

Applying the Zachman Framework Data Dimension to Determine Content of a Digital Library

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Abstract

The paper describes how the Data dimension in Zachman Framework is applied to determine the contents in the design of a collaborative digital library for school projects. Zachman Framework abstracts the characteristics and features of the digital library based on six artifacts, Motivation, Data, People, Process, Place and Time, as well as explains their structures and processes from the perspectives of the planner, owner and designer of the digital library. Information obtained from multiple data gathering techniques helps to populate the requirements of these perspectives to ascertain the design details of the digital library's scope, business and system model. Planner's perspective of the Data dimension describes the digital library resources in various media types and format. The owner's perspective describes the subject scope, collection and resource criteria. The designer's perspective defines the metadata profile for the digital objects resource description. These perspectives are used in the implementation of a collaborative digital library of historical resources at the physical design layer, as well as in the modules and subsystems.

Keywords: Collaborative digital libraries; Zachman Framework for Enterprise Architecture; Digital library content; Digital library framework; Malaysia

1. Introduction

Formal frameworks are crucial to specify and understand clearly and unambiguously the characteristics, structure, and behavior of complex information systems such as digital libraries. Gladney et al. (1994) wrote that the broad and deep requirements of digital libraries demand new frameworks and theories in order to understand better the complex interactions among their components. Supporting this claim, the summary report of the Joint NSF-European Union (EU) Working Groups on Future Directions of Digital 1 Libraries Research recommended that "new frameworks and theories be developed in order to understand the complex interactions between the various components in a globally distributed digital library" (Schauble and Smeaton, 1998).

There are several frameworks being conceptualized and described in digital library research since 1995 for the design, development, evaluation and interaction of digital libraries (Levy and Marshall, 1995; Moen and McClure, 1997; Saracevic and Covi, 2000; Fuhr et al., 2001). Levy and Marshall (1995) discussed a work-oriented perspective of digital library research that is based on the work people do, and how digital libraries assist in the completion of work related tasks. Their framework highlights three crucial characteristics of digital libraries: document, technology, and work process (which involves research and service). Moen and McClure (1997) identified a framework of five interacting dimensions in Government Information Locator Service (GILS): policy, users, technology, contents, and standards. The evaluation framework also includes three perspectives, representing the "views" of the stakeholders in the GILS: users, agencies, and the government. Marchionini and Fox (1999) identified four dimensions of digital library development: community, technology, service and content. Saracevic and Covi (2000) presented a framework, consisting seven levels, for examining digital libraries: social, institutional, individual, interface, engineering, processing and content. Fuhr et al's (2001) framework consists of four major dimensions, namely data/collection, system/technology, users and usage. Sandusky (2002) developed a list of six attributes in framing digital library usability research: audience, institution, access, content, services,

and design and development. Soergel (2002) offered a digital library research framework consisting of three guiding principles and eleven specific themes for research and development. Marcos (2004) introduced 5S and formalisms for streams, structures, spaces, scenarios, and societies — as a framework for providing theoretical and practical unification of digital libraries. All these frameworks emphasize the importance of a holistic approach to examine digital libraries as examining a single view of such as services are likely to be limited in their utility.

This paper shows how Zachman Framework for Enterprise Architecture can be adopted as a formal framework for the design of digital libraries, providing a precise specification of requirements against which the implementation can be compared for correctness. The framework abstracts the characteristics and features of the digital library, as well as explains their structures and processes from various levels of stakeholders. The paper specifically focuses on how the data dimension of the contextual (scope), the conceptual (business model) and the logical (system model) layer in the framework are applied to determine the contents of a collaborative digital library.

2. Contents of Digital Libraries

Digital objects form an integral part of any digital library's collection (Kahn and Wilensky, 1995). A viable digital library must have a diverse and inclusive collection to make it truly useful and functional. There are three methods of building digital collections: through digitisation, acquisition of original works and access to external materials (Cleveland, 1998). The first method, digitisation, is the conversion of any fixed or analogue media in existing collections, such as books, journal articles, photos and paintings, into electronic form through scanning, sampling, or re-keying. The second method, acquisition of original digital works is the creation of digital resources by the actors of the digital library such as authors and publishers. The last method provides pointers and hyperlinks to external web resources not held in-house or in local servers. Beyond text, video and audio, some digital libraries incorporate 3D objects, simulations, dynamic visualizations, and virtual-reality. Besides that, there are also dynamic digital events and objects such as interactive multimedia computer simulations and games, virtual worlds, video programming, animated texts, hypermedia corpuses, on-demand video, and collaborative scenarios in the digital environments that become part of digital libraries (Marchionini, 1997). As such, this enables digital libraries, in comparison with print-based libraries, to easily support the modification of their contents. Hoadley and Bell (1996) maintain that "... structuring Web pages based on 'content' (through keywords or topics) and 'context' (such as social group who produced it, and discussion that gave rise to the ideas) may prove to be another important features digital libraries could afford

