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Exploring the Usage of Information Technology for *Library Automation*

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Abstract

The basic objective of this research study is to provide a detailed perspective of current scenario of public libraries workings and procedures in Karachi (Pakistan) and propose automation with implementation strategy. The study elaborates on the needs of automated library management system components ideally packaging into an ALMS. Differences between available library management system(s) and proposed ALMS have been highlighted as well. This study recommends the development as well as implementation architectures, development technologies required human resources, and Infrastructure (i.e. servers, client machines etc.) for ALMS as a preferred system for public libraries in Karachi. In this study we have proposed a new model for public libraries that refocuses them on the vital task of knowledge management coherent within their communities by way of forming a hub for sharing and disseminating pertinent knowledge. A multi-layered architecture has been proposed for managing information on both local and global levels by creating a connection among multiple instances of system via internet. Statistical data collected by surveying thirty public libraries all over Karachi played a pivotal role in the proposed system design.

Different aspects of the system has been identified, quantified and grouped into robust and flexible modules to facilitate the common interactions with the application. The system incorporates modules as pluggable and/or reusable components using MVC design pattern to ease the process of adding, modifying, and/or deleting modules without affecting the integrity of the system. The system features an extremely fast NoSQL database for local storage for real time and offline search (while internet is down). All local databases are combined to form a global database to facilitate the passive users (book readers) of the system. The system also defines four different user-views to provide multi-level access of either the local or global database to its users. Since the horizon of technology is very fragmented, the system is designed to be extremely portable by using

Electron framework which enables the application to cover all major platforms Windows, Linux, and Macintosh which are most widely used Operating systems by Institutions.

Keywords: ALMS. Implementation Architectures, Development technologies, Infrastructure, A multi-layered architecture, Sample Surveys ,system Design, MVC ,NoSQL.

Introduction

Libraries are a stepping stone for the future as well as a bridge with the past. In the later part of the new century, the rapid progress made in all directions– political, economic, educational, industrial, technological and scientific, brought about a radical change in the primitive concept of library as a place for the protection and preservation of books for a few to a social institution for the masses. “Libraries have served people from every walk of life regardless of their profession, culture, language, gender or age. They are carriers of a civilization, and without them, the development of a civilization would have been impossible; they are hence the agent of change.” (Haider, 2007)

“In the ancient era , there was a system of recording and preserving human thoughts and ideas for future generations. This system or institution gradually came to be referred to by the term ‘library.’ The fundamental aim of libraries is to provide timely, accurate, pertinent, and reliable information for their users.”(Ebiwolate, 2010).

A number of different types of library exist that are distinguishable based on their users, collections, functions, and services. “Mostly, libraries are classified into five categories: (1) Academic Libraries (2) School Libraries (3) Special Libraries (4) National Libraries and (5) Public Libraries..” (ALA, 2017).

Our main focus in this research paper are Public libraries” which are now acknowledged to be an indispensable part of community life as promoters of literacy, providers of a wide range of reading for all ages, and centers for community information services.” (encyclopedia Britannica www.britannica.com .”They represent an indispensable link in the scientific system, while they also crucially support and ensure the advancement of knowledge thereby elevating the intellectual spirit of a society.” (Kinya, 2011). Public libraries play an important role in educating the society by acting as a means through which people get access to books outside their home. “They provide support to citizens who are jobless, underprivileged, and those that have health challenges. In addition, they impart knowledge and inculcate reading habits among children and adults alike (Mattern, 2014; Mcharazo, Kauaria & Lahti, 2012; Prabhjeet & Paramjeet, 2015). No other institution, public or private, does a better job of reaching people who have been left behind in today’s economy like the public library.”

Zickuhr *et al.* (2013) in a study of the value of public libraries in America observed that residents attest to the fact that public libraries play a significant role in their day to day life. They promote quality of life and deliver many services that would have been difficult to locate elsewhere. Most Americans confirmed that they have had numerous positive skills by virtue of their use of public libraries located around their communities. They also believe that public libraries have done a good job in adopting recent technologies. Summarily, public libraries

influence people in five major areas: education, social policy, information, cultural enrichment and economic development (Brophy, 2001)

During the past decades, developing countries like India and Bangladesh have shown increasing awareness of the need for developing and upgrading their libraries specially public libraries and resources as quickly as possible based on their importance in the growth of a country; but the situation in Pakistan is quite different.

Problem Statement

During the past decades, developing countries like India and Bangladesh have shown increasing awareness of the need for developing and upgrading their libraries and resources as quickly as possible based on their importance in the growth of a country; but the situation in Pakistan is quite different. It seems that public libraries in Karachi have not adopted the new technologies based on ICT for their management. The reason may be that no standard available library Management System is developed to meet their needs nor communication and internet facilities or infrastructure was developed and nor interest was shown due to lack of political will of the government at provincial or federal level. The manual management not only restricts our libraries' internal operation and usage, but also unproductive for national literacy enhancement, reading culture, civic sense and community development. In this study we have provided a detailed survey where it is mentioned that there is an overall decline in resources available at public libraries.

Objective of the Study

The primary objective of the study is to establish communication and coordination among all functional public libraries that work under the local government in a metropolitan city like Karachi. This research will primarily gather pertinent information from these libraries, and an attempt will be made to communicate identified problems to the concerned authorities. However now some improvement and technologies are being implemented in institutions libraries and universities.

Listed below are the technical objectives of the study:

- To highlight the shortcomings and mismanagement of the existing public library systems by doing need based analysis.
- To propose Automated Library Management System for public libraries operating in Karachi.
- To suggest cost effective solution for public libraries with improved and quality services.
- To find ways of promoting reading culture in society as a part of an extended library services along with on line services (Sangeeta Dhamdhare 2013)

Methodology

Research technique (Surveys) was carried out to collect data from public libraries of Karachi based on a structured questionnaire developed. In the investigation a total of 30 public libraries were identified in different districts/towns of Karachi. The researchers personally visited and monitored survey work of all public libraries and collected data accordingly.

Proposed Solution

We propose an automated LMS which should possess following functionality to address problems mentioned above:

1. The system helps librarians to store, retrieve, edit and delete books data along with the information about the readers who borrowed them.
2. Readers should inquire LMS about availability and other relevant information about books without having to visit the library.
3. The gathered information about readers through our system should be in such a managed form that it can be utilized to improve and predict behavioral patterns of the readers.

Keeping in view, the users and storage requirement, we will design our system with four major components:

- (1) Local Database
- (2) Global Database
- (3) Administrator's Endpoint
- (4) Librarian's Endpoint
- (5) Public Endpoint.

The Global Data Base is the centralized location which holds all the collection of individual libraries and is also served as main public access point. Rest of the details of proposed solution and methodology will be discussed ahead in Chap. No. 4.

