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Analysis of the University of Khartoum Library System Using the Structured Systems Analysis and Design Methodology (SSADM)

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Abstract

This paper investigated and analyzed the University of Khartoum Library System in terms of the operations and functions carried out in the three core sections of the library i.e. the Acquisitions, the Cataloguing and classification, and the Reader Services (Circulation) Sections. The purpose of the study was that the analysis would be used later as the basis for determining the specific functional requirements of a computer-based Integrated Library Management System (ILMS). The author employed a number of techniques for the purpose of gathering information about the existing library system, including interviews, document analysis, and literature review. The study used the Structured Systems Analysis Methodology (SSA) in analyzing the existing library system. This method necessitated the decomposition of the system into smaller functional subsystems. The study finally documented the results of the University of Khartoum Library System analysis by Data Flow Diagrams (DFDs).

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تحليل نظام مكتبة جامعة الخرطوم باستخدام منهجية تحليل وتصميم النظم الهيكلية

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مستخلص: هدفت هذه الورقة الى دراسة و تحليل نظام مكتبة جامعة الخرطوم من حيث العمليات والوظائف التى تجرى في اقسام المكتبة الاساسية وهى قسم التزويد، قسم الفهرسة والتصنيف، وقسم خدمات المستفيدين. الغرض من هذا التحليل هو استخدامه لاحقا في تحديد المتطلبات الوظيفية الخاصة بنظام إدارة مكتبات مبنى على الحاسوب. تم استخدام عددا من الطرق لجمع البيانات عن نظام المكتبة القائم تشتمل على المقابلات، تحليل الوثائق، ومراجعة الادبيات في مجال تحليل وتصميم النظم. وتم استخدام منهجية تحليل وتصميم النظم الهيكلية *Structured Systems Analysis and Design Methodology (SSA)* والتى تتطلب تفكيك النظام القائم الى نظم فرعية اصغر. واخيرا تم توثيق عملية تحليل النظام القائم باستخدام مخططات تدفق البيانات *Data Flow Diagrams (DFD).*

Introduction

The University of Khartoum Library, established in 1902, is the largest university library in the country. It has been serving the university community ever since. Because of the recent proliferation in the number of new universities, the library has assumed an additional role; providing library services to users from outside the university. The library has been functioning manually throughout its history. This fact caused the library to function less effectively in terms of the internal library housekeeping activities. This has had a negative impact on the library's ability to provide efficient and effective services to its users. In this age of information technology, information superhighway, and digital libraries, it is difficult for a library to cope up with the ever-increasing volume of information while operating manually. Thus, library automation has become a necessity nowadays, so that the library can carry out its basic function of meeting its users' needs.

Objectives

The major objective of this study is to analyze the library operations carried out in the U of K library system. This analysis will assist in determining the functional requirements of a proposed computer-based Integrated Library Management System (**ILMS**). This entails the functional decomposition of the existing library system, highlighting the points of strengths and weaknesses of each of the three core subsystems under study, and consequently improving the flow of information between the different library subsystems.

Scope

This study covers three subsystems of the University of Khartoum Library System **(UKLIS**) namely, the Acquisitions subsystem, the Cataloguing and Classification subsystem, and the Circulation subsystem.

Methodology

This study employs the Structured Systems Analysis (SSA) Methodology. This methodology is characterized by the use of graphic documentation. Data flow diagrams are used for the purpose of structured analysis.

Structured interviews and document Analysis are used acquiring detailed facts about the nature of the existing Library System**:** Three structured interviews were held with the respective heads of the investigated subsystems .Valuable facts on the existing system are obtained by reading and analyzing various records including annual reports, ad hoc reports, forms and charts

Literature review

The systems approach

O'Connor and McDermott (2004) highlight the need for systems thinking skills in today's world; they outline the following benefits of systems thinking:

i) We will be able to predict events and prepare for them;
ii) We will have more effective ways of dealing with problems, and better thinking strategies;
iii) The way to gain more influence in our organizations or institutions is to understand the structure of the system. It is the structure of the system, not the effort of the people in it that determines the outcome.
iv) Systems thinking help us to understand the complexity of a process so as to improve it. It also helps with team and team building, because teams act as a system.

McLeod (1983) in reviewing the systems approach asserts that in an organization, the manager should see his organization as a system residing within a larger environmental system and consisting of several subsystems; consequently, the manager will be able to understand a problem if it exists.

Systems and Systems Analysis

Teague and Pidgeon (1985) define a system as an interrelated set of components that are viewed as a whole. The components work together to perform a function or to achieve an objective.

Harris (1995) extends the definition of systems and define an information system as "... a well-coordinated collection of resources that gather and transform data into information products and services that help the enterprise perform its designed function" Harris (1995, 8). It is clear that this definition applies to the library, as its main objective is to provide information services to its clientele.

Whitten et al (1994) define systems analysis as "the dissection of a system into its component pieces to study how those component pieces interact and work" Whitten et al (1994, 120). According to this definition, system analysis encompasses the following activities:

- The survey of the system,
- The study and analysis of the existing information system
- The definition of the "business" requirements and priorities for a new or improved system (this is also called logical design).

Thus, systems analysis involves the study of a system in order to modify it, hopefully for the better (Fitzgerald and Fitzgerald (1987).

Theirauf (1988) outlines the following primary objectives of systems analysis:

a. To define the objectives that the new system must meet.
b. To determine output requirements for the new system.
c. To identify any constraints on the development and operation of the new system.
d. To specify regular and unusual conditions under which the new system will operate.

Methodologies of Systems Analysis and Design

Wassermann (1980) defines a methodology as a combination of tools and techniques employed within an organizational and managerial framework that can be consistently applied to successive information system development projects. Wassermann further outlines five methods representing a large number of techniques used for assisting in the requirements analysis and/or specification phases of the system life cycle; these methods are:

a. Structured Systems Analysis (SSA)
b. Structured Analysis and Design Technique (SADT)
c. Problem Statement Language (PSL)
d. Software Requirements Engineering Methodology (SREM)
e. Use Specification Method.