Borgman et al. (1996) in her definition of digital libraries describes "metadata" as content of digital libraries. Metadata is important in digital libraries because it is the key to resource discovery and integrated access. It is another level of content to librarians that act as a means to the content for users. Metadata is mostly used as intermediate steps to retrieving content but creators and digital librarians are creating new types of surrogates for objects to allow users to quickly preview and browse content. Many digital libraries such as American Memory, Connecticut History Online (CHO) and National Science Digital Library (NSDL) projects adopt Dublin Core as the metadata schema (Dublin Core, 2004) for implementing and maintaining metadata due to its simplicity and extensibility to assemble and integrate records from different systems into a centralised system (Foulke et al., 2003). NSDL qualified Dublin Core metadata records take several forms: (a) item metadata records which describe individual digital resources outside of the repository and function as surrogates for these resources; (b) collection metadata records which serve as a general aggregation record for linked items and as an administrative base for managing import and update of items; and (c) link metadata records which describe the relationships between metadata records within the repository (Lagoze et al., 2002).

Several researchers (Twidale, Nichols and Paice, 1997; Twidale and Nichols, 1998) have recognised the potential for users, rather than librarians, to contribute to the development of a digital library collection through user-supplied data (USD). Such USD can come in many different forms, although it can be split into two main groups: data automatically collected from users' activities and data explicitly generated by users (Nichols et al., 2000). Implicit additions to a collection include search term suggestion and ratings. There have been many proposals for explicit USD, which includes annotation, key-word addition, evaluative commentary, hypertext links, ratings and error correction. Nichols et al. (2000) indicate that annotation has been frequently proposed as a technique for users to add content and share ideas in a digital library system. However, Wilensky (2000) notes that "despite its evident usefulness, digital annotation capabilities are not very widespread" as no widely-accepted framework for annotation metadata (analogous to Dublin Core for resource metadata) or widely-used tools for the creation of annotation metadata have yet emerged. As many digital library developers do not yet incorporate annotations into their public interfaces, users have not become accustomed to seeing annotation information in digital libraries, and have not begun to think up new, creative uses for annotations (Arko et al., 2006)

Wallace, Krajcik, and Soloway (1996) succinctly summarise the following six important features of digital library content that make them significantly different from traditional libraries in ways which support student learners: (a) content is current; (b) content can be from primary resources; (c) content is comprehensive; (d) resources are presented in various formats; (e) student can publish them online; and (f) content is readily accessible. To this list, Masullo and Mack (1996) added "re-use of teaching resources". This is the feature being focused on by the EduPort project (Masullo and Mack 1996) and the NSDL projects such as DLESE, MERLOT and NEEDS, whose goal is to support re-use of teaching resources by reflecting teachers' experiences with materials acquired from digital libraries.

3. Methodology

The Zachman framework for enterprise architecture proposes a matrix-like structure for classifying and organizing the representations of an enterprise (Zachman, 2006). The rows consider six different perspectives on the enterprise, representing its major stakeholders: planner, owner, architect or designer, engineer, implementer and the organization worker. The planner's perspective reflects the context that establishes the list of relevant constituents that must be accounted for in the descriptive representation for the other perspectives (owner and designer). The descriptive representation of owner's perspective reflects the usage characteristics of the digital library, what the owner is going to do with it and how they will use it once they get it in their possession. The descriptive representation of designer's perspective forms the basis for the design of the digital library system, as well as the features for manipulating the tangible aspects of the digital library. The columns specify six contextual dimensions summarized in Table 1.

The collaborative digital library has been conceived to support secondary school students information needs in conducting school-based projects. Zachman Framework for Enterprise Architecture is used as the approach to elicit user requirements and define the digital library organisation, processes, technology and information flows (Abrizah, 2007). In applying Zachman Framework and to holistically control the study, the case study approach and an urban secondary school in Malaysia was chosen as the case sample. The study adopted multiple data collection techniques which incorporate (a) survey questionnaire; (b) interviews and focus group interviews; (c) site observations to observe specific environment of the collaborative digital library implementation; (d) document analysis of students projects and other documents related to the goals and objectives, as well as processes and procedures of implementing school-based projects; (e) user testing

and evaluation of the digital library prototype; and (f) literature review of digital library projects.

