



# Design and Implementation Options for Digital Library Systems

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**Abstract:** An institutional repository and digital library is a new concept for collecting, managing, disseminating, and preserving research works created in digital form by researchers in individual organizations and institutions. These tools can assist in narrowing the digital divide or the digital gap (through knowledge sharing) between the third world countries and developed countries which continues to widen between the information rich and the information poor. This in its turn can have positive effect as an instrument for sustainable economic advancement. The purpose of this paper is to shed light on design and implementation options for digital library systems. It aims at explaining the phases and stages required for designing a digital library system. The stages are explained in a simple way so that digital library developers can use these steps as guidelines for designing a digital library in the most effective way.

**Keywords:** Digital Libraries, Systems Development Life Cycle, Content Management Systems

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## 1. Introduction

There are a wide range of views in the literature as to the actual nature of digital libraries. The intention of this paper is not to provide the entire collection of definitions of the digital library, but rather a number of representative definitions. A variety of terms are still in use interchangeably such as electronic library, hybrid library, cyber library, and virtual library etc.

Arms, [1] views a digital library as “managed collection of information with associated services, where the information is stored in digital formats and reachable over the Internet”. Witten and Bainbridge [2] define the digital library as “a focused collection of digital objects, including text, video, and audio along with methods for access and retrieval, and for choice, and preservation of the collection”. A digital library has the following characteristics [3]

- 1) It is prearranged and managed collection of digital objects
- 2) It is available and obtainable over Internet or server
- 3) It is a universal information infrastructure
- 4) It supposed to offer service

The last point indicates that there is a difference between a digital collection and a digital library in that the last

mentioned supposed to offer service to end users. Therefore, a digital library is considered a collection of information objects and a collection of services that should be provided by the digital library.

“The definition of a digital library that came up in 1994 Digital Library Workshop emphasized that a full service digital library must complete all the necessary services of conventional libraries and also make the most of the known - well advantages of digital searching, storage, and retrieval [4] Leiner, [5] reports “There are a great and varied set of services, including services to support administration of collections and services to provide replicated and reliable storage and retrieval, etc.”

## 2. Design and Prototyping

This stage involved the design of an appropriate digital library system to assist in developing the services provided to end users. A quasi-experimental and system design approach could be used for this phase of the project.

This phase which called (design and prototyping) should focus on developing the digital library which suppose to suit the needs and requirements of target users and to provide services that most frequently required by selected users. The design should aim at not only providing access to, or retrieval

of, information, but rather to deliver electronic services to target users. At this stage, the developer should identify a number of collections—printed and/or digital— that are of importance to users, and a user-centered digital library system can be designed to meet user requirements and expectations. The first crucial step is to decide the objectives of designing the digital library. This step has to be considered early – before any further steps are taken.

The broad objectives of designing a digital library system might be as per the following:

- 1) Developing the standard of services presented to end users to enhance the level of research activities within the organization or the institution.
- 2) Using and putting into practice modern ICT to improve the current level of services and to solve the problems that the corporation or the organization face.
- 3) Producing a design for a low cost digital library that provides not only access to, and retrieval of, information, but also the services that are most frequently required by the users.

It is always significant to define terms, so it would be meaningful to begin first with the meaning of the word system. It is important to define this term because digital libraries are often considered as a system which according to Buchanan [6] is a set of logically related components (software, hardware, processes, people, data, information etc.) brought together to accomplish a predefined organisational goal which, in online systems, is achieved primarily through the processing of information”.

### 3. The Systems Development Life Cycle (SDLC)

There is a general agreement that there is no standard method for designing a digital library. Guidelines published by International Federation of Library Associations IFLA [7] for designing and building integrated library systems indicate that “even though there are many methodologies that address a project’s life cycle, the following four phases are generally accepted as standard: envisioning, planning, developing, and deploying or stabilizing”.

From the library’s perspective, the scope of the project is not a methodology but rather a definitive statement as to what the digital library is intended to do –what services it will offer to its users and what functions it will perform. Buchanan [8] states that the standard development lifecycle (SDLC) provides the common methodology and high-level operational guidelines within which software is developed and maintained. According to Dennis [9] the SDLC is the process of understanding how an information system can support business needs, designing the system, building it, and delivering it to users.