Rowely (1996) divides information systems methodologies as follows:
1. Functional decomposition methodologies: these include top-down approach; bottom-up approach; and HIPO(hierarchy plus input-output-process);
2. Data-and process-oriented methodologies: these may be divided into two broad categories:
a. Data oriented methodologies, which includes Structured Analysis and Design Technique (SADT); and Structured Systems Analysis and Design Methodology (SSADM).
b. Process-oriented methodologies; these include methodologies such as the Jackson System Development (JSD); Structured Analysis, Design and Implementation of computer Systems (STRADIS); Warnier/Orr methodology; Information Engineering Methodology (IEM); and Jordan Structured Analysis and System Specification.
3. Prescriptive Methodologies: These include Chapin's approach; Design by Objectives (DBO); Problem Analysis Diagram (PAD); and Problem Statement Analysis (PSL).

Avison and Fitzgerald (2002) stress that the Structured Systems Analysis and Design Method (SSADM), is a successful method because it does not rely on a single technique. They explain that SSDAM relies on three particular design techniques:
i. Logical Data Modeling, which refers to the process of identifying, modeling and documenting the data requirements of the system being designed.
ii. Data Flow Modeling, which represents the flow of information around a system, the way it is changed and stored and the "sources" and "sinks" of information outside the system.
iii. Entity Behavior Modeling, the process of identifying, modeling and documenting the business events which affect each entity and the sequence in which these events occur.
Avison and Fitzgerald (2002) conclude that one of the advantages of using SSDAM is that the result is a detailed view of the system and all its processes. Thus, there is no possibility of leaving out any part of the system described and a clear list of requirements is produced.

The Structural Perspective of SDLC

Structural systems analysis is a modern approach to different analysis and design phases of the system development process which has a number of advantages over other traditional approaches.

Fitzgerald and Fitzgerald (1987) define structured analysis as a systematic, top-down technique that refines goals and objectives that are presented by means of a layered model of systems requirements. They explain that the purpose of structured analysis is to communicate more effectively with users during the entire system development life cycle. They conclude that the end result of structured analysis produces a structured specification that uses a number of basic tools and techniques such as context diagrams, dataflow diagrams, data dictionaries, normalizations, and other processing documentation such as decision tables, decision trees, and structured English.

Satzinger (1993) points out that structured analysis uses functional decomposition, dataflow diagrams, and a data dictionary to model information systems

Theirauf (1988) stresses that structured systems analysis services as a sound basis for designing and installing a new system, provided that it is economically feasible to do so. He then outlines the following activities, in the detailed investigation of the present system, as modules of structured systems analysis:

a. Review of historical aspects
b. Analysis of inputs
c. Review of data files maintained
d. Review of methods, procedures, and data communications
e. Analysis of outputs
f. Review of internal control
g. Modeling of the existing physical system and logical system
h. Undertaking of other analyses and considerations
i. Undertaking of overall analysis of present information system.

Davis and Olson (1985) maintain that the use of systems concepts to decompose the information system and define the boundaries and interfaces of each subsystem is generally called Structured Design. They further stress that the structured design approach encourages definition of subsystems from the top down, that is, at each level of the hierarchy the interfaces between the lower level subsystems are clearly defined.

Methodology of Documenting the Facts

Data Flow Diagrams (DFDs):

These are the most important tools used by system analysts. This is the process of identifying, modeling, and documenting how data flows around an information system. A Data Flow Model consists of a set of integrated Data Flow Diagrams supported by appropriate documentation. Data Flow Diagrams (DFDs) represent processes, external entities, and data flows. Fitzgerald and Fitzgerald (1987) define a data flow diagram as a graphic representation of a system that shows data flows to, from, and within a system. It also shows the processing functions that change the data and the storage of this data. DFDs show the movement of information (data flows) from both the physical and the logical viewpoint .i.e. how it is done and what is done.

There are two types of DFDs; physical DFD and logical DFD. A physical DFD representation of processes shows the performer, the place and the method of performance of the process.

Downs (1988) points out that there are several methods by which data flow diagrams can be constructed, each corresponding to a system design method. He further outlines two methods:

i. The bottom-up approach which starts with a flow to or from a user (external entity) and progressing through the whole system at this detailed level.
ii. The top-down approach – employed in this study- which starts with the most high-level functions and the major data flows in and out of these. A diagram with a small number of boxes, called the context diagram, is constructed to represent the top level. This is expanded to produce a more detailed diagram, and so on.

Components of DFDs

Teague and Pidgeon (1985) explain the components of a data flow diagram. According to them, a data flow diagram consists of four components, each drawn with a different symbol as will be explained below.

i. Data Flow: a data flow is a movement of information within the system or across the system boundary. It can be thought of as a pipeline through which packets of data of known composition flow. Data flows

must be an input or output of a process box. Data flows are represented by directed arcs whereas physical flows are represented by a double line as far as this study is concerned; e.g. the flow of books from one section of the University of Khartoum Library System to another is represented by a double line.

ii. Process: a process transforms or changes incoming data flows into outgoing data flows. Each process is documented with a brief Process Description, which is a brief outline of the process activity which is taking place. Processes are represented by circles in a DFD.

iii. External Entity: These are sources or sinks of data (people or organizations or other systems) that are lying outside the context of the system under study. External entities are represented by squares in a DFD.

iv. Data stores: these are files or repositions of information. A data store can hold permanent, temporary, historical, or external data. These files receive inputs or outputs only from processes. Stores are identified with a D+Number, the D stands for data. Data stores are represented by an open rectangle whereas duplicate data stores are represented with an open rectangle with two vertical lines.

Products of Structured Analysis

Teague and pidgeon (1985) point out that the major product of structured analysis is the structured specification, which is a document defining the user requirements of the new system. This document consists of three major components, they are:

i) a set of data flow diagrams
ii) a system dictionary, and
iii) a database description.

As for the structured specification of the **U of K Library System,** only DFDs are produced for the purpose of this study. There are a number of DFDs later in this study that depict the functions and activities of the system under study.

Detailed investigation and analysis of the existing system

Description of the Existing System under Study

There are three subsystems covered by this study, namely;

i. The Acquisitions subsystem, also called (the Book Orders Section)

ii. The Catalogues subsystem;

iii. The Circulation subsystem also called (the Reader Services Section).