Table 1: Dimensions of the Zachman Framework

Dimension	Focus	Purpose
What	Data	The enterprise's data and how it is used.
How	Function	The process of translating the mission of the organization into its business and into successive definitions of its operations.
Who	People	Who is related with the major artifacts of the organization: business processes, information and IT. Higher level cells refer to organizational units; lower level refers to system users.
Where	Network	The geographical distribution of the organization's activities and artifacts
When	Time	How each artifact relates and evolves with timeline
Why	Motivation.	The translation of goals into actions and objectives

Information obtained from these data gathering techniques helps to populate the requirements of the top three layers (18 cells) in Zachman Framework to ascertain the design details of the digital library's scope, business and system model. The planner is concerned with positioning the digital library in the context of its environment. This is when the planner enquires about the demographics of the stakeholders, ICT individual differences, their readiness to participate and collaborate, their awareness of the concept of digital libraries and their perception of the digital library initiative. The owner is interested in the digital library's deliverable and how it will be used. The designer is concerned with how the digital library is to perform its functions. This involves investigating the resources that are used, the user behaviour of seeking for and using resources, the experience of searching, the relevance perceived and the problems encountered. It also involves review of current digital library features through published literature, analysis of contents of reports produced and official documents, as well as site visits and observation. The possible sets of constructs or artifacts to represent the cell content for each dimension in the top three rows or layers of the Zachman Framework are presented in Appendix. The following section illustrates how the three tiers of Zachman Framework – the contextual (scope) or planner's perspectives, the conceptual (business model) or the owner's perspectives and the logical (system model) or the designer's perspectives – are applied to determine the contents of the digital library.

4. Results: What Constitutes the Digital Library

Each of the first three cells in the data column addresses understanding of and dealing with the collaborative digital library's data. What (data) describes the digital library resources students used to fulfill their research needs. The data component, at the macro level identifies the information resources included or covered in the collaborative digital library, and at the micro level, concerned the collections, quality, accuracy, usability, description and organisation of the resources in the digital library.

(a) Types of Resources

The contextual model from the planner's perspective begins with the identification and description of the resources that concern the digital library and affect its direction and purpose to fulfill students' information needs in conducting research projects. The survey (n=397) indicates that high proportions of students feel comfortable with digital resources, use them substantially, and are relatively well equipped to find these resources. The most popular digital resources used are web pages (316, 79.6%) and digital images (190, 47.9%). Document analysis of students' projects confirmed the various web resources students used for their projects. Therefore, to cater for their information needs, the content

available through the digital library, comprises three main categories of resources, without policy-controlled access, as depicted in Figure 1. These resources are:

- Resources that are born digital. This includes web documents such as online reports, textual documents and still digital images that are accessible and usable via conventional browsers. Digital items used outside the browser environment or with special plug-ins (usually after downloading) include dynamic images, moving pictures (video), sound collections (audio) and learning objects.
- Digitised resources or digital proxies for physical items, such as report folio, teachers guides, certificates and transcripts, photographs and newspaper cuttings.
- Links to other resources relevant to the domain focus of the digital library, such as websites of libraries, archives, government departments, ministries, academic institutions and other authoritative resources.