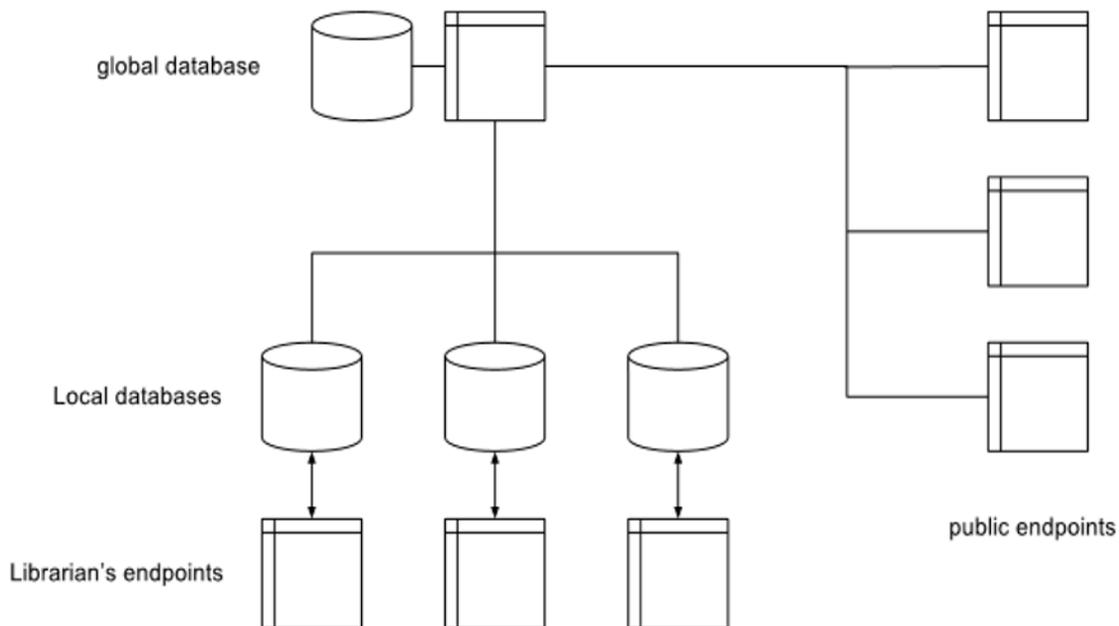


Figure 0. Overview of Proposed Solution

Contribution

So, what's new being iterated in this paper ;main question that needs to be answered? This work is only the beginning towards a lot of questions that are now arising with its full horizon. But the new finding and attempts which up to best knowledge are not clearly answered or available in literature are listed below:

- (1) Until now no solution exists for library automation that supports multiple platforms biggest worry of which is Windows Platform which is the most used OS ever.
- (2) Until now there is no online portal which provides combined view of libraries to perform search queries.

Literature Review

A review of literature related to this thesis shows that numerous studies have been conducted in Pakistan and abroad to examine the different aspects of public libraries, library automation, automated library management system and integrated library management system.

Khurshid (2000) has based his research on the facility of public library in Pakistan. It was a survey-based research and supported by the Technical Working Group. The survey was designed to visit 34 cities drawn from each provincial, district and tehsil headquarter. A detailed questionnaire was distributed to 169 libraries and the result concluded that there were only 128 local bodies which provided library facility in the country. There were 346 cities and towns in the country which did not maintain a proper library. The result of the survey interpreted that the services provided by these libraries were unsatisfactory, thus proving that the libraries failed to create a positive impression of the value and utility they were expected of. The strength, competence and performance of the staff, too, were unsatisfactory.

Similarly, Khurshid (1998) investigates the historical perspective of the movements of library in Karachi city emphasizing the Karachi Library Board that introduced the system of libraries in that city. The key components and the reflection of Education policy of 1972-1980 at Public libraries was discussed in this study. The finding of the study revealed the inefficiency of the services, resources and physical facilities of seven public libraries in 1975 and this accounted for a diminishing use of public libraries. Three phases were highlighted of the Karachi municipal libraries' development: (1.) 1947-1970 (2.) 1970-1978, and (3.) 1979-1987. Later, the status of Municipal libraries in Karachi in 1994 was also analyzed.

Haider(1998) has surveyed the development of public libraries before and after the freedom of Pakistan. The study focused on the advancements, at its best, has been piecemeal, and at its worst, non-existent. He identified that knowledge of indigenous needs and realistic approaches are important factors need to be considered for planning of libraries in order to get far more than before. For betterment of Pakistan's public libraries six factors are pointed out as vital for the planning process, which can also be helpful for other developing countries.

In Hanif (1992),it is suggested that libraries should be modernized, specially the public library, in two distinct direction; first, using the technology in library housekeeping, second, to change the

concept of the library- what a library is or is to be. On the basis of above concept, he divided the functions of libraries into three broad divisions.

- Collection and Preservation
- Dissemination of information and
- Provision of material to user for reading in the library premises as well as on loan for study at home.

Khan (1992) has corroborated that a public library is the masses' only free institution of education, but unfortunately, the public libraries of Karachi do not have a well-coordinated system for facilitating its users' needs. At the time of Jamshed Nusserwanjee Mehta, the first Mayor of Karachi and remembered as the maker of Modern Karachi, Karachi Metropolitan Corporation (KMC) is providing better facilities through museums, libraries, reading rooms, etc. In Pakistan, public library system has not received the reorganization and financial assistance it needs. It is not undisclosed that public libraries in Karachi are certainly not operating properly without ample budgetary support.

Haider(1980) investigates that in 19th century the massive changing occurred in the society. One of which was establishment of the Karachi Metropolitan Corporation. When Sir. Charles Frere was the governor of Sindh, he established the Frere Hall Library under his supervision and that was the revolutionary period of Sindh. After that further different libraries established, but according to study, there was lack of library resources that became the ultimate cause of libraries' down

Barber et al. (2000) "have reviewed in detail the case of new technologies to provide high value added services in the context of public libraries in Buenos Aires city and surrounding areas. The main results of the survey are: 1) The percentage of automated functions of libraries surveyed is- Acquisition (31.50%), cataloguing (65.80%), serial control (21.90%), circulation (28.8%), Reference (34.20%), and OPAC (26%); 2) 71.2% of units surveyed do not belong to library network; 3) 47.9% of units have an Internet connection; 4) 15.1% of libraries have their own website, 27.4% of libraries use e-mail for reference service; and 5) 32.9% provide online library catalogue with in-home access, 11% provide online library catalogue with Internet access, 17.8% have other catalogues and databases on CD-ROM. The study concluded with the remarks that the main deficiencies observed in IT services in the public libraries are lack of adoption of standard for information exchange and processing, use of database administrators instead of integrated library systems, lack of information quality control, and less use of information and communication technologies for service provisions."

Karisiddappa (1999) has discussed the areas of technological usage to carry out operations of library such as development of computerized bibliographic databases, bibliographic services via online, regional and national networking, and creating non-bibliographic databases, bringing the evolution and application of technology from conventional to contemporary age. To satisfy the increasing demands of the public the study also shows the functions of satellite based nationwide computerized communication network for e.g. NICNET, GISTNIC, and DISNIC. Finally, emphasis was made over the requirement of internet access and skilled professionals at public libraries.

Ramana and Kumar (1997) stresses the value of need- based planning and provided essential 43 plans in order to design and imply the information storage and retrieval process for the development of automations in Public libraries;

“1) It requires the financial support from funding agencies, talent, education, creativity, determination, management and above all vision on the part of the library professional and other support staff and

2) The professionals should get themselves trained and take the lead in operating the systems.”

Keenan et.al. (1981) have given a report of the details of the research project on Bibliographic Information Retrieval On-line services (BIROS). It was carried out jointly by Manchester Polytechnic and Lancashire County Library. The objectives of this project were to trace out the effect of the services provided to attain information about motivation and the reaction of staff and users to the services and to analyze the level of satisfaction from those services. The British library supported the experimental development of four public libraries’ online information services in order to appreciate this project. These libraries were namely: Birmingham, Liverpool, Lancashire, and Sheffield. The project resulted in the providing of set essential guidelines for the on-line services. This study revealed the following facts:

“1) An on-line service increases the demand for books and increases inter-library loans;

2) Much time has to be spent by the staff for training, updating knowledge, for practicing search skills, and for actually carrying out searches; and

3) The type of end-users attracted to this service depended on the nature of services offered.”

Chatterjee and Das (2015) provide an overview of library automation and the changing scenario of library management. The influence of ICT has changed the library operation and its functionality to a faster and more efficient mode. Users need not frequent from one shelf to another in search of a document; instead, they receive it simply by sitting in front of a desktop. Automation has reduced manpower. In this article the authors discuss the concept of automation, its requirement and the various components which help to automate library. Some software commercial software package also enlist which are available for automation purposes. The authors, moreover, also discuss the difficulties related to the library automation program.

Muhammad et al (2014) reveal in their study the present level of automation in the libraries of selected Management institutes in the city of Aligarh. Questionnaire and informal interviews was used for this study. They selected samples through the stratified sampling method, collected the data randomly and examined the questionnaire. The finding shows that three of four libraries are moderately automated, except Al-Barkaat, which is fully automated. Seventy% of librarians consider that services of libraries are improved by automation, while eighty-five% of users admit that modern automated system are far better than the manual systems used traditionally. Three of the four libraries lack qualified and trained human resources to manage automation.