Each one of these subsystems is going to be analyzed in terms of the activities performed. These activities are detailed in the description of the inputs, processes and outputs of each subsystem. Data flow Diagrams combine the verbal description of these procedures.

Figure 1 the "Context Diagram of the U of K Library System" and Figure 2 "Level 0 Data Flow Diagram of the U of K Library System" show the area under study of the U of K Library system.

The Acquisitions Subsystem

Functions of the System

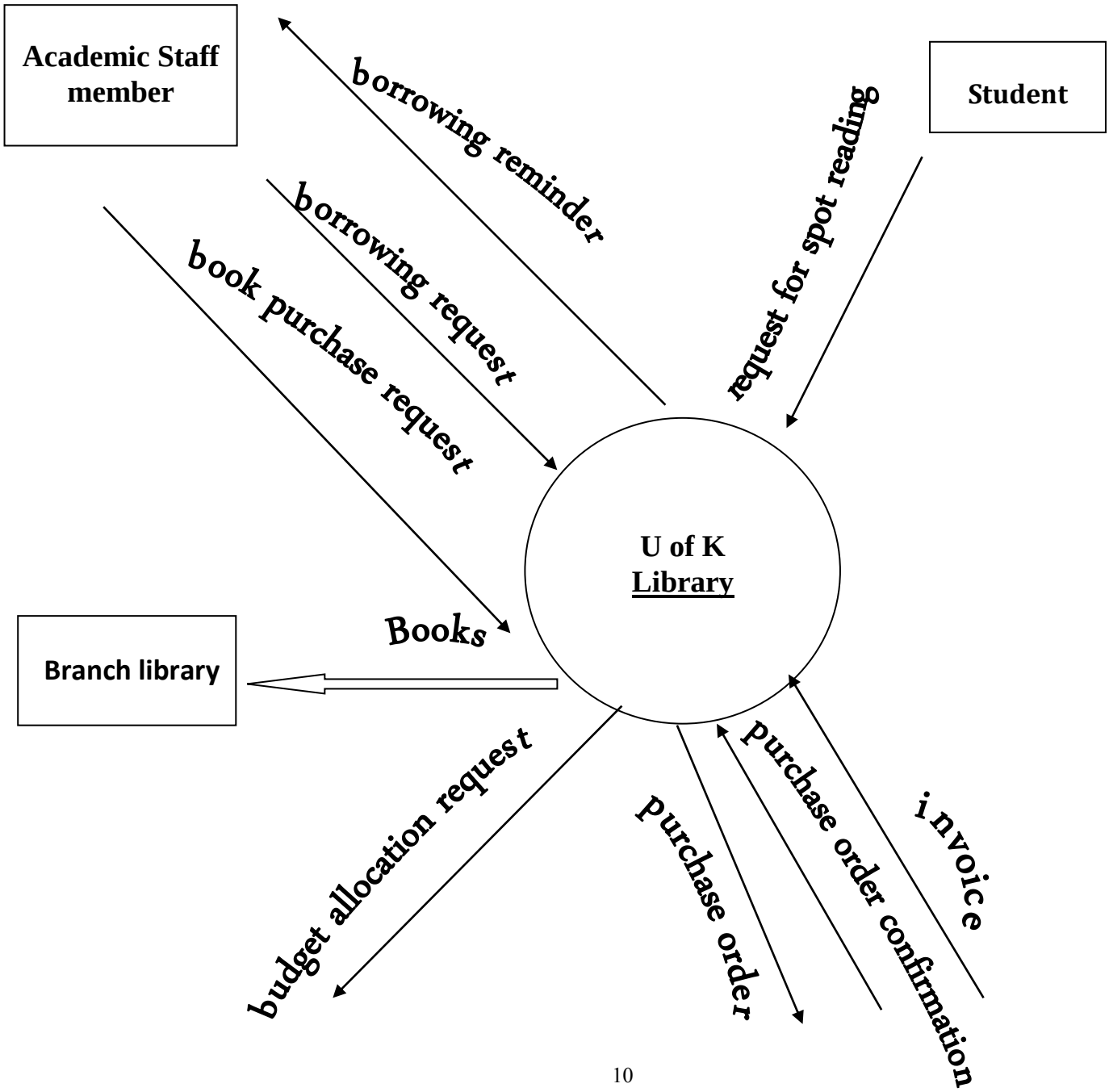
The function of this subsystem in the library is to acquire library materials from different sources and by a number of ways and means. These ways include the following;