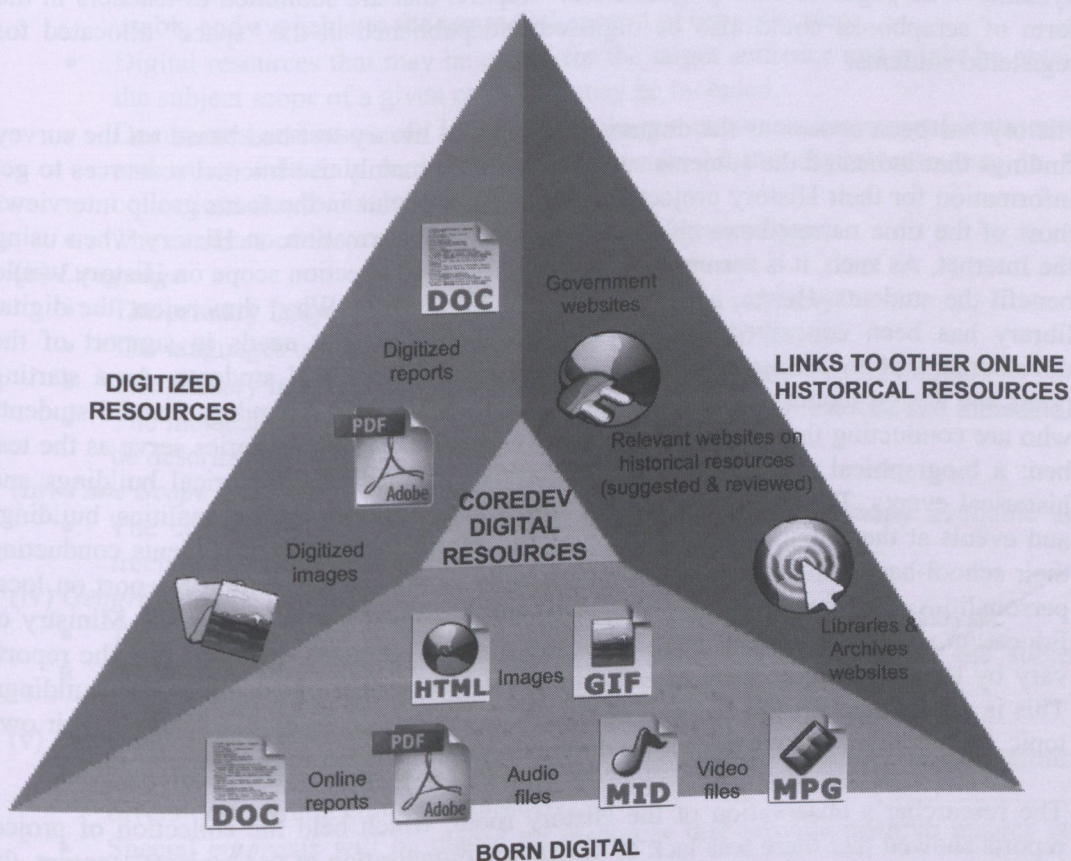


Figure 1: The Digital Library Resources in Various Media Types and Format

As students are willing to collaboratively build the digital library resources in the form of project report, the digital library also incorporates this type of resource either digitized from their report folios, or submitted electronically to the system. As such, the contents of the digital library will result from a publication process of students' research project. The digital library collection incorporates not only digital resources in different media types such as text, images, web documents, audio and video, but also in different digital formats with different levels of content quality and metadata. Therefore, the resources contained within the collections range from highly granular, for example images and movies, to highly-integrated, for example students research projects. Other types of resources include discussions on special topics or feedbacks archived from community discourse and static information such as user documentation and Frequently-Asked Questions (FAQs). User documentation and FAQs are two important information needed to facilitate students to use the digital library as it is expected that students will learn to use the digital library on their own, as survey findings revealed that many of them self-taught themselves to use the Internet (104, 26.1%).

(b) Subject Scope, Collection and Resource Criteria

The owner's perspective at the conceptual model is a contiguous model of the resources expressed in terms of domain focus and topics seen by the owners of the digital library, that is the educational community comprising students and teachers. Unlike research digital library collections, educational digital libraries depend heavily on the direct contributions of resources from their communities of users (McMartin and Terada, 2002). Based on their business plan (owner's perspective of the motivation dimension), the owners would encourage the students to contribute resources by publishing their own projects in the digital library and share them with others, as the students had been allowed to word-process their project report. The students may either develop content for the digital library by submitting their reports in the electronic format or build static or dynamic Web pages of their project work. Reports that are submitted to teachers in the form of scrapbooks could also be digitised and published in the "space" allocated for registered students.

History has been chosen as the domain of the digital library test-bed based on the survey findings that indicated the students surveyed ($n=397$) mainly use Internet resources to get information for their History project (75.5%, 299). Students in the focus group interviews most of the time narrated examples of searching for information on History when using the Internet. As such, it is assumed that a digital library collection scope on History would benefit the students. Hence, as specified in the Motivation (Why) dimension, the digital library has been conceived, and is constructed to meet the needs in support of the development of local historical resources for secondary school students. As a starting point, the design focuses on the needs of history teachers and secondary 2 and 3 students who are conducting their school-based history projects. Three categories serve as the test bed: a biographical portal of selected Malaysian personalities, historical buildings and historical events. The basis for choosing topics and resources on personalities, buildings and events at the initial stage is to support the information needs of students conducting their school-based history projects which usually centre around writing a report on local personalities, historical buildings or places, and historical events (Malaysia, Ministry of Education, 2002). Document analysis of the students' projects indicated that the reports vary by topics and there were report submissions on similar personalities and buildings. This is exacerbated by the fact that students were given the freedom to choose their own topic, and teachers did not restrict the number of topics written for a particular project.