Haider (2007) has investigated that hurdles in application of automated library management system in Pakistan’s libraries are systematic planning of automation, software and hardware collection, absence of standards, financial restrictions and most importantly, lack of enthusiastic

and competent human resource. It is enforced that for the development of information policy, increasing technological awareness, and counseling and for betterment of staff, organization of users' educational programs keen attention must be given and emphasized the planning by each library regarding automation of library operations.

Kashyap's (2006) book is about the designing techniques of computer-based library and information systems. The objective is to give the accounts of systems theory to support one examination and design, also to promote libraries with information technology based systems, to outline the methods for conducting system study and explaining the usage and implementation of systems analysis and strategy tools and methods. The book provides system philosophy, system classes and their characteristics, system concepts, system analysis and design methodology.

Similarly, Tiwari (2002) notices the automation in the 90s as a highly conflicting matter, in terms of resources, skills and abilities. Library automation has been drastically changed in the past years, which started with a individual task and has grown by including the use of computing and telecommunication tools. Today, there is library without walls and that utilize technological advancements to promote the services, resources and relationship present between libraries and resources universally. This virtual library, earlier referred to as the library without walls, therefore, is a reality.

Based on this, the future is assumed to be providing services not only to experts of it but will include information kiosks; having access on all information even with minimum or no knowledge of computer. Information scientists are supposed to develop human computer interfaces, while library scientists will be managing the resources accordingly.

Dilroshan (1998) studies and highlighted that library automation is just the first step. Understanding and coping with upcoming changes and developments in information and communication technology is vital. Huge investments over the collections and services of library could be lost, if the libraries got unable to face the challenges successfully.

Malik (1995) stated that In 1980s the automation in libraries of Pakistan was introduced and a number of libraries have continued to be automated since 1987.

In Sheeba and Jayaramam (2017), discussed the goals, objectives and requirements necessary for the advancement of tools and techniques for library in a developing scenario. This paper also explains the different steps of software selection.

Buragohain (2017) discusses the current status of public libraries in selected district libraries of Assam. The tremendous development in Information Communication Technology and their application in the libraries have opened a new door for the libraries and users alike. In the age of Information Technology, there is a significant change in the methods and techniques of seeking the information and way of information dissemination, on the other hand. The Public Library System is a type of information system which allows the information seeker to use the resources of its end user. But unfortunately, the public libraries of Assam are not fully automated due to a lack of efficient IT infrastructure as well as inadequate library staffs. Therefore, theses public libraries are unable to satisfy their users.

Maureen and Blessing (2011) provide a framework for the designing of automated library management of state universities, Nigeria. The authors stated that this research would support

university libraries to keep a track of all transaction perform by securing library user's information, as well as correctly locating library material easily, and tracking of charging and discharging of material. The findings were used to design an ALMS for Delta State University in Nigeria.

Matoria (2007) describes the status of library management system, e-Granthalaya, for public libraries in India. This was the efforts of the Indian government's National Informatics Centre (NIC). The study focused on the comprehensive deployment of this software at a national level along with its potential and challenges.

Depending upon the agreement of authorities of libraries and state, funds and infrastructure the study is implemented on such factors. Also, the understanding of the upcoming challenges by the NIC is given in the scale and scope of the deployment of *e-Granthalaya*. Through an infrastructure deployment phase, a "single window access" is provided by national efforts following a service integrated phase: both of these are considered in tandem with local situations and technological advancement. The final product is proposed as a web-based online library service that helps to connect public libraries of India and other integrating services of library at a single window access. The authors identified the key elements highly required for better orchestration of providing funds, system's acquisition, data entry of catalogs, hosting and etc. The project will be beneficial for various groups of libraries of India as a proposed model for automating, networking and federating of resources.

Survey Design , Analysis and Interpretation of the Data

Karachi city is the capital of Sind which is administrated under Local Government System. It is crucial to understand the administrative hierarchy of Local Government as it impact the sole infrastructure of public libraries. The Karachi Local Government System consists of the Karachi Metropolitan Corporation(KMC) headed by the Mayor And Deputy Mayor which is subdivided into six District Municipal Corporations (DMCs) each headed by a Chairman and Deputy Chairman. The districts or Zila of the Karachi Local Government are, as under Sindh Local Government Act of 2013 are (1)District Central (2) District West (3)District East (4) District South (5) District Malir (6) and District Korangi

1.1 The survey of public libraries has been performed to understand and analyze available Intellectual resources, Human resources, Financial resources, Library Sections, Technical Management of library holdings (Cataloguing and Classification), available Services and IT facilities. Intellectual Library resources means total holdings and asset which include Books, News Papers, Magazines, Audio Video Cassettes and Manuscripts. Human resource means the employed staff by provincial and local government for running public libraries. Financial resources represent the individual budget allocated to each library by government. The Existing Library Sections are Acquisition, Circulation, Reading rooms, Reference Sections, Periodical Section, Technical Section, Children Section, Computer Section, Research and Rare book Sections. It has been observed that least IT infrastructure exist in libraries which affect the management and service quality and automation in public libraries as a whole. In this survey, all existing thirty public libraries were visited. All the libraries are ordered according to lexicographic principle for identification purpose and thus are assigned numerals from 1 till 30 as shown in

1.2

1.3

Table . Among those 30 public libraries, there is only one library namely Liaquat Memorial Library which works under the administration of Sind Provincial Government. Three libraries: Frere Hall library, City library and Faizee Rahamin Art gallery Library are working under KMC. All other libraries work under DMC (DMCs). The administrative flow of libraries is shown in Figure _2..

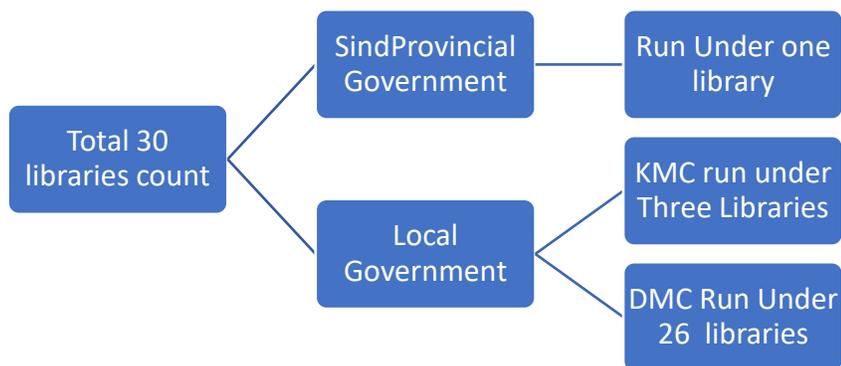


Figure 2. Administrative flow of Karachi Public Libraries

Table 1 Lexicographic Ordering of Karachi Libraries

CODE	NAME OF THE LIBRARY	TOWN	Year
1	Akhter Colony Public Library, Akhtar colony	Jamshed town	1977
2	Al Huda Library	Liaquatabad town	1978
3	Allama Iqbal library	Jamshed town	1968
4	Allama Shabir Ahmad Usmani Library	Liaquatabad town	1971
5	Central library, Korangi	Landhi	1968
6	City Library	Kmc	1989
7	Col Muhammad Khan Library	Gulberg town	2002
8	Fyzee Rahamin Art Gallery Library	Dmc	1991
9	Frere Hall Library	Dmc	1865
10	Fatima Jinnah library	Landhi	1986
11	Frere market library	Saddar	
12	Hasrat Mohani Library	Liaquatabad town	1975
13	Gulshan-e-Iqbal Library	Gulshan	
14	Iqra library	Landhi	1984
15	Jigar Muradabadi Library	N. Naziamabad town	1997
16	Liaquat Memorial Library (public reference library)	1950; transferred to Sindh Govt	
17	M.A. Jinnah Library	Korangi	
18	Maulana Muhammad Ali Johar Library	Landhi	1981
19	Molvi Abdul Haq Library	Landhi	1983
20	Mufakir-e-Islam library	Korangi	
21	Naseerabad Public library	Gulberg town	1983
22	Nawab Khawaja Muhammad Shafi Delhvi Library	Jamshed town	1999
23	Nazeer Hussain library	Korangi	
24	Nishter Park library	Jamshed town	1988
25	Prof Karrar Hussain Library	Liaquatabad town	1977
26	Sehba Akhter library (former children's library)	Liaquatabad town	1970
27	Shah Faisal Shaheed Library	Shah Faisal town	1990; closed
28	Sir Syed Ahmed Khan Library	Landhi	1982
29	Taimuria Public Library	North Nazimabad	1983
30	Shuhda-e-Haq Pubic Library (closed)	Malir Town	closed

