/c_pemayaran.php. The order confirmation submenu provides a facility to view incoming order data and confirm existing orders. The function that was first displayed before confirming the order is the order management function. Before being allowed to use management_message function, the system first checks whether the user has a member status. If true, the user can use order management_function. The following is the listing code of the order management page as presented in Figure 15.

```
function manajemen_pemesanan($offset=0) {
    if (($this->session->userdata('login') == TRUE) AND
       ($this->session->userdata('hak_akses') == 'member')) {

    $data['h2_title'] = 'Manajemen Pemesanan';
    $data['main_view'] = 'member/pemesanan/manajemen_pemesanan';
    $uri_segment = 3;
    $offset = $this->uri->segment($uri_segment);

    $pemesanan = $this->m_pemesanan->manajemen_pemesanan
    ($this->limit, $offset)->result();
    $num_rows = $this->m_pemesanan->count_all_num_rows();
```

Figure 15. Listing Code manajemen_pemesanan Function

D. Payment Implementation

The process for displaying the payment page is located in application/controller/c_pembayaran.php section. Payment submenu provides a facility for making order payments. Previously the system checked whether the user has a member status. The following is the listing code of the payment page as presented in Figure 16.

```
function bayar_pesanan() {
    if (($this->session->userdata('login') == TRUE) AND
       ($this->session->userdata('hak_akses') == 'member')) {

    $data['h2_title'] = 'Bayar Pesanan';
    $data['main_view'] = 'member/pembayaran/bayar_pesanan';
    $data['form_action'] = site_url('c_pembayaran/bayar_pesanan');

    $this->form_validation->set_rules('id_pemesanan',
     'ID Pemesanan', 'callback_valid_pembayaran');
    $this->form_validation->set_rules('nilai_pembayaran',
     'Nilai Pembayaran', 'required|min_length[1]|numeric');
```

Figure 16. Listing Code bayar_pesanan Function

Payment page for the order as shown in Figure 17.

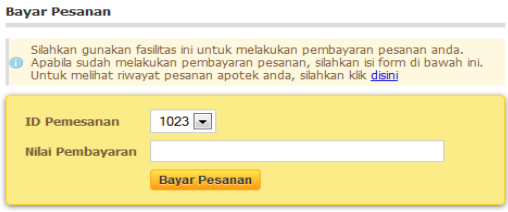

Figure 17. Display pay orders

E. Report Implementation

The process for displaying the report page is located in application/controller/c_laporan.php section. Report submenu provides facilities for displaying sales and purchase reports. Before being allowed to use the sales report function and purchase report function, the system first checks whether the user has a member status. If true, the user can use the sales report function and purchase report. The following is the listing code of the sales report page as presented in Figure 18.

```
function laporan_penjualan() {
    if (($this->session->userdata('login') == TRUE) AND
       ($this->session->userdata('hak_akses') == 'member')) {

    $data['h2_title'] = 'Laporan Penjualan';
    $data['main_view'] = 'member/laporan/laporan_penjualan';
    $data['form_action'] = site_url('c_laporan/laporan_penjualan');

    $this->form_validation->set_rules('tahun',
     'Tahun', 'required|min_length[4]|integer');
```

Figure 18. Listing Code laporan_penjualan Function

F. Implementation Showing Stock

The process to display the page showing stock is located in application/controller/c_publik.php section. Submenu displays stock providing drug search facilities. Page display shows the stock as presented in Figure 19.

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Figure 19. Display showing stock

X. CONCLUSION

After the research is successfully carried out, the conclusions that can be taken are as follows:

1) This study successfully developed an integrated pharmacy information system using Service Oriented Architecture and using an object-oriented approach.

2) This study successfully implemented Service Oriented Architecture using a web service.

3) This research successfully developed an integrated ordering system between different pharmacies, both different in terms of the location of pharmacies and pharmacy owners by applying the Collaborative E-Commerce concept. Implementation Showing Stock.

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