The researcher's observation of the History room, which held the collection of project reports showed that there was lack of systematic organisation of the projects' content, the reports were uncatalogued, not even at the collection level. Many students submitted two topics in a project report, associating a historical personality with a historical building. The most popular personality researched on was Tunku Abdul Rahman (Malaysia's first Prime Minister), who was associated with the Sultan Abdul Samad Building (where Independence Day celebration was held in the early years) or the Merdeka Stadium (where the Prime Minister declared Malaysia's Independence in 1957). To facilitate resource discovery in the digital library environment, this indicates the need for two types of metadata elements to describe the resources, *collection* and *relation* metadata elements. The collection metadata is specific to group the resources of similar topics, such as personalities; Tunku Abdul Rahman and Tun Mahathir (Malaysia's Fourth Prime Minister) collection. The relation metadata groups the features, which define the relationship between a personality resource (for example Tunku Abdul Rahman) and other targeted resources such as buildings (such as Sultan Abdul Samad Building or the Merdeka Stadium). Therefore the content is typically made available in the form of collections, which refers to groups of resources organised around a theme or topic. Figure 2 presents the semantic description of the domain focus, contents, content criteria and

scope of the collaborative digital library, which populates the owner's perspective of the Data dimension of the Zachman Framework.

The students and teachers interviewed emphasized the needs for contents to be "clear, accurate, adequate, organised, valid, reliable, informative and resourceful". These needs are therefore used as a set of general guidelines or selection criteria of resources accepted for submission. Based on document analysis of the students' projects and teachers' feedback, the digital library collections was scoped as follows:

(i) **Subject**

- The digital resources that are collected are intended to meet the subject scope(s) of the collections.
- The digital resources that are collected are intended to be well designed, readily usable and available to the target audience(s) of the collection.
- Digital resources that may be useful for the target audience and might be outside the subject scope of a given collection may be included.
- Documents and resources about the teaching techniques, assessment instruments and other materials to help support the use of the digital resources in the collections may be included.
- The contents of the resources should be generally error-free.

(ii) **Language**

- The primary language of the students project report is Malay.
- The languages of the collections are both English and Malay.
- The primary language of the metadata describing the resources is English
- The metadata standard for the collection also allows for resources and metadata to be described in Malay.

(iii) **Time Scope**

- The collections will contain materials that are generally readily available and freely accessible to the audience.

(iv) **Geographical**

- The resources in the collections are primarily from and for use in Malaysia.
- Worldwide resources are included in the collection if they meet the subject scope(s) and needs of the collections' target audience(s).

(v) **Diversity**

- The resources in the collections will, to the extent possible, reflect cultural diversity or exhibit cultural neutrality.
- Special emphasis will be placed on resources that provide positive images and role models in Malaysian history.

(c) Description and Organisation of Resources

The designer's perspective of the data dimension concerns with the description and organisation of the resources and provides a more information-based perspective of the digital library, which shows that the collaborative digital library contains repositories of knowledge, information, data, metadata, relationships, annotations, user profiles, and documents. The digital library utilizes the concepts underlying the Information Network Overlay (INO) (Lagoze et al., 2002) which models the digital library resources, their descriptions, and the web of information that builds around them with as data, documents, metadata, collections and relations. As such, in this Data dimension, the digital library resources are characterized and searched mainly via "metadata records" that describe content at the collection or item level. The digital library metadata are more exhaustively defined, and unique identifiers are specified. The entities or metadata elements are used to more closely reflect the underlying structure of the digital library and its relationships. In this cell, entities are converted to table definitions, which serve as the basis for identifying the database design requirement. The digital library metadata frameworks use lists of

terms that are simple, based on the recommendations about metadata and vocabularies for retrieval in the educational contexts put forward by DLESE Quality Working Group 3 on Metadata Structures (DLESE Quality WG3, 2004).