Intellectual Library Resources

According to survey findings, Liaquat Memorial Library has maximum collection of 1,71,172 (approx. 2 Lacs) books among all thirty public libraries of Karachi. This figure is helpful in discriminating the status of provincial libraries and local government libraries i.e. KMC and

DMCs. This difference can be realized from the fact that all 26 local libraries collectively hold 2,20,066 books (approx. 3 Lacs). The strength of library holdings is shown in fig-3.

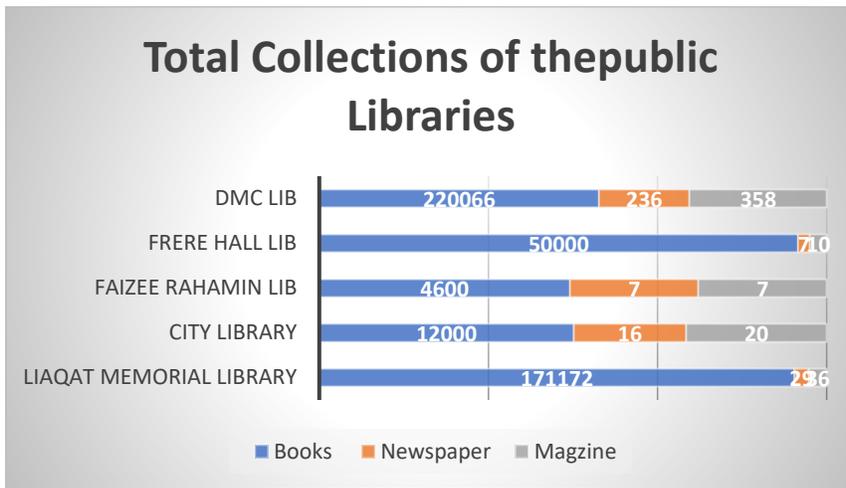


Figure- 0 Total Human Resource Collection of Public Libraries of Karachi

We also gathered information about the library staff employed under local government and categorized them as Professional, Semi- Professional and non- Professional. Here professional represents skilled and professional librarians as per library system standards all over the world. His responsibilities include Preparation of budget, purchasing of material, Classification, Cataloging and other technical stuff. Semi Professional are trained staff to perform day to day library functions for e.g. data entry, shelf reading, assist readers in localization of user desired material and book. The rest of employed persons would be considered as non-Professional library employ. The Professional staff can be considered as a measure of quality service for improved library services. The currents statistics of employed persons in Karachi libraries is shown in

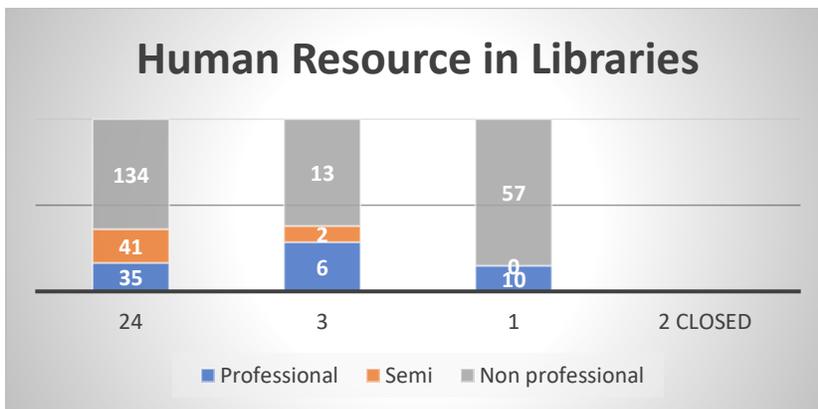


Figure 4 Existing Employed Human Resource of Karachi Libraries

Financial Resources

Finance is the backbone of any public library. Library managers need to control the operations as well as monitor and manage the finances of the institution. Public library financial activities involve the job of managing funds, budgeting, and controlling costs. It also involves the growth of assets. Public libraries get funds from the following sources national funds that are distributed to province, The Local Government OR Municipal Corporation allocate the Budget to public libraries. In Karachi, Pakistan Provincial Government Finance Provincial Library and Local Government Finance KMCs and DMCs Libraries. We gather yearly statistic of allocated budget from the local Government offices Budget Book. Fig- 5 shows that the allocated budget is slowly increasing in an exponential way with an average of 200 million per district.

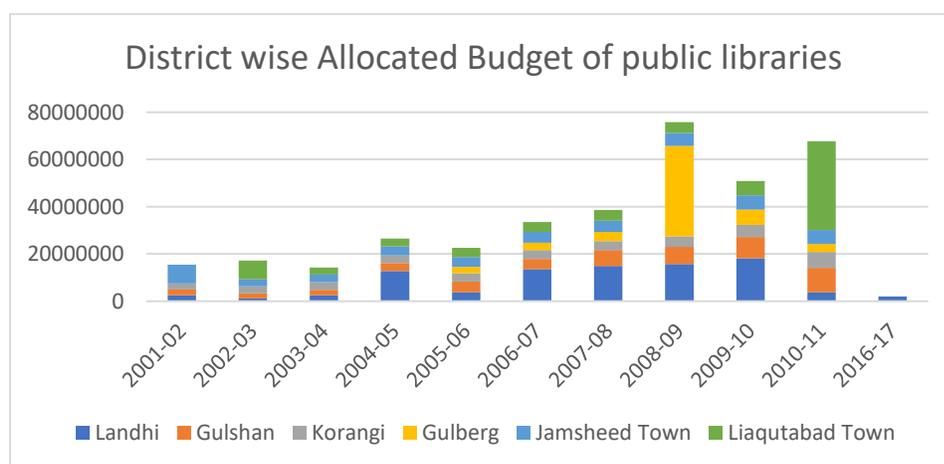


Fig 5 . Annual District wise allocated Budget for Public Libraries

Services Provided by Public Libraries

Error! Reference source not found. reveals the ratio of services provided by the public libraries of Karachi to their users. Only Liaquat Memorial Library does not allow the borrowing facility to their users because it is a reference public library. It cannot be ignored that Liaquat Memorial Library and Taimuria Public Library have a collection of rare books. Among out of 30 libraries 70% libraries allow the borrowing facility to their user and 80% libraries provide reference facility or ask a librarian services and only 2% libraries provide Selective dissemination information service (SDI) it is the most important special services of public libraries with the help of this services public libraries provide selective information to their selective user

IT Facilities

Survey shows that total Six libraries have of computer peripheral in the libraries. Most of the libraries have no equipment. Only Central Library, Korangi, have 4 computers for their users and one printer, while Faizee Rahamin Art Gallery Library and City library also have one computer and one printer, Gulshan e Iqbal Library one and Molvi Abdul Haq Library (Now E-Library) have 9 computers for their user. Four Public Libraries namely City library, Molvi Abdul Haq Library, Faizee Rehamin Art Gallery Library and Gulshan -e-Iqbal Library are using computer for various their house keeping operation in the library. Most of the libraries are using

manual system and there is immense need of automated library management system (ALMS) for public libraries of Karachi and Pakistan.