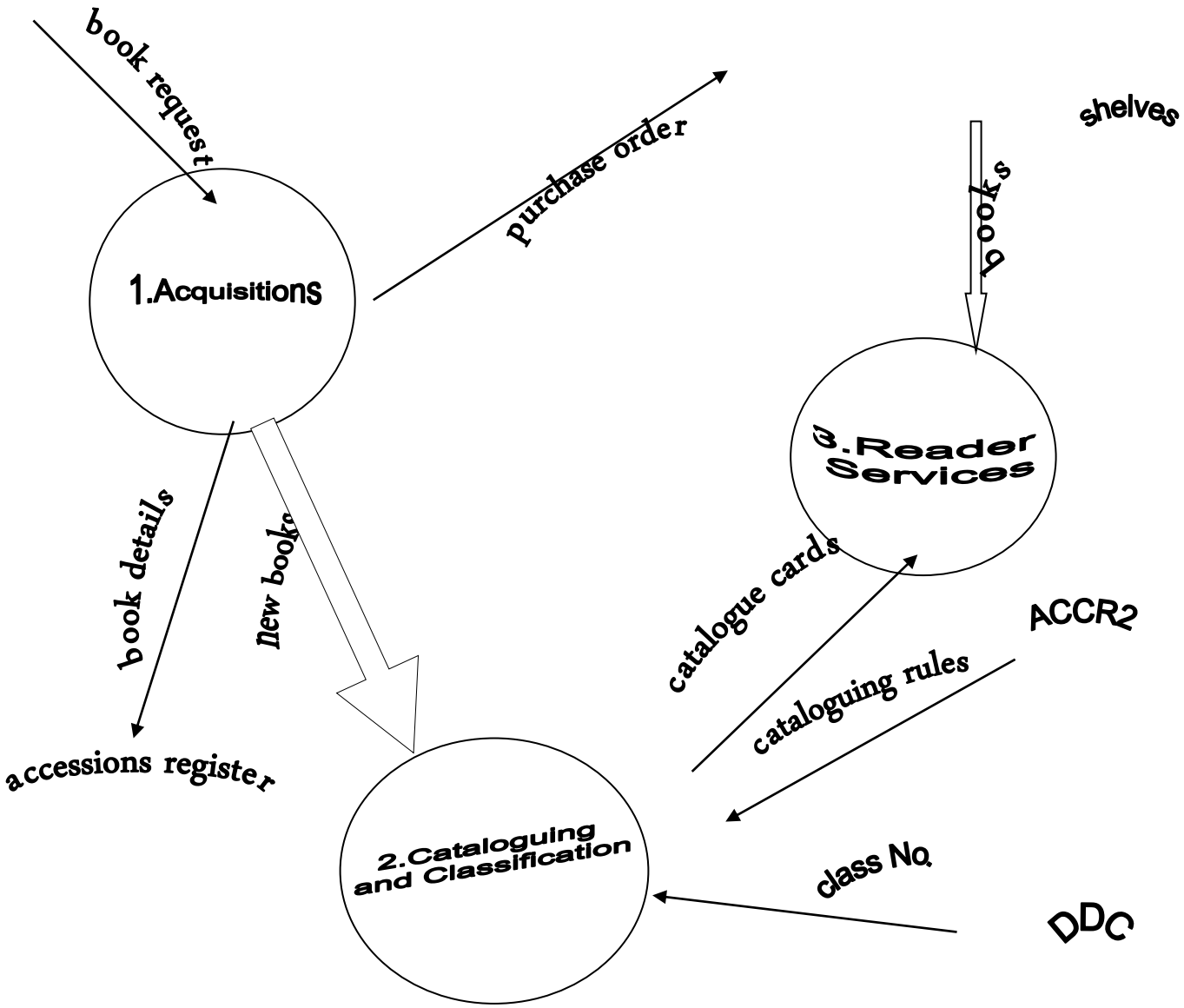
i. By purchase;

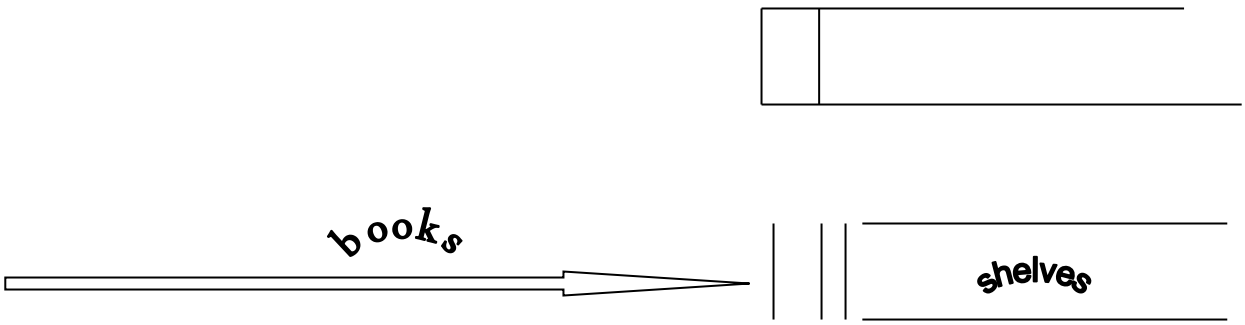
ii. By donation

iii. By exchange, whereby the library has exchange programs with a number of other university libraries.

Fig. 1. Context Diagram of the U of K Library System




book request
purchase order
1.Acquisitions
shelves
books
3.Reader Services
book details
new books
accessions register
catalogue cards
ACCR2
cataloguing rules
2.Cataloguing and Classification
class No.
DDC


books
shelves

All acquired books are registered in the Accessions Register with each book having a unique accession number. This register is a repository showing the actual number of books holdings in the library, which is about 357,607 items at the time of carrying out this study.

The major activities performed by the Acquisitions subsystem are the following:

a. Receiving suggestions for procurement of books from faculty departments.

b. Checking for requested materials and placing orders with registered vendors or agents.

c. Accessioning acquired books.

d. Sending the procured materials to the cataloguing and classification section for technical processing.

e. Maintenance of files and records of procurement.

f. Maintenance of expenditure details about books.

g. Compilation of exchange lists.

h. Supervision of exchange programs with other libraries.

Procedures for Acquiring Books

The library orders purchases of books directly from book suppliers either locally or abroad. The acquisition of books follows the following procedure:

a. University academic staff fills Book Request Form.

b. Request forms are passed on to the head of the acquisitions section.

c. Head of Acquisitions section verifies that the requested item is not in stock or on order.

d. Request is passed on to the Chief Librarian for approval.

e. Approved request is sent back to the Acquisitions section.

f. Book order is prepared and sent to the book supplier.

g. A copy of the order form is kept in the Books-on-Order file.

h. After receiving the requested book, the copy of order is moved form Books-on-Order file to Received-Books file.

i. Received book is registered in the Accessions Register with a unique serial Accession Number.

j. The book is then transferred to the Cataloguing and Classification section.

k. The requester of the book is informed that the book is available now (after it is classified and catalogued).

These procedures are depicted graphically in Figure 3 “Physical Data Flow Diagram of the Acquisitions Subsystem”, and Figure 4 “Logical Data Flow Diagram of the Acquisitions Subsystem.