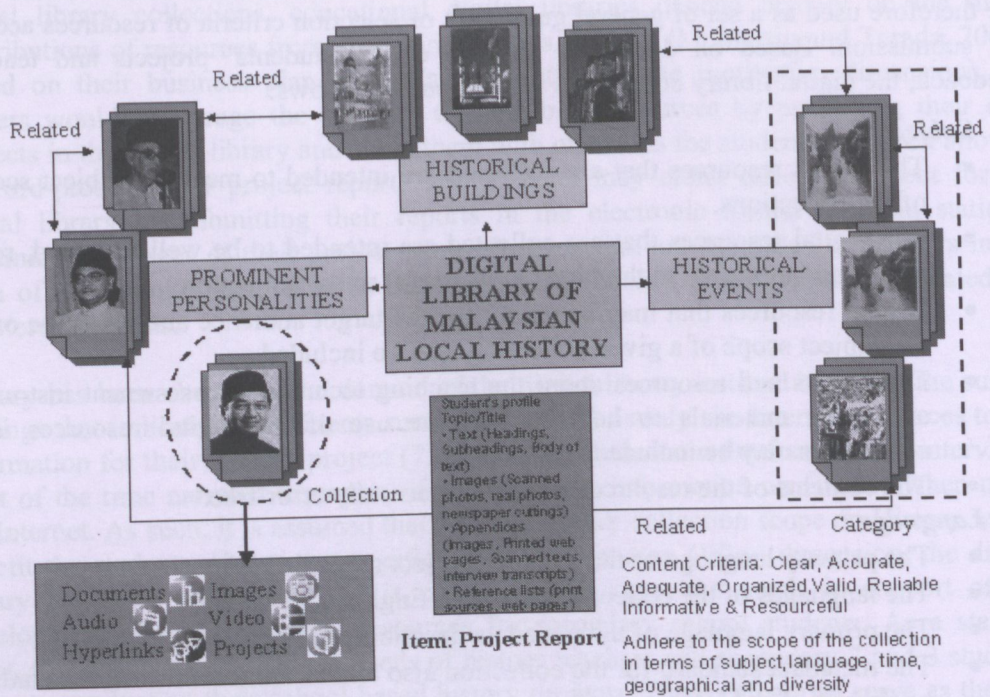


Figure 2: Domain Focus, Contents, Content Criteria and Scope of the Collaborative Digital Library of Students Project

Table 2 presents the table definition for the digital library data, which covers the digital objects data and metadata, user information, annotation and static information pages. Administrative, technical and descriptive metadata are used. Administrative metadata is created by the author, technical metadata is automatically-generated and descriptive metadata is assigned by the content access provider (human indexer). The descriptive metadata schema used for the object data description is the Dublin Core (DC) Metadata (Dublin Core Metadata Initiative, 2004). The digital library has altogether 16 metadata elements and incorporates DC's 14 out of 15 elements, namely title, creator, subject, description, publisher, contributor, date, type, format, identifier, language, relation, coverage and rights. The DC source metadata element is not used. Two other elements incorporated are Collection and Ranking metadata. Table 3 presents the metadata profile for the digital objects resource description.

Table 2: Table Definitions for the Digital Library Data

Digital Object Data	Administrative Metadata Elements	Technical Metadata Elements
a) Project Report	Report Title / Subtitle Creator (First Name / Last Name) Subject, Keyword Description / Description Text Document, Attached digital objects, appendices, references File name Grade and Marks	ProjectID ObjectID File type File size Format Filepath; Thumbnailpath

b) Other Digital Objects	Administrative Metadata Elements		Technical Metadata Elements	
• Text files	File name; Title; Description		DocumentID; ObjectID; File type; File size; Format; File path; Thumbnail path	
• Images	File name; Title; Description		ImageID; ObjectID; File type; File size; Format; File path; Thumbnail path; Image Width; Image Height	
• Audio files	File name; Title; Description		AudioID; ObjectID; File type; File size; Format; ; File path; File Length; File bitrate	
• Video files	File name; Title; Description		VideoID; ObjectID; File type; File size; Format; ; File path	
• HTML documents	File name; Title; Description		HyperlinkID; ObjectID; File type; File size; Format; File path; URL	
Object Data Description	Descriptive Metadata Elements			
	Title Creator Subject, Keyword Description Publisher Contributor	Date Type Format Identifier Language	Relation Coverage (Spatial, temporal) Rights Collection Ranking	
User Information	Students		Administrators	
a) Profile Information	StudentID (T) First Name (A) Last Name (A) Race (A) Gender (A) Date of Birth (A) (Month, Day, Year)	Address (A) Contact No (A) School (A) Form / Class (A) Last Login (T)	AdministratorID First Name (A) Last Name (A) Race (A) Gender (A) Date of Birth (A) (Month, Day, Year) Address (A)	Contact No (A) SchoolID (T) Status (A) (Administrator's access level) Last Login (T) Last Updated (T) E-mail Address (A)
b) Account Information	Email address	Password	User Id	Password
School Information	SchoolID (T) School Name (A) Address (A) Contact No (A)	Fax No (A) Postcode (A) City (A)	State (A) Homepage URL (A) Last Updated (T)	
Annotation	FeedbackID (A) Name (A) Comments (A)	Type of Comments (A) E-mail Address (A) Reply (Yes/No) (T)	Date Checked (T) Date Posted (T) Students Grade (A) Students Marks (A)	
Static information pages	FAQs	Description of the digital library	User Documentation	