Survey Finding and Process Modeling

Librarians are the key users of LMS which are mainly responsible for providing right and timely information to Patrons. We identified a major automation gap by survey analysis of public libraries. We have observed that major work in LMS automation is Patron Oriented. There is an equal and immense need to automate various manual processes with respect to Librarians in addition to library Patrons. Major processes of an LMS are Acquisition, Circulation and Cataloguing. We in this research Identify and conceptualize different processes specially with respect to librarian. The purpose of conceptualization not only helps in process automation but also provide an advance and technical bird view of ALMS architecture.

Survey Findings

Through thorough study of public libraries of Karachi, it was found that the libraries handle all housekeeping operations manually. In the case of Acquiring books libraries send all request to the publisher or book seller manually which was so time consuming. In the collection development department also known as Acquisition section, books are registered by writing down the details of each book such as the date the book, accession number, author, title, publisher, year of publication number of copies on the accession register (a document used in maintaining the collection of books in the library). This form or method of books registration is inefficient. Staff from other departments take part in classification and cataloging of books due to shortage of professional staff. From the library user's point of view, the time taken to search for a book which may or may not be on the bookshelf or may not be correctly ordered, is time consuming.

Manual system is also involved in the processing of issuing and discharging book in the libraries. Students apply for membership card in the library. The application lists the terms and conditions of the charge agreement and requires student's signature. The student uses the card for issuing books for a week or 15 days. When students want this book for more periods then he or she bring this book and re-issue it from the library. In the case of losing book and late return, the student pays the fine as per library policy. Automated library management system will be helpful and to all public libraries to convert their manual process into automated system. Specially book order process, member registration, registration of new books, location of the book in the library section, easily issuance and return the books and update the library record and monitor the library services.

Conceptualization Framework

All the interactions of librarians have been modeled as processes which in turn comprises of many activities. The main purpose of process and activity modeling is to identify variables, events and interactions involved in an LMS for modeling of various LMS modules and information structure. To conceptualize, we categorize library activities into two main types depending on their effect on LMS. The activities which will affect the state of the library in terms of its collection and services provided to reader will be treated as *Active activity* while the activities which are simply request to outside world will be treated as *Passive activity* in an LMS. Active activities or group of such activities are valid candidate for Events or procedures of an ALMS. All the major processes,

variable, activities, their types along with time duration is listed in Table 2.1. A detailed account of the redesign of libraries can be found in Marilyn Mitchell (2007).

Acquisition Process

The Acquisition process initiates with patron need based survey on yearly basis as per rules. The demand of Patron will be verified by librarian to avoid unnecessary duplication of library material. He also uses international bibliographic tools such as publisher catalogue and national bibliographies for the validation of public demand. Such bibliographic tools also help in analyzing purchase cost of demand material. Once the demand is verified, the librarian is supposed to place order to vendors provided that funds for purchasing are available. For local material the order usually arrives in 2 weeks but for international demand, the shipment will take at least 4 weeks (1 month). The checking of received books and other library holdings is the mandatory responsibility of librarian. The processing of received items not only include entry in registers but also involves bill preparation which will be sent to finance department for audit purpose. The work flow model in Figure 6 shows the whole acquisition process from user request to bill preparation.

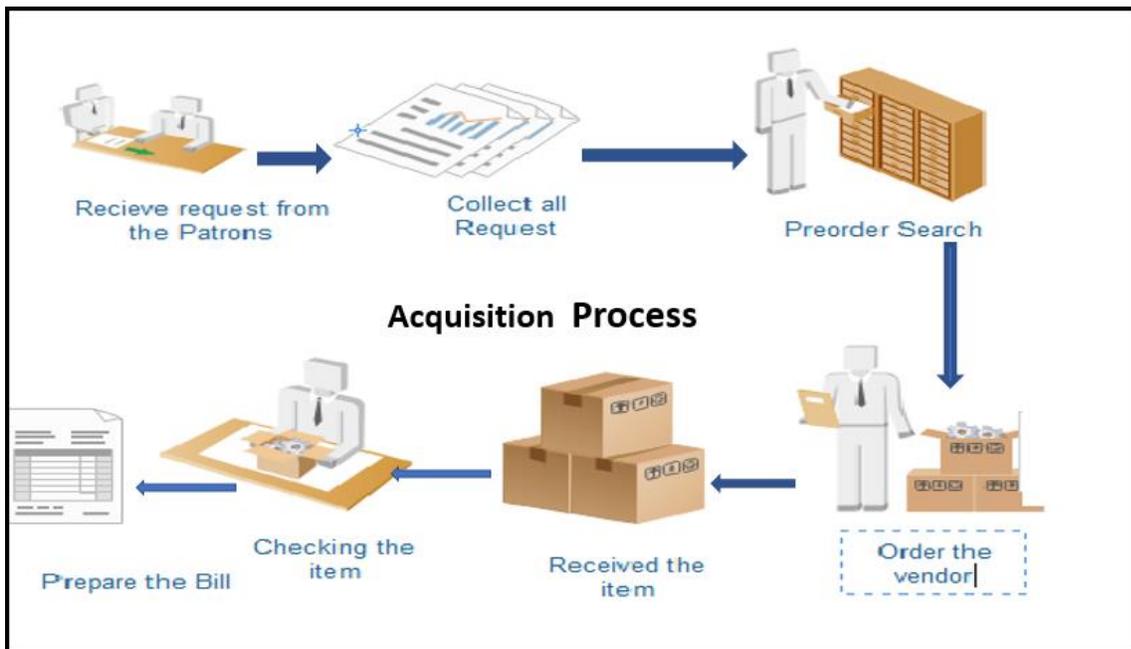


Figure 6 Work flows modeling of Acquisition Process

Among all activities of Acquisition process there come across certain other activities which are part of this process but will not affect the state of any LMS for e.g. request of quotation from vendors. Similarly order Evaluate activity involves invoice preparation which is simply send to finance department. All above discussion has been listed in Table -2, in summarized form.

Table- 2 Process, Activities, Variables and Time Duration

Process	Activities	Manual Operational Time	Update LMS	Nature of Data and Variables involved	Type of Activity
ACQUISITION	Observe Demand	365 days	No	Demand Variable	Active
	Analyze Demand	30 days	Yes		
	Check Fund	7 days	Yes	Decision Variable	Active
	Request Quotation	20 days	No	--	Passive
	Place Order	7 days	No	amount of Order	Passive
	Order arrival	60 days	Yes	<ul style="list-style-type: none"> • Delivery Lag Time • Cost of Order • Library Stock 	Active
	Generate invoice	15 days	No	--	Passive
CLASSIFICATION	<ul style="list-style-type: none"> • Bag of Words • Normalization • Remove Stop words • List strong words • Sort words • Assign depth • Build DDC No. 	30 minutes/book	Yes	Text / String	Active
CATALOGUING	<ul style="list-style-type: none"> • Enter Book Description • Search Book 	15 minutes/book	Yes	Attributes e.g. Accession No, Call No, Name of the Author, Title of the book, Subject Heading and ISBN, Place, Name of publisher and date of publication.	
CIRCULATION	Borrower Registration	6 Days			Active

	Patron Verification	5 Minutes			
	Book Issuance	30 Minutes			
	Return of Book	15 Minutes			
	Generate Overdue notice	30 days			

Classification

In Table-2 we have mentioned that classification of library holdings is first main technical job done by librarian. Subject wise Classifications an integral part of LMS as this process help to organize by library resources according to subject. Dewey Decimal Classification scheme (DDC) is the most popular scheme which are using almost all public libraries for organizing library material. According to DDC the classification number of any book comprises two parts. The first part represents the domain according to Dewey classification while the second part stands for specific subject of that domain for e.g. 003.3 is an example of classification number. When we look into DDC first summary we assign it main class Generalia, if the title of book is not listed in the standard subjects defined by Dewey for book organization. After assigning it to class Generalia, librarian supposed to read from second DDC summary where he or she identifies 003 as *Computer and Internet systems*. Once the subject is identified from second summary, the base subject can be fully identified from third summary. This number mainly serves as an access point for both librarian and Patron. For e.g. if a query comprises of text “Psychology of Boys” then the DDC generator must generate 155.432 where the 3-digit base number represents 3 levels of major subject hierarchy while the n digit fractional part represents subsequent deep levels of relevant subfields. In base number, UNIT place represent main class, TEN place represent the next down level of main class and similarly HUNDRED is one level more down of the that main class. The similar multilevel hierarchy is observed in relative part of DDC number such as 0.1,.01,.001 and so on.