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Fig. 3. Physical Data flow Diagram of the Acquisitions Subsystem

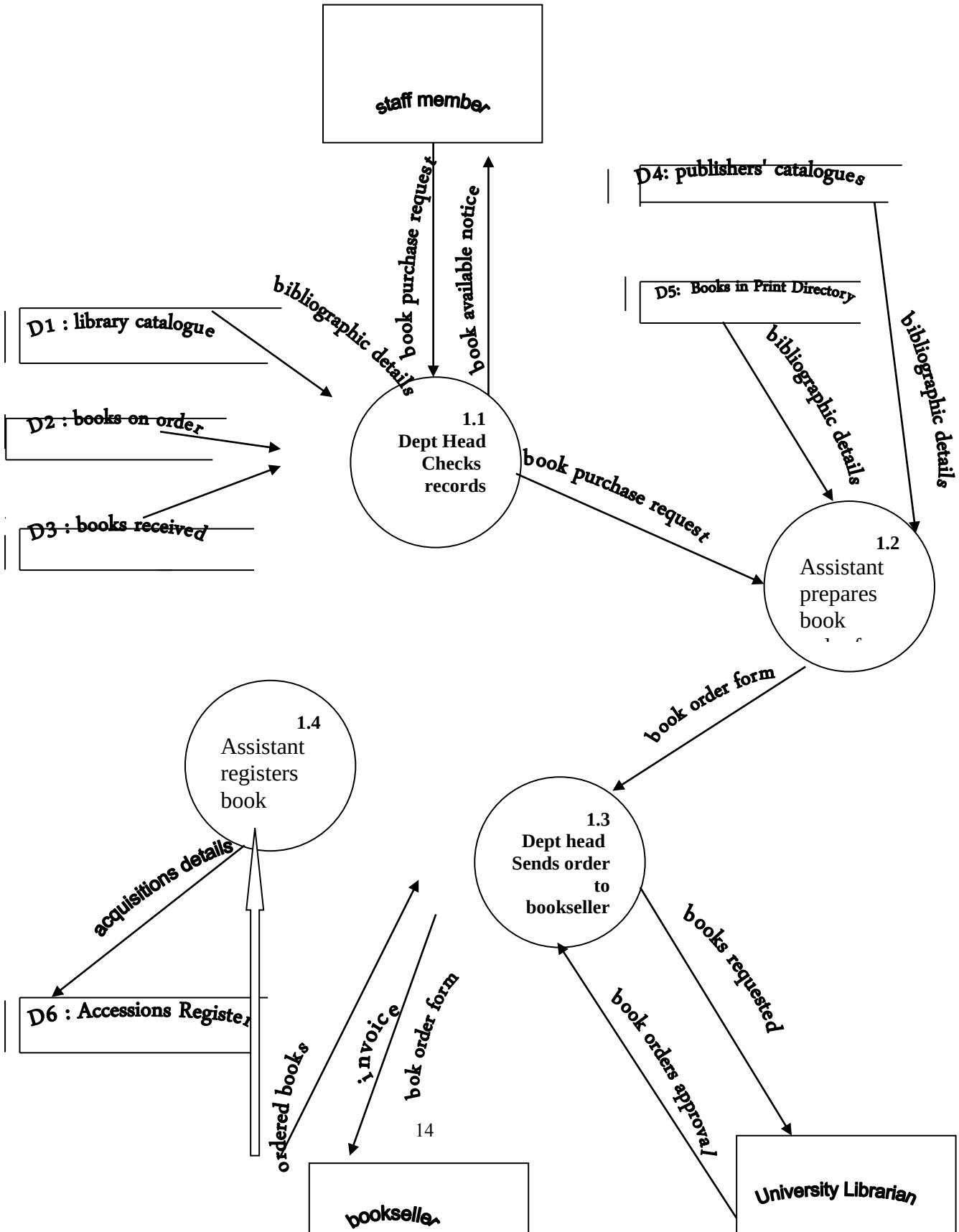

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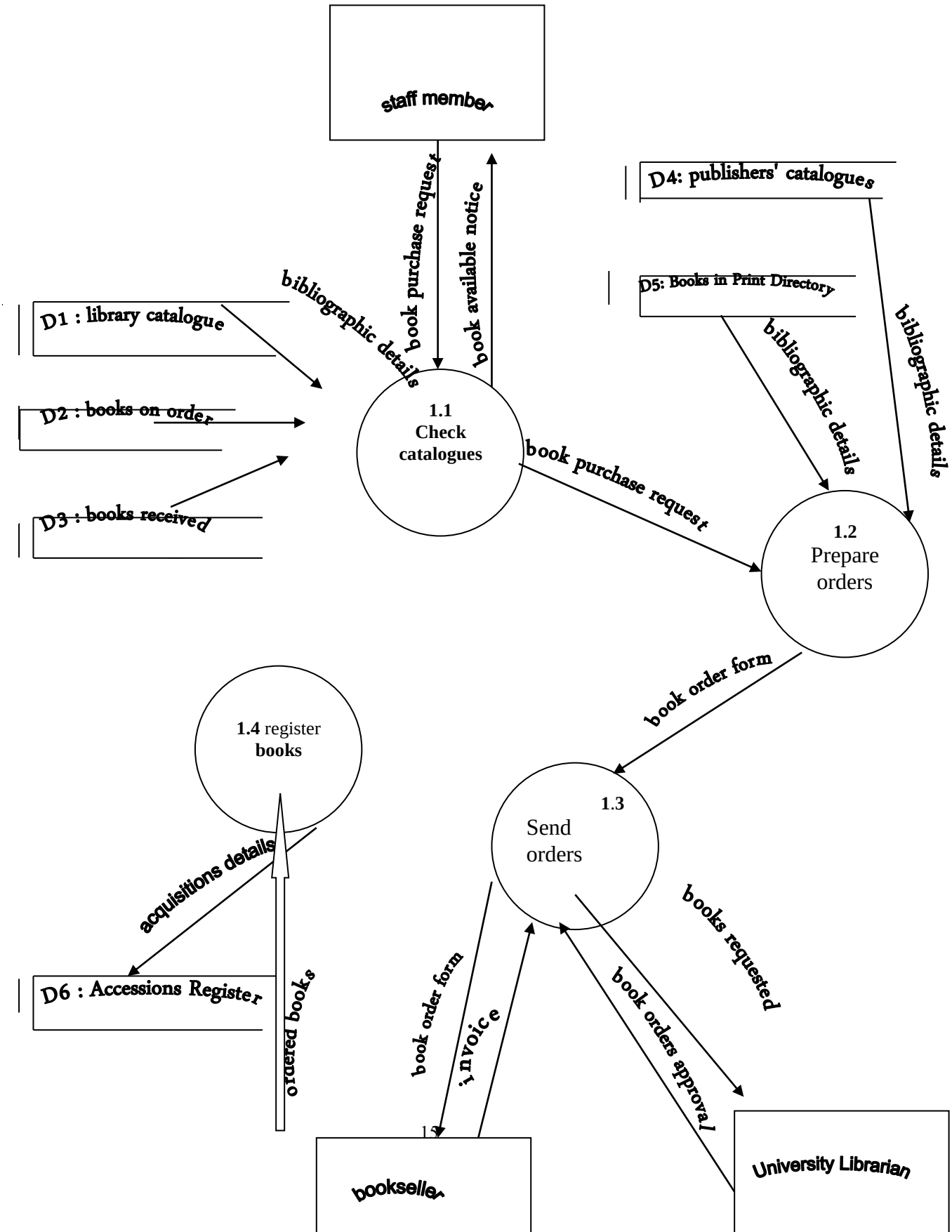
Fig 4. Logical Data Flow Diagram of the Acquisitions Subsystem