A – Administrative Metadata

T – Technical Metadata

D – Descriptive Metadata

Table 3: Metadata Profile for the Digital Objects Resource Description

Elements	Label / Qualifiers (-) / Encoding Scheme (•)	Element Definition
*Creator	Creator	An entity primarily responsible for making the content of the resource.
Title	Title	Name given to the digital resource
Subject	Subject - SubjectID - Category • Famous personalities • Historical buildings • Historical events - Subject Headings (Controlled) - Keywords (Uncontrolled) - Subject Date and Time	A topic of the content of the resource. Subject will be expressed as keywords, key phrases or classification codes that describe a topic of the resource.
Description	Description - Synopsis; Cast (for video files)	A textual description of the content of the digital resource. Examples of Description include, but is not limited to: an abstract, table of contents, reference to a graphical representation of content or a free-text account of the content

*Publisher	Publisher	An entity responsible for making the resource available
*Contributor	Contributor	An entity responsible for making contributions to the content of the resource.
Date	Publication Date - Date of Creation - Date of Modification	A date of an event in the lifecycle of the resource Typically, Date will be associated with the creation or availability of the resource
Type	Type <ul style="list-style-type: none"> • Documents • Images • Audio • Video • Hyperlinks • Projects 	The nature or genre of the content of the resource. Type includes terms describing general categories, functions, genres, or aggregation levels for content. Recommended best practice is to select a value from a controlled vocabulary
Format	Format - Documents (Doc, Txt, Pdf) - Images (jpeg) - Audio (wav) - Video (mov) - Hyperlinks (html) - Projects (Html)	The physical or digital manifestation of the resource. Typically, format includes the media-type or dimensions of the resource. Recommended best practice is to select a value from a controlled vocabulary
Identifier	Identifier - URI - URL - Filename - Filepath	An unambiguous reference to the resource within a given context. Recommended best practice is to identify the resource by means of a string or number conforming to a formal identification system
Language	Language <ul style="list-style-type: none"> • Bahasa Malaysia • English 	A language of the intellectual content of the resource.
Relations	Relation - RelationID; ObjectID - Related ObjectID; Relation	A reference to a related resource.
*Coverage	Coverage - Temporal - Spatial	The extent or scope of the content of the resource
*Rights	Rights	Information about rights held in and over the resource. Typically, Rights will contain a rights management statement for the resource, or reference a service providing such information. Rights information often encompasses Intellectual Property Rights (IPR), Copyright, and various Property Rights. If the Rights element is absent, no assumptions may be made about any rights held in or over the resource
Collection	Collection - Collection ID - Collection Full Name - Collection Name - Collection Category1 - Collection Category2 - Collection Category3 - Collection DateTime - Year Start - Year End	Specific collections are created to facilitate browsing by collection.

- Optional

5. Practical Implication and Conclusion

This paper has shown how the data dimension in the view of the planner, the owner and the designer of Rows 1, 2 and 3 of the Collaborative Digital Library Framework (Appendix) is identified. Planner's perspective describes the digital library resources in various media types and format. Owner's perspective describes the subject scope, collection and resource criteria. Designer's perspective defines the metadata profile for the digital objects resource description. These perspectives are used in the implementation of

the digital library at the physical design layer, and in the modules and subsystems. Figure 3 and 4 present the screenshots of the indexing module which allows users to define relationships of contents and better quality control of the metadata description in order to facilitate resource discovery of digital objects in the digital library.

This framework contributes to another dimension of a framework for digital library research and development and “a structured vision for the development of new ideas” (Soergel, 2002). The digital library adheres to Soergel’s guiding principles and ten themes for digital library research and development, as well as incorporates the dimensions of other framework (Moen and McClure, 1997; Marchionini and Fox, 1999; Marcos, 2004; Sandusky, 2004), but instead of listing them as requirements or ticking against a checklist, this research has embedded the requirements in a system’s architectural framework and present them more systematically.

The study has also interpreted the “the functioning system” level in Zachman Framework, and added to the digital library framework as user testing and evaluation of the system to make the design and development process wholesome. As a testbed system, the collaborative digital library known as CoreDev has demonstrated its capabilities in serving an educational community as has been reflected by the positive feedback on the functional requirements from 44 users. The beta tester demographics (n = 105) indicate that the digital library is reaching its target communities. To date, CoreDev has developed a useful collection of 777 resources consisting of 126 documents, 35 projects, 437 images, 23 audios, 34 videos and 90 hyperlinks. CoreDev is now available at <http://coredev.fsktm.um.edu.my>.