The SDLC typically consists of four fundamental phases or stages: planning, analysis, design, and implementation as demonstrated in figure 1. Each phase is itself composed of a series of steps. The discussion below looks at each of these stages in the context of the development of a digital library.

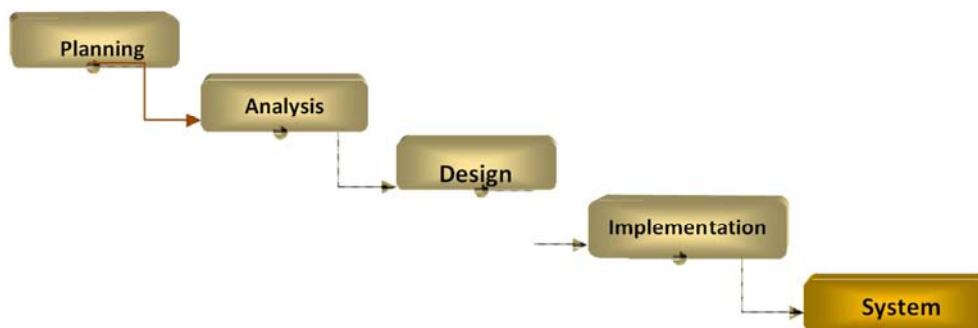


Figure 1. (SDLC) Phases.

#### 3.1. Planning Phase

The planning phase is considered a fundamental process of understanding why a digital library should be built and determining how it should be built. This process results in a vision document, which outlines the rational effort the project, the expected outcomes, the project’s feasibility, goals and constraints, opportunities and risks, and the structure of the project.

Questions examining economic, technical, and organizational feasibility should be answered at this stage e.g.

- 1) What exactly is the project?
  - a) Is it possible?
  - b) Is it feasible?
  - c) Can it be done?

- 2) If a digital library is built, will it be used?
- 3) Economic feasibility
  - a) Are the benefits greater than the costs?
  - b) If benefits outweigh costs, then the decision can be taken to design the library.
- 4) Technical feasibility
  - a) What is the current scenario of ICT within the organization?

The aforementioned questions suppose to be answered at this stage to determine the expected value of designing a digital library service.

Data should be collected in this stage of the research to gather information pertaining to information resources and services. Data and information collected can assist the developer in identifying how users would prefer to use

information resources and digital collections as well as understanding the implications for metadata and the requirements for designing the digital library.

Data gathered at this phase can help to identify the most required and frequently used resources, problems, etc. The output might be a list of the most frequently used resources and services as well knowledge as to how the new system should operate, in terms of the hardware, software, and available infrastructure. Identifying the frequently used resources and their formats, e.g. hard copy or electronic form, is important at this stage. Internal resources, which consist of E-books, reports, articles, research papers, and publications created by researchers within selected organization, should also be specified to assist in building the digital library in the most effective way.

### 3.2. Analysis

The analysis phase answers the questions of who will use the system, what the system will do, and where and when it will be used (Dennis) [10]. During this stage the researcher (developer) should investigate the current situation, identify improvement opportunities, and develop a concept for the new digital library (system). The next step is information gathering through interviews. The analysis of this information in conjunction with input from the data gathered led to the development of a concept for the new system. Interviews should have been conducted earlier in order to gather information related to existing ICT infrastructure, currently used IT applications, and information resources and services.

### 3.3. Design

Once the analysis was concluded the developer is then able to start designing the new system (digital library). The design phase or stage decides how the system will operate, in terms of the hardware, software, and available infrastructure. The first step in the design phase is to develop the design strategy, i.e. whether the system would be built by using commercial digital library software or would be developed using freely available digital library software. This led to the development of the basic architectural design for the system that described the hardware, software, and network infrastructure that would be used.

The question as to which software package to use is to be driven by the present state of the organization funding. In case of financial constraints, freely available software can be used for developing the new system (digital library).