The Cataloguing Subsystems

Activities of the Cataloguing and Classification Section

The following activities are carried out in this section:

a. Cataloguing the book following the Anglo-American Cataloguing Rules, second edition (AACR2). This is done by extracting the major bibliographical data that describe the book. Major bibliographic data include the following items:

- Author statement, including editors, revisers, translators, etc.
- Title, including subtitles
- Edition,
- Place of publication, publisher, and date of publication,
- Series statement,
- International Standard Book Number (ISBN),
- Price.

b. Classifying the item according to the Dewey Decimal Classification Scheme (**DDC**). Implementation of the **DDC** in the U of K library is a realization of one of the recommendations of the Carpenter report as mentioned earlier. Previously, the library used to classify according to the Bliss Bibliographic Classification Scheme.

c. Assigning a call number for the catalogued item with the help of the Dewey decimal classification Scheme DDC and authority file.

d. Pasting the spine of the book and noting the call No. on the spine label.

e. Preparing temporary catalogue cards to be used by the staff of the circulation subsystem because there was always time lag before the final catalogue cards are typed.

f. Preparing library catalogue cards; author, subject and classified catalogue cards for each processed item.

g. Sending the processed books to the Reader Services Department (the Circulation Section).

h. Sending reminders to staff members who have requested some of the processed items.

i. Transferring catalogue cards to the Reader Services Department, where they are kept in their respective catalogue boxes.

The above activities are depicted graphically in figure 5. "Physical DFD of the Catalogues subsystem", and in figure 6 "Logical DFD of the cataloguing subsystem".