Cataloging

Library catalogue is the most important tool for searching library material within a library it is also called as location tool and arranged in alphabetical order. It contains complete physical description of book Such as Accession No, Call No, Name of the Author, Title of the book, Subject Heading and ISBN, Place, Name of publisher and date of publication. All public libraries prepare catalogue cards according to Standard Anglo-American cataloging code- 2 (AACR-2 code). The librarian will enter physical description of book or holdings which user will access to find his desired book.

Circulation

Circulation process mainly deals with end users of public library. This will become the access point of all stake holder of library which mainly includes book readers and librarian. Circulation

process in public libraries starts with user registration. Once a user is registered he or she can request for book borrowing or periodical reading. As there are millions of items available in the library, it is impossible to locate the desired item without catalogue. The registered user search in catalog for his desired book, note down its call number and provide it to library staff for the issuance of that particular book. As we already discussed that all the library holding will be organized in a systematic manner using DDC numbers, the librarian will check the availability of requested item and if it is not already reserved or issued, the book will be given to user for reading. It depends on user that he will take book to home or read it in library premises. It is important to note that periodicals or serials are not taken to home as per library rules. The flow of circulation is conceptualized in Fig -7.

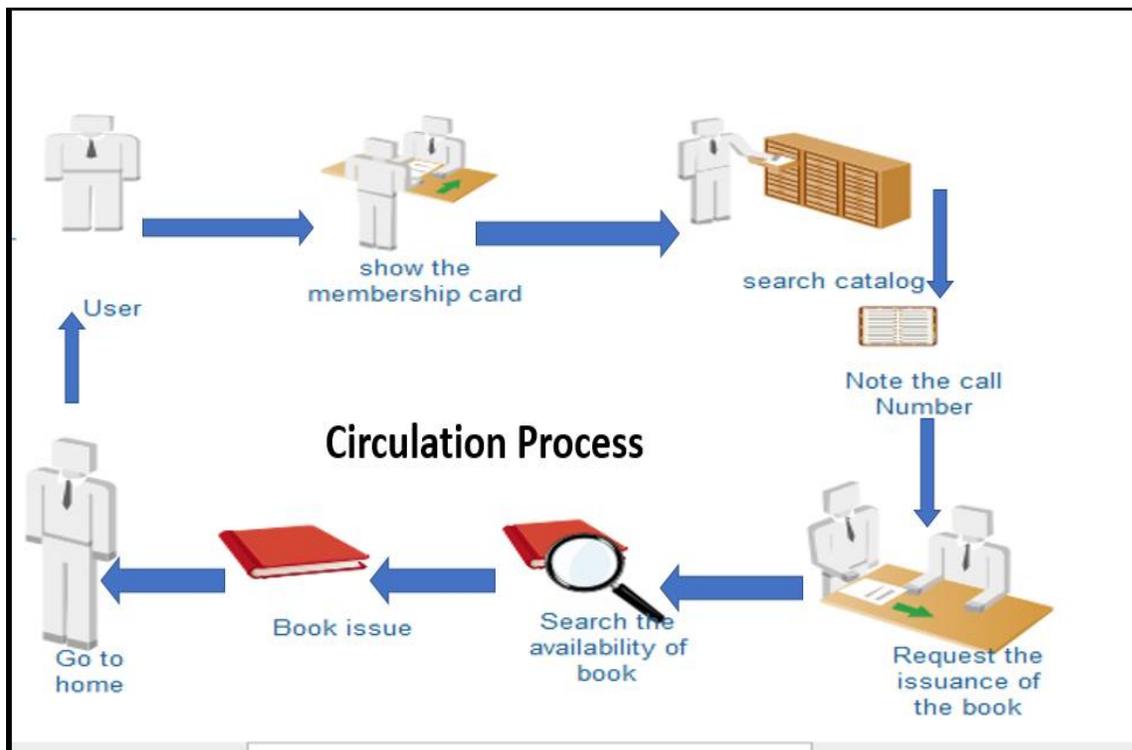


Figure 7 Work flow of Circulation Process

Designing and Mapping Architecture

The purpose of this paper is twofold:

(1) To map real time public library processes onto cost effective and flexible client server architecture

(2) To propose modifications in mapped architecture for future adaptability. To contribute to existing work on public libraries; we designed a web based Automated Library Management System name as PALMS: **P**roficient **A**utomated **L**ibrary **M**anagement **S**ystem. PALMS architecture is specially designed for need satisfaction of public libraries in developing countries with special focus on Pakistan. After detail analysis of existing system procedures and work flow (Naveed Sehar & Aqil Burney, 2017), it has been decided that proposed ALMS for public must able to manage and fulfill requirement of real-time communications by deputed Librarians in libraries, Home users, Visiting users and Book vendors. Since public libraries are not meant for commercialization and profit, the primary design goal of PALMS has been listed first to identify its non-functional requirements.

1.4 Design Goals of PALMS

- PALMS should offer lower development, maintenance, and integration cost to its stakeholders.
- PALMS should provide ease of access to its users
- PALMS should provide offline working capability to its users.
- PALMS should be robust enough to handle unforeseen scenarios; hence it should provide backup and restore features.
- PALMS should possess flexibility with respect to both software and hardware; thus should run on different operating systems.
- PALMS will incorporate the promotion of reading and research culture in region among communities at national and international level by social networking and event notification system
- PALMS will satisfy timely demand of readers via book recommendations based on user reading and research patterns.
- PALMS should provide contact point for vendors to facilitate acquisition and satisfy user access demand.
- PALMS should facilitate library staff via automated classification and cataloguing system.

In order to facilitate home users, visiting users, library staff and vendors to access PALMS data repository with varying ranges of access devices like mobiles and desktops, PALMS will provide data access for different levels of user needs ,see figure 8.