### 3.4. Implementation

The final phase in the (SDLC) is the implementation phase, during which the system is actually built. Dennis [11] states that this stage usually gets the most attention because, for most systems, it is the longest and most expensive part of the development process. The first step in implementation is system construction, during which the system is built and tested to ensure it performs as designed. After designing the

proposed digital library, the prototype digital library, which has been designed should be tested to ensure that it performed as designed

## 4. Design Options

According to Dennis [11] “there are many different systems development methodologies, and each one is unique because of its emphasis on processes versus data and the order and focus it places on each (SDLC) phase”. Structured design is the first main type of systems development methodology, and rapid application development is the second major methodology.

Structured design includes water fall development in which each phase is completed before moving on to the next phase, with formal reviews happening in between [12]. The second type of structured design is called parallel development in which instead of doing the design and implementation in sequence, a general design is produced for the whole system and it is then divided into a series of distinct subprojects that can be designed and implemented in parallel. Once all the subprojects are completed, there is a final integration of the separates pieces and the system is delivered [13]. The primary advantage of this methodology is that it can reduce the schedule time required to deliver a system. The drawback of this approach lies in the fact that the subprojects are not completely independent; design decisions made in one subproject may affect another and the end of the project may require significant integrative efforts. Rapid application development is the second type of systems development methodology. It emerged in the 1990s and attempts to solve and address the weakness of the structured development methodologies. It includes the phased or staged development approach and the prototyping methodology. The phased methodology is a process whereby the application is delivered in stages, typically in order of functional priority. Standard design processes are followed until functional or technical specifications are complete for the application [14] Figure 2 demonstrates the phased or staged methodology.

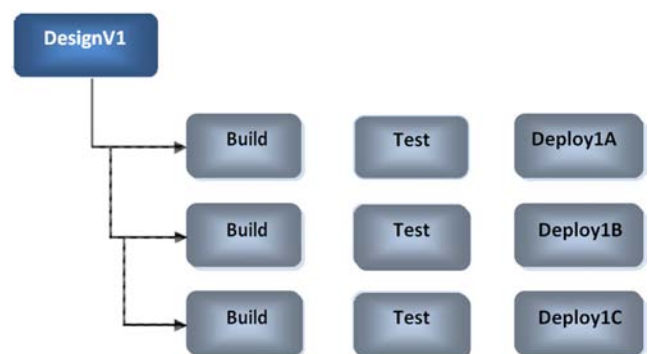


Figure 2. Staged methodology.

The major drawback to phased development is that users begin to work with systems that are intentionally incomplete.

The prototyping methodology performs the analysis, design, and implementation phases concurrently, and all three

phases are performed repeatedly in a cycle until the system is completed. With this approach the basics of analysis and design are performed, and work immediately begins on a system prototype. The first prototype is usually the first part of the system that the users will use. This prototyping approach can be adopted for designing the proposed digital library because the key advantage of prototyping is that it

very quickly provides a system for the users to interact with, even if it is not ready for widespread organizational use at first. The prototype digital library had to be evaluated by target users to get feedback on its functionality before its final installation and usage by the users. Figure 3, demonstrates the prototype methodology.

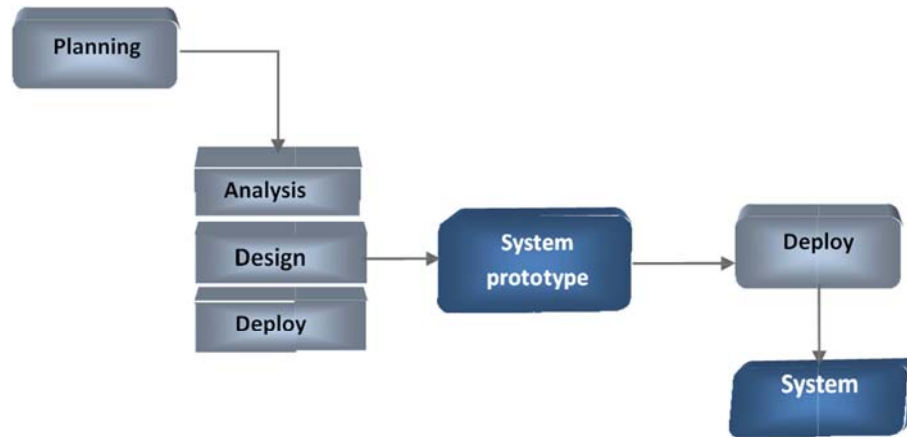


Figure 3. Prototyping methodology.