Fig. 5. Physical Data Flow Diagram of the Cataloguing Subsystem

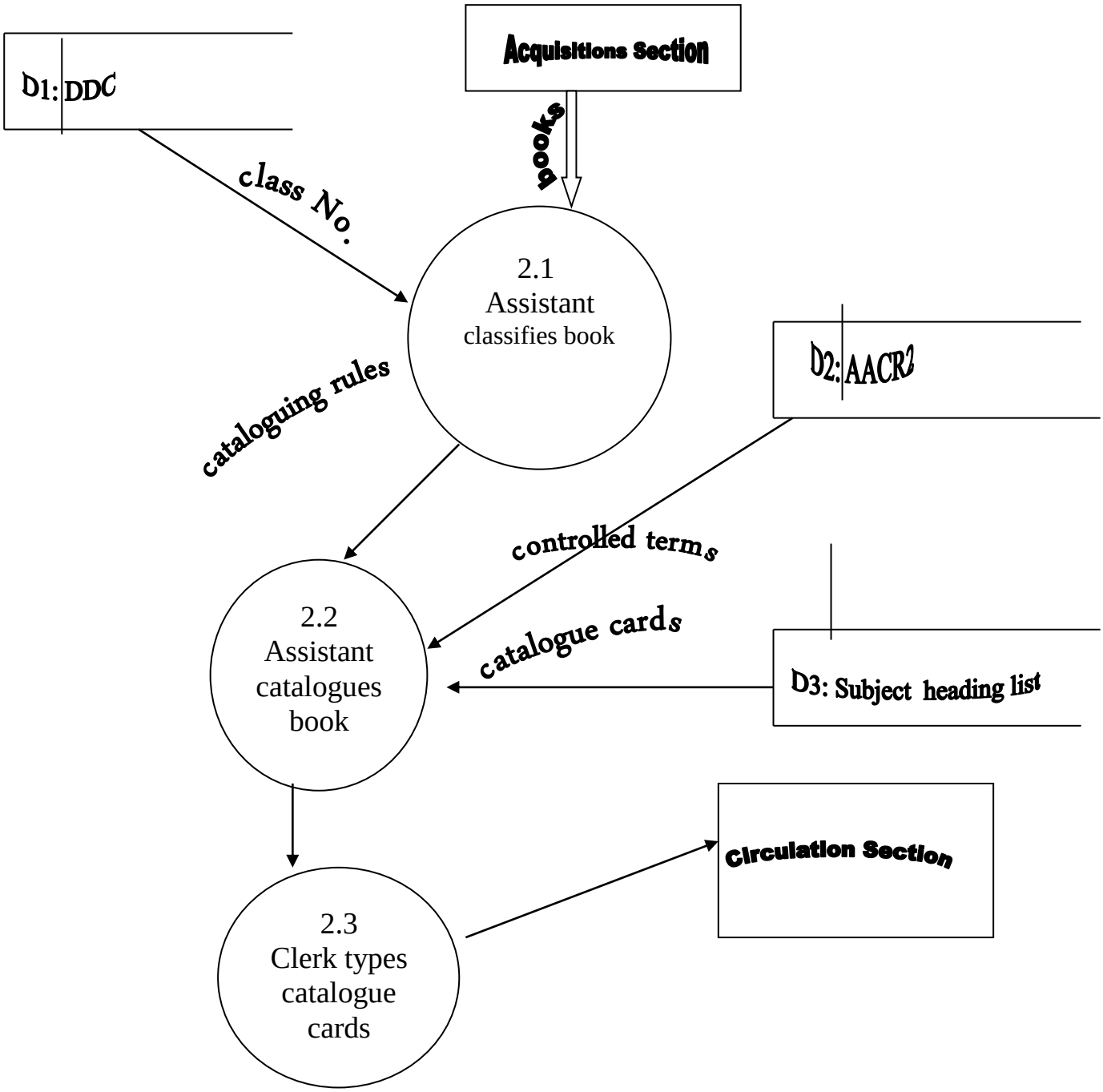
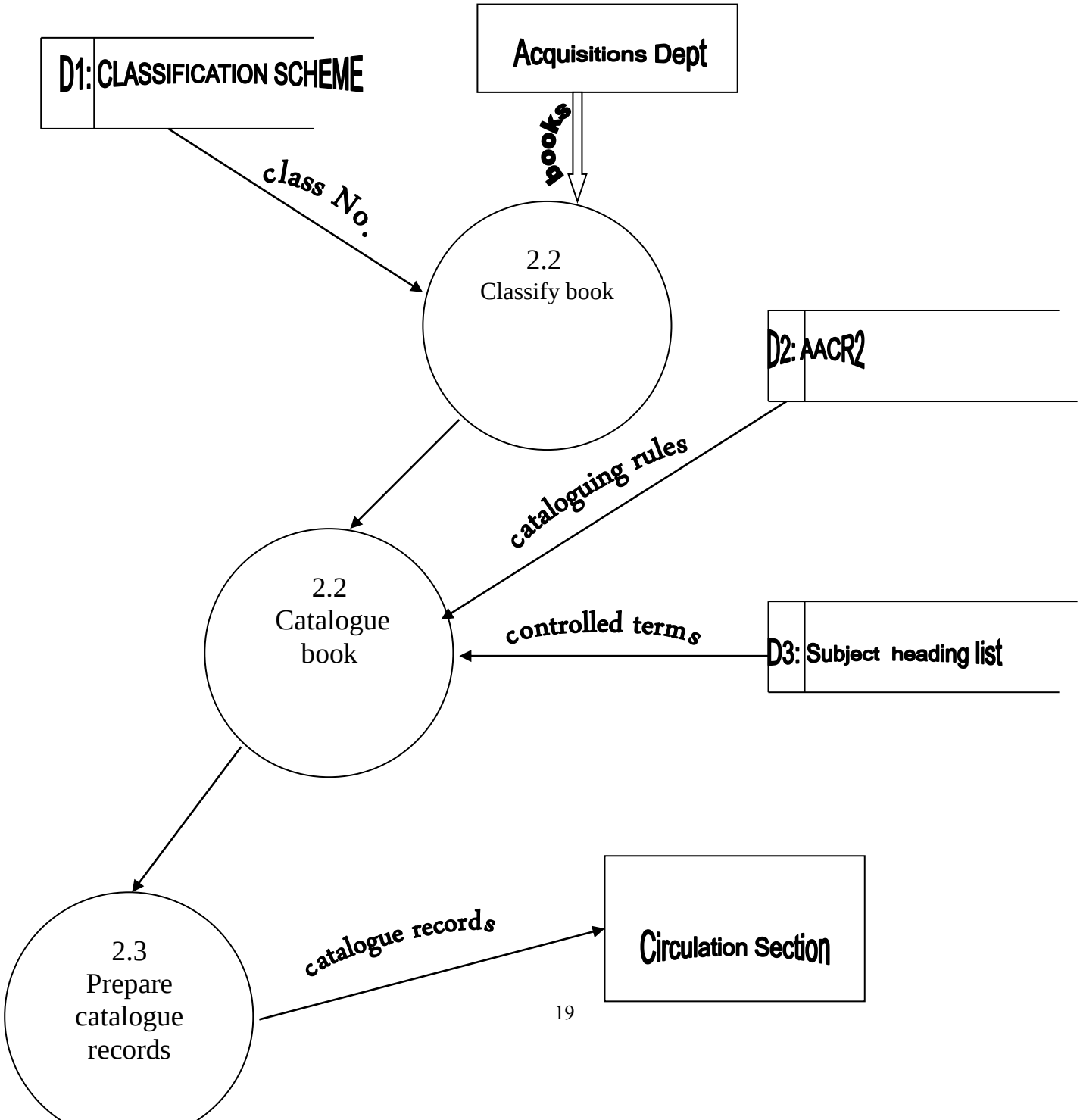


Fig. 6. Logical Data flow Diagram of the Cataloguing Subsystem



The Circulation Subsystem (The Reader Services Section)

Procedures in the Circulation Subsystem

The procedures below are depicted graphically in figure 7. 'Physical DFD of the Circulation Subsystem"

a. Requests for spot reading are received from students.

b. Requests for borrowing are received from staff members.

c. Borrower's data is checked against the borrowers' file before loans are granted.

d. Catalogues are consulted for call numbers.

e. Books are issued to borrowers.