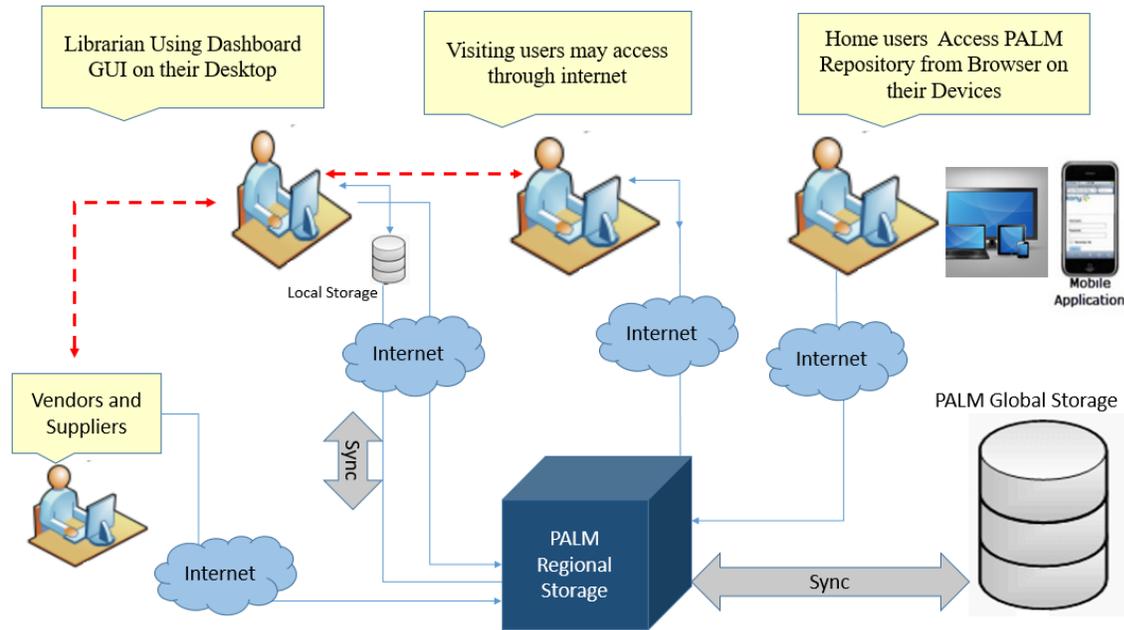


Figure 8 Different Levels of Users in Real Time PALMS environment

In proposed PALMS Environment, the technical library staff of a particular library can access PALMS regional Database for user management, handling acquisition, classification, cataloguing and circulation. Though creation of user facility is available to technical library staff but the user will avail searching facility only after synchronization of local database to regional database. PALMS permit home and library visitors to access library catalogue remotely through web. Pre-selected vendors and book suppliers can also be given privilege to access available books in library but the current system needs to mature in the sense that all the manual processes for e.g. quotation request, order placement, purchasing and billing processes will also be handled automatically in future systems.

PALMS Layered Architecture

The architecture that best meet the design goals of PALMS is multi-tier Client Server Architecture. The Client/Server model is best available option in contrast to purely centralized and peer to peer networking as it is cost effective, flexible, and speedy and provide better user interface. Figure 9 shows the proposed architecture with a client side, main server side and a global serve scheme.

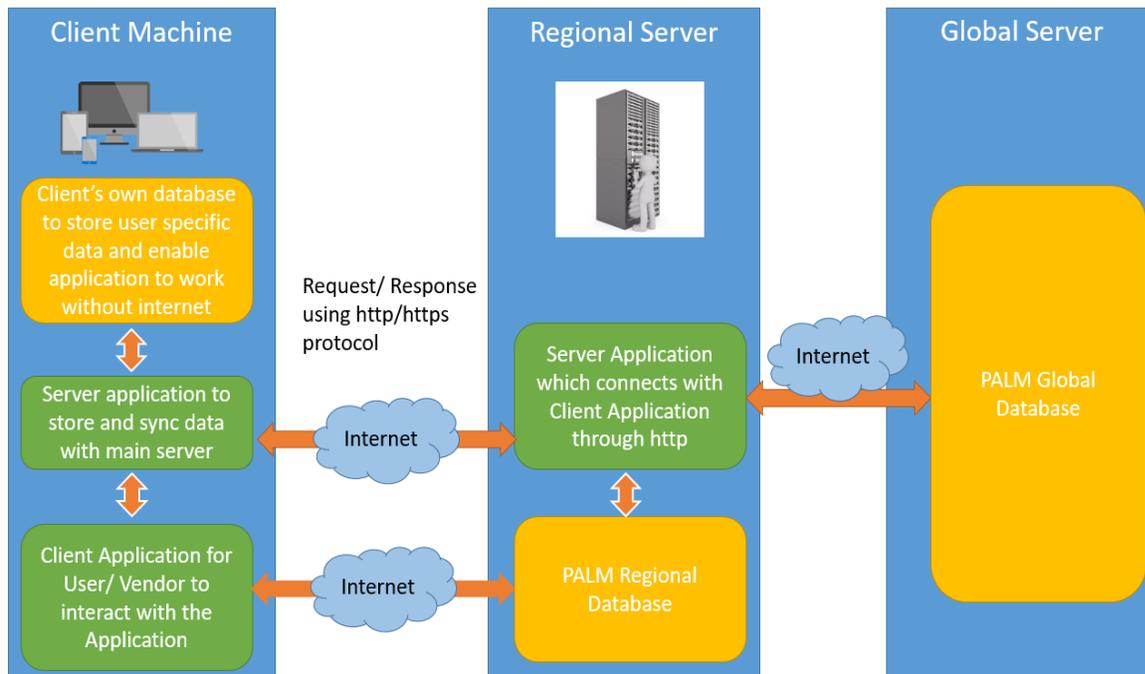


Figure-9. Proposed Client/Server Architecture for Public Libraries Automation

The client side of PALMS represents desktops, laptops, and/or mobile devices (smartphones, iPads) which are physically disbursed at different geographical locations in or outside of libraries. The client devices are given privilege to access a small backup database which holds its own library user, book, serial and vendor information so that the system remains accessible and functional in absence of internet connectivity (i.e. offline mode). Once internet becomes accessible; local device immediately syncs data with PALMS regional server (two-way sync). Every client device runs its own independent client-side application to interact with authenticated users i.e. TLS (Technical Library Staff). The public library visitors are considered as authenticated users in proposed architecture and thus will access regional storage through web applications from anywhere where internet connectivity is available (home, office, etc.). All end users including vendors and suppliers will access regional server to retrieve information regarding existing book records.

The regional servers play very important role as it is the central access point for all libraries for a region. In Figure 8 PALMS will store all the regional data of public libraries in a Regional Storage system, where regions are based on geographic basis instead of density of network traffic because every region should be given privilege to maintain its own data center. For e.g. recently UK has detached from Europe, it need its own data repository to be operational in the region with same previously available resources. Secondly due to this regional storage, security and privileges can be enhanced. The final component of system architecture is global Database whose main role is to sync all information from regional servers. This server will help in extracting user reading pattern and will help in generating reports at global level.

The architecture presented in Figure 9 can be transformed into its equivalent layered architecture of Figure 10 on the basis of human user interaction pattern. Whenever an interaction is initiated by a user on server side, it will promulgate into system through pre-defined user interface (UI)

within the Presentation Layer. During requested interaction fulfillment execution, it traverses through various layers. For instance, followed by presentation layer, there comes security layer whose main responsibility is to manage access patterns of system based on registered user's access rights. The registered user will invoke certain predefined procedures on client side to access and retrieve all stored information of books, serials and library holding from data access layer utilizing pre-written stored procedures, functional and/or plain queries. Data access layer on server side will provide requested information to registered user(s) from regional data storage. Data access layer communicates b/w server and client using secured protocol.