## 5. Design Flow Diagram

Designing a digital library usually comprises several phases [15]. The phases are shown in figure 4, which depicts the design flow diagram.

Each phase consists of a number of stages, each stage is subdivided into steps and each step contains a series of tasks. Thus the total work is broken down in to manageable portions. The stages and steps required for designing a digital library are described in details as follows:

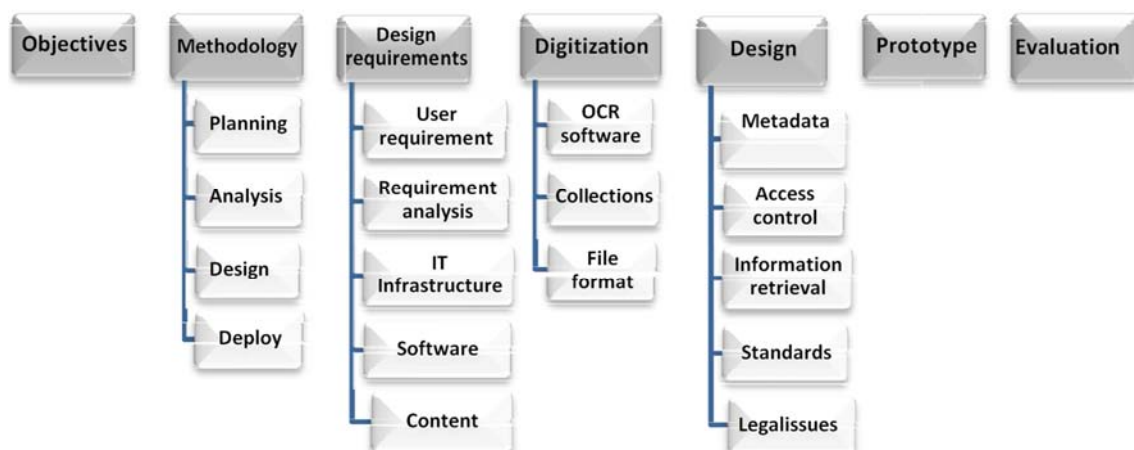


Figure 4. Design flow diagram.

- 1) Objectives
  - a) Determine the goals of designing the digital library
- 2) Methodology
  - a) Planning
  - b) Analysis
  - c) Design
  - d) Deploy
- 3) Design requirements
  - a) User requirements
  - b) Requirement analysis
  - c) IT infrastructures
  - d) Software
  - e) Content
- 4) Digitization
  - a) OCR software
  - b) Collections
  - c) File format
- 5) Design
  - a) Metadata
  - b) Access control

- c) Information retrieval
  - d) Standards
  - e) Legal issues
  - 6) Prototype
    - a) Testing the prototype
  - 7) Evaluation
- Testing digital library usability issues

## 6. Navigation Design

The navigation component of the interface allows users to enter commands to navigate through the digital library and perform actions to review information which it contains. The navigation component also presents messages to the users about the success or failure of his or her actions. According to Dennis [16] the goal of a navigation system is to make the system as simple as possible to use.

Most digital library software has a built-in interface which enables users to navigate through the digital library. Every digital library software has its unique navigation components, it is anyway necessary to customize the interface of the digital library in accordance with user needs and requirements. In particular there is a need to customize the interface to support features such as front page design, header for the digital library, collection icon, cover images, and interface look and feel.

## 7. Conclusion

Developing policy that positions information technology IT applications, and especially open source software (OSS), as part of a strategic plan for enhancing library services is a necessity. Many libraries especially in developing countries are suffering from being unable to deliver the required services to their users due to various barriers and obstacles. Drawing a policy that positions open source software as part of a strategic plan for improving library services is expected to assist in solving many problems, such as scarcity of electronic resources and absence of access to up-to-date information resources in addition to meeting the requirements and needs of the users. Open source software (OSS), in conjunction with open access (OA) can also be beneficial to libraries in the long run. For instance, open source and open standards can help libraries provide patrons

with easier access to OA materials and other resources, as open standards make it possible to create interoperable systems to access the literature in various OA journals seamlessly.

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