Fig. 7. Physical Data Flow Diagram of the Circulation Subsystem

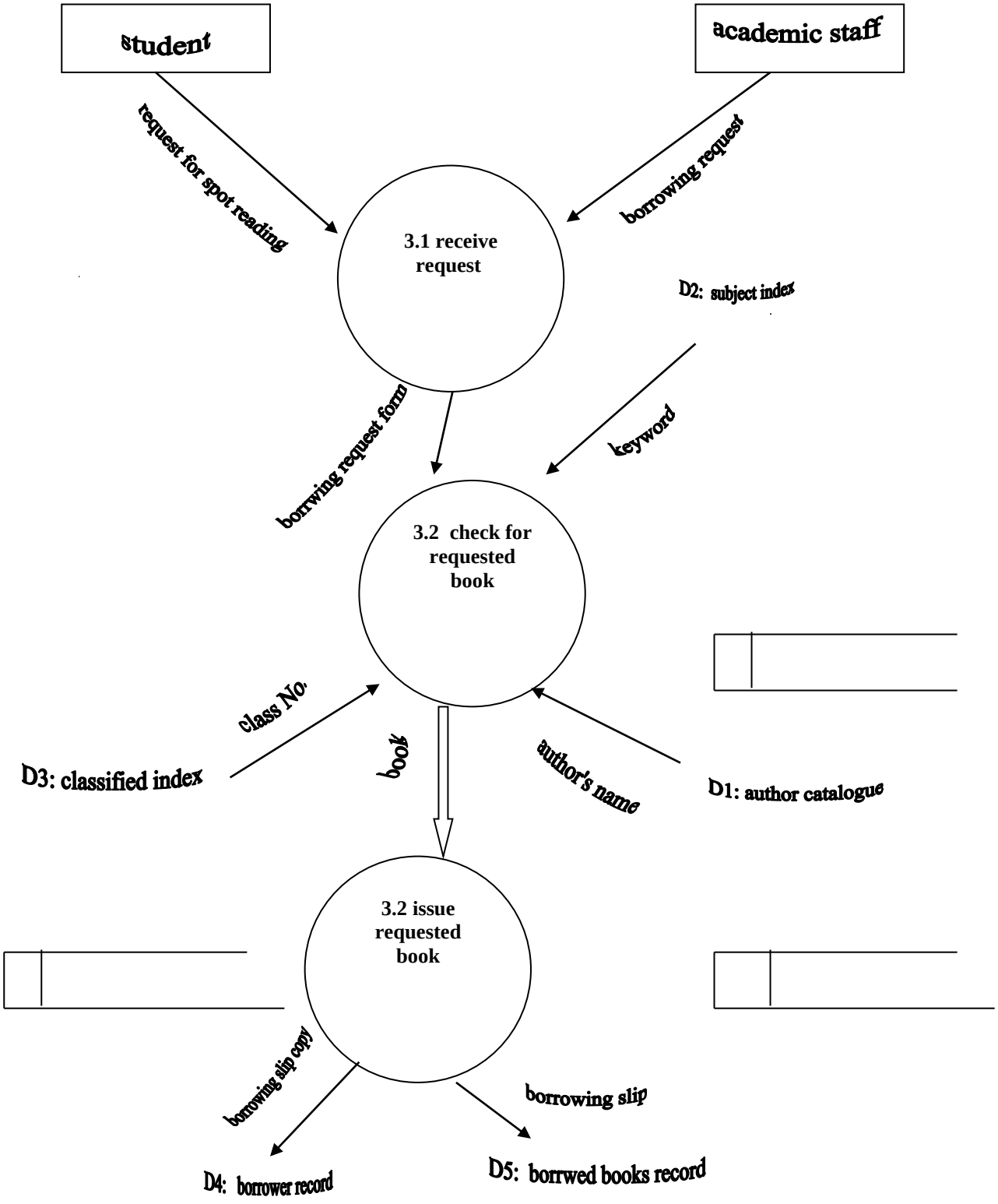
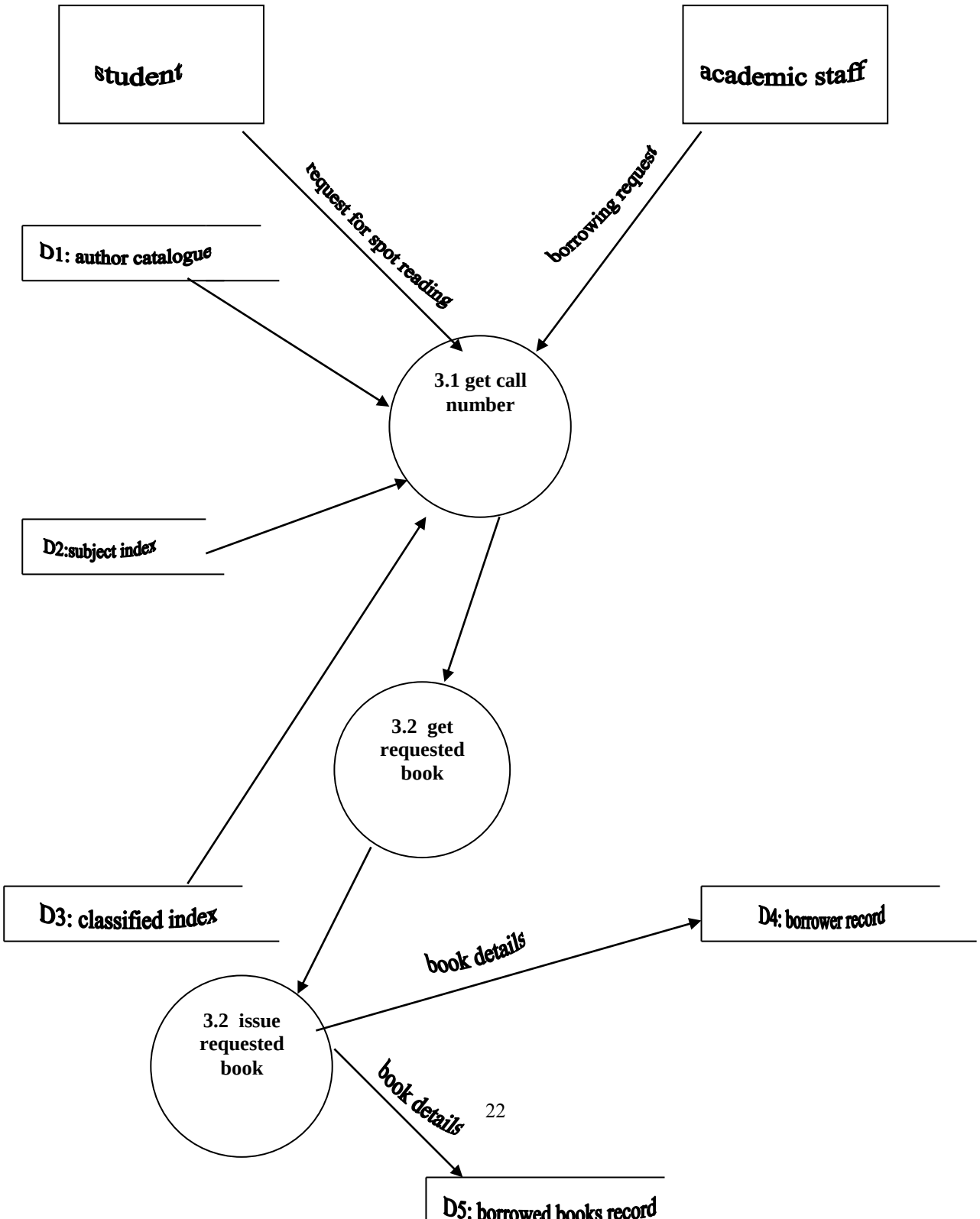


Fig. 8. Logical Data Flow Diagram of the Circulation subsystem



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