The screenshot shows a web interface for 'Collaborative Resource Development'. At the top right is a 'HOME' link. Below the header is a breadcrumb trail: 'Navigator > Home > Administration > Index Uploaded Materials > Add'. There are also links for 'Back to: Previous Page' and 'Help for Adding Entry'. The main form is titled 'Adding New Entry - Page 2' and is divided into several sections:

- DigitalObject Table :: General:** Contains 'Type: Image', 'Format: GIF' (dropdown), and 'Size: 0.01 KB'.
- DigitalObject Table :: Prescriptions:** Contains 'Collection: Tun Abdul Razak' and 'Category1: Prime Minister'. A link '>> Edit Collections and Categories' is present.
- DigitalObject Table :: Logistics:** Contains 'Uploaded: True', 'Uploaded MaterialID: 347', 'Filename: 51.jpg', 'Filepath: /sReport/data/repository/168/data/51.jpg', and 'Thumbnailpath:'.
- OImage Table:** Contains 'Image Width:' and 'Image Height:' fields, both followed by 'pixels'.

At the bottom right of the form is an 'Add' button. Below the form, there is a reminder: 'Remember to Add your entry' and a footer with 'Adding New Entry - Page 2' and links for '>> Log Out | Previous Page | Help |'.


Figure 3: Data Object Description for an Image File

HOME

Collaborative
Resource Development

Navigator > Home > Administration > Index Uploaded Materials > Add
Adding New Entry - Page 1 Help for Adding Entry

DigitalObject Table :: General

File: 

Title: TOKOH SEJARAH TUN ABDUL RAZAK

Creator: Nur Hanisah, Fadzil
*optional

Description: Perdana Menteri Malaysia yang kedua Tun Abdul Razak Hussien

Type: Image

DigitalObject Table :: Prescriptions

Subject:
» Search and Check Subject Headings

Keyword:

Rights:
*optional

Publisher:
*optional

Collection: Ahmad Ibrahim
» Edit Collections and Categories

Ranking: (0-100)
» view other rankings

Spatial Coverage:
*optional

Temporal Coverage: (yyyy-yyyy)
*optional
 For single year coverage,
 » enter the same year twice: (2001-2001)
 For unbounded year coverage,
 » enter the starting year: (1979-)

Contributer:
*optional

DigitalObject Table :: Logistics

Uploaded: True

Remember to Add your entry Add

Adding New Entry - Page 1

Figure 4: Data Object Description Using Dublin Core Metadata Elements































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APPENDIX

	Why MOTIVATION	What DATA	Who PEOPLE	How FUNCTION	Where LOCATION	When TIME
VISION (GUIDELINES)						
Scope (Planner) The researcher	 1. Motivation to use, major goals and objectives, curricular and programmes significant to the digital library	 2. Digital library resources to fulfill students information needs in conducting research projects	 3. Identification and description of people and organisations to which the digital library assigns responsibility for work.	 4. The activities students perform in conducting research projects; The activities teachers perform in supervising research projects	 5. Identification and description of organisation and individual location of access where stakeholders use the digital library.	 6. Events to which the Digital Library responds relative to time
DESIGN (STANDARDS)						
Business model (Owner) The educational community (stakeholders)	 7. Business plans to use the digital library	 8. Semantic description of domain focus and topics of resources in the digital library	 9. Users and related roles (Person & Role Diagram)	 10. Conceptual model of services in the digital library	 11. The organisation's (owner) digital library network diagram	 12. Chronology of events and duration of research project
System model (Designer) The researcher	 13. Digital library functional requirements	 14. Data definition for digital library resources	 15. Users and Functional Roles in the Digital Library Architecture	 16. Digital library programme modules	 17. Digital library notional distributed systems architecture	 18. Event phases and process components
IMPLEMENTATION (STANDARDS)						
Physical design	 19. System operational requirements	 20. Physical data model for digital library resources	 21. Digital library system human-system interface description	 22. System design, language specification and structure chart	 23. Digital library information network detailed architecture	 24. Digital library system control structure
Modules and Subsystems	 25. Technical requirements	 26. Digital library resources' metadata and DBMS scripts	 27. System security architecture and operations	 28. Code statements, control blocks, DBMS stored procedures	 29. Physical data network components, addresses and communication protocols	 30. Digital library component timing description
OPERATION STANDARDS						
Functioning digital library system	Users feedback on systems overall operation	Users feedback on the ease of handling data	Digital library participant description	User s feedback on procedural and system documentation	Users feedback on the robustness of the network	Users feedback on system operation related to time