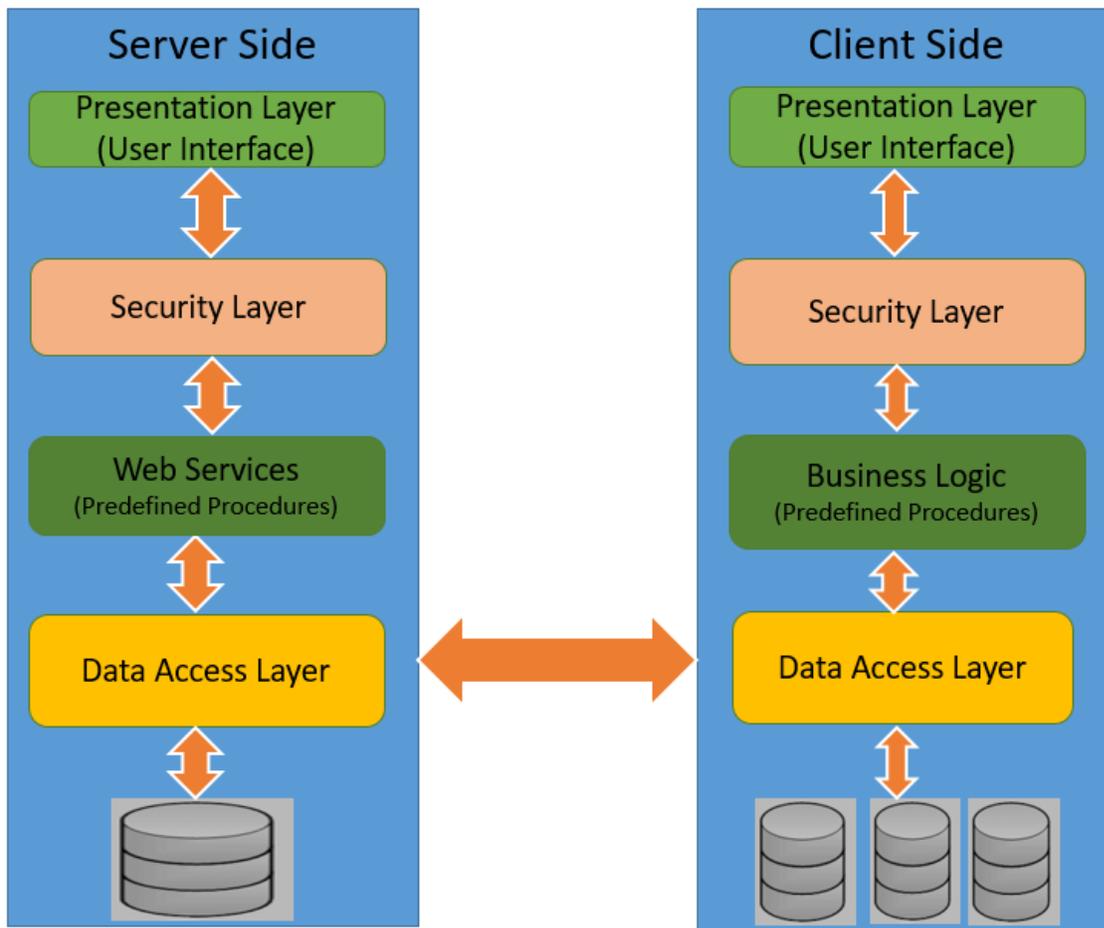


Figure-10 Client Server Layered Communication Mechanism

PALMS Application Architecture

The PALMS application architecture has been built on MVC (Model View Controller) Design Pattern to intact modularity, extendibility and ease of use. MVC provides developers with better code reuse and parallel development to make future changes and/or enhancements robust and easy. According to rule of thumb for best architecture, modifications must be minimum and all the future changes would be incorporated as insertions. Figure 11 represents MVC architecture design of

PALMS. PAMS have multiple modules to make application loosely coupled for example if Finance is taken out from the application, the rest of the modules must remain functional.

Each module might have Models, Views and Controllers whose definition is given below:

- Model:** Classes which holds data like value object classes
- View:** Front end of module
- Controller:** Contains business logic and bridge between model and view.

The main modules of ALMS are Login module, Book Catalogue Module, Serials cataloguing Module, Acquisition Module and Finance Module. Each of this module can access few subcomponents which are Globule, Formatter and Renderer. The responsibility of globule is to visualize a pop up bubble in case of any abnormal situation and thus any component can invoke this functionality. Similarly, formatter and renderer are considered as sub components of each model mainly for formatting, rendering and buffering of data.

Controller is responsible to execute proper function of a module, in response to user interaction with view any of component. Whenever an event occurs, it first invokes the respective event handler in controller. The event handler in controller, validate the event data and send its response back to controller in the form of yes or no. In case of 'yes', the controller invokes the corresponding module functionality. Every request from user and any response history is maintained in logger through PALMS controller.

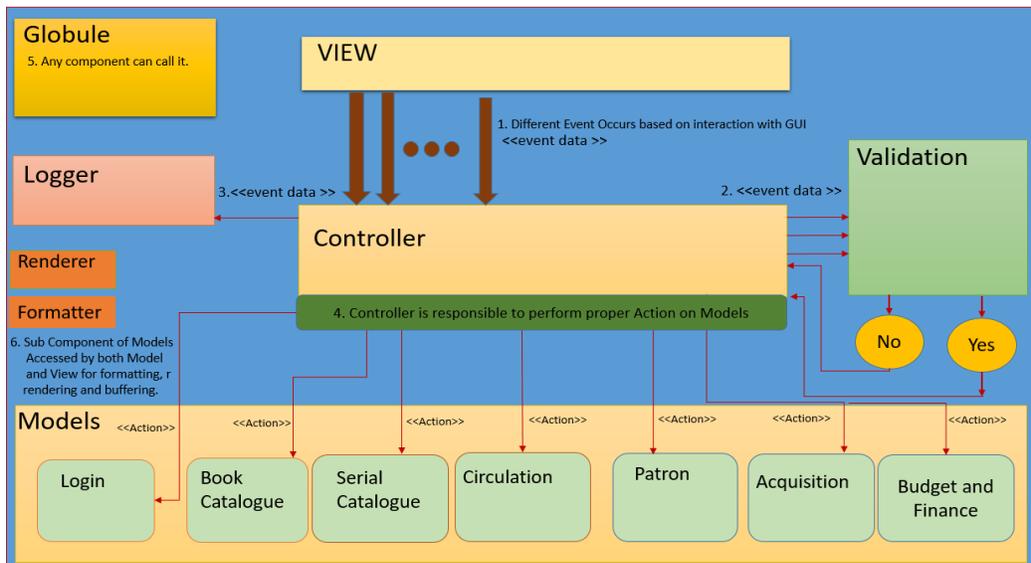


Figure 11 MVC Architecture of PALMS Application

1.5 PALMS Database Design

The system we are going to implement features a local database per library. For a database there are a plethora of options available to choose from each having their own set of advantages and disadvantages as shown in Table 3. Since our application does not need very complex API support

we can drop the SQL and MangoDB options. This greatly simplifies the installation process for the end user. They don't have to worry about starting services in correct order to make system work properly. Now we were left with two options SQLite and NeDB. After extensive testing we went for NeDB due to its faster query response and seamless integration with the system.

Table 3 Regional Database Design Choices for PALMS

Regional Database	Advantages	Disadvantages
MySQL, Oracle, SQL Server	Extremely flexible and can handle huge quantities of data.	Very large package. Requires standalone installation process. Complex API
MangoDB	Simple API, efficient for flat data structures. Very fast	Large package. This also requires standalone installation.
SQLite	Moderately complex API, lightweight than its superset SQL	Known issues with some technologies. Medium footprint.
NeDB	Simple API. Extremely efficient and very lightweight. Very small footprint	Can only handle moderately sized databases.

Since every library has its own local database, there must be a way to combine all that data into a single searchable repository, on which users can perform queries. The functional requirements of this database are different from local database. In this case we had a lot of options to choose from. The Table 4 given below describes some options. It is quite clear from the above table that we went with the NoSQL option for e.g. MongoDB.

Table -4 Global Database Design Choices for PALMS

Global Database	Advantages	Disadvantages
SQL	Very flexible, support for very large databases	Complex querying mechanism causes a bit of overhead
NoSQL	Really simple yet flexible ORM based querying system. Easy to swap storage architecture	Less mature than SQL but stable enough for our purposes

Design of Authentication Protocol

Since our system combines information from libraries to create a searchable repository. There is a need for an administrator to authenticate that information. We designed a simple authentication protocol to gather correct information from libraries which works as follows:

1. Request is made to the admin by a library/library user to be setup as registered source of information
2. Admin sets up the library/library user and assigns a unique ID and a password for authentication and registered access.
3. Library and library users have to login using valid credentials i.e. ID and password to access the PALMS and able to use the system.
4. Admin has the rights to revoke access for any library/library user at any time by removing the credentials from the database.

Conclusion:-

We did need based analysis and survey of all public libraries of Karachi and found an immense need of automation of all library procedures. To fulfil those automation needs we designed and developed a multi-tier, responsive and cross platform client server application based on recent technologies. The web based system is implemented using typescript language along with NoSQL database at local systems. Since software is an ever-evolving entity.

While designing this system we employed MVC design pattern and built it in a way such that new module can be plugged into it with relative ease. We kept its code open source so that whole community will be able to contribute to its development to fulfill the ever-evolving needs of the end users. , we propose that there is an immense need to connect all the public libraries using regional servers and dedicated data center.

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