A handbook for library decision makers making use of system dynamics and simulation modeling to handle library decisions. It is an extension of the application of simulation modeling in social systems such as libraries for day-to-day decisions. Library middle managers as well as top managers can make use of this tool. Are you a librarian who wants to make a difference in your decision making? This is the tool you need.

Andrew Mwesigwa

Andrew Mwesigwa has M.Sc. in Information Systems and Bachelor of Library and Information Science degrees of Makerere University. For over 10 years he has managed information services both in NGOs and academic institutions. Currently he is a Librarian I Academic at Makerere University. His professional philosophies are the 5 laws of library science.

A Decision Support Tool for Library Book Inventory Management
managing book stocks and space in view of user needs

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Andrew Mwesigwa

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by

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A Project Report Submitted to School of Graduate Studies in Partial Fulfillment for the Award of Master of Science in Information Systems Degree of Makerere University

OPTION: Information Systems Management

October, 2009
Declaration

I, Mwesigwa Andrew, do hereby declare that this Project Report is original and has not been published and/or submitted for any other degree award to any University before.

Signed: [Signature] Date: 02\textsuperscript{nd} October 2009

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This Project Report has been submitted with my approval as Supervisor

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Dedication

I dedicate this work to my lovely wife Gift Peninah Wakabala-Mwesigwa, who has been very understanding and sacrificed the first year of our marriage, to enable me finish the Masters degree. I will forever be grateful [Psalm 128:3].
Acknowledgements

First of all, I give God the glory for enabling me to finish this work. [Psalm 124].

I would like to appreciate my Supervisor, Dr. Ddembe Williams for guiding me throughout this work and for inspiring me to develop a liking for System Dynamics and its role in real life. Thank you for helping me to see the world differently by introducing, to us as a class, systems thinking. I am also indebted to Dr. Agnes Rwashana, Mr. Benedict Oyo and the entire staff in the Department of Information Systems for their input in my work.

I appreciate my family; my Mum, Mrs. Lillian Sansa, brothers Peter and Paul, the Wakabalas, the Nabuleres and the Otims for being a backbone for my life.

Let me thank my Pastors, Robert and Jessica Kayanja, Pastor David and Mrs. Grace Makoko, and the entire Pastoral staff at the Miracle Centre Cathedral, for encouraging and challenging me to pursue my God-given dreams.

Lastly, my appreciation also goes to the Makerere University Library Staff, Institute of Environment Staff, students and Librarians for allowing me to use their data and for allowing to be interviewed in the midst of their tight work schedules.

May God richly bless you all.
Contents

Declaration ......................................................................................................................... i
Approval ........................................................................................................................... i
Dedication ........................................................................................................................ ii
Acknowledgements ......................................................................................................... iii
Contents ........................................................................................................................... iv
List of Tables .................................................................................................................... viii
List of Figures ................................................................................................................... ix
List of Acronyms .............................................................................................................. x
Definitions of Key Terms ............................................................................................... xi
Abstract .......................................................................................................................... xii

1 INTRODUCTION .......................................................................................................... 1
  1.1 Background .............................................................................................................. 1
  1.2 Sources of the Problem .......................................................................................... 2
  1.3 Problem Statement ............................................................................................... 2
  1.4 Objectives .............................................................................................................. 3
    1.4.1 General Objective ............................................................................................. 3
    1.4.2 Specific Objectives .......................................................................................... 3
  1.5 Scope ...................................................................................................................... 3
  1.6 Significance of the Study ....................................................................................... 3
    1.6.1 Benefits to Society ......................................................................................... 3
    1.6.2 Academic Contributions ................................................................................. 4

2 LITERATURE REVIEW ............................................................................................... 5
  2.1 State of the Art on Library Management Systems ............................................... 5
  2.2 Library Decision Support Systems ........................................................................ 5
  2.3 State of Practice of Book Inventory Management ................................................. 6
  2.4 Conclusions .......................................................................................................... 7

3 METHODOLOGY ......................................................................................................... 8
  3.1 Introduction ............................................................................................................. 8
  3.2 System Dynamics .................................................................................................. 8
4 PRESENTATION OF RESULTS ..........................................................16

4.1 Data Analysis .................................................................16

4.1.1 Reader Composition. ..................................................16

4.1.2 Use of Course Reference Lists in the Library.........................17

4.1.3 Curriculum Coverage Reflected by Library Book Stock...............17

4.1.4 Use of Books in Other Libraries.......................................18

4.1.5 Key Issues in Library Book Inventory Management...................18

4.1.6 Book Retrieval Mechanism.............................................19

4.1.7 Sharing of Few Copies of Books: an Inconvenience.....................19

4.2 Dynamic Hypothesis ..........................................................21

4.3 Relationships between Variables and Loops in the Dynamic Hypothesis....21

4.4 Causal Loop Diagram ..........................................................23

4.5 Modeling Decisions ..........................................................24

4.6 Model Structure ................................................................24

4.6.1 Book Management Sub-System ..........................................25

4.6.2 Shelf Utilization Sub-System ............................................26

4.6.3 Floor Space Management Sub-System ..................................27

4.6.4 Readers Sub-System ........................................................28

4.6.5 Faculty Management Sub-System ........................................29
Appendix I: Interview Guide for Faculty Managers (Lecturer/Library Coordinator)........61
Appendix J: Interview Guide for Library Users.................................................64
Appendix K: Interview Guide for Librarians......................................................65
Appendix L: Time Line and Research Budget.....................................................67
List of Tables

3.1 Comparison Summary of System Dynamics Methodologies .......................... 12
4.1 Number of Library Users................................................................. 17
4.2 Readers’ Use of Course Reference Lists................................................. 17
4.3 Course Reference Titles Reflected in Library Book Stock.......................... 17
4.4 Curriculum Coverage in the Library....................................................... 18
4.5 Readers’ Use of Books in Other Libraries................................................. 18
4.6 Factors Affecting Library Users............................................................ 18
4.7 Retrieval of Books .............................................................................. 19
4.8 Sharing of Few Copies of Books............................................................. 19
4.9 Books Shared ..................................................................................... 20
4.10 Inputs of the Model .......................................................................... 33
4.11 Out Table of the Model ..................................................................... 34
5.1 Evaluation of the Tool/Model................................................................. 46
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Iterative and Non-Linear Modeling</td>
<td>9</td>
</tr>
<tr>
<td>3.2</td>
<td>Dynamic Synthesis Methodology</td>
<td>13</td>
</tr>
<tr>
<td>4.1</td>
<td>Reader Composition Pie-chart</td>
<td>17</td>
</tr>
<tr>
<td>4.2</td>
<td>Dynamic Hypothesis</td>
<td>21</td>
</tr>
<tr>
<td>4.3</td>
<td>Causal Loop Diagram</td>
<td>23</td>
</tr>
<tr>
<td>4.4</td>
<td>Book Management Subsystem</td>
<td>25</td>
</tr>
<tr>
<td>4.5</td>
<td>Shelf Utilization Subsystem</td>
<td>26</td>
</tr>
<tr>
<td>4.6</td>
<td>Floor Space Management Subsystem</td>
<td>27</td>
</tr>
<tr>
<td>4.7</td>
<td>Readers Subsystem</td>
<td>28</td>
</tr>
<tr>
<td>4.8</td>
<td>Faculty Management Subsystem</td>
<td>29</td>
</tr>
<tr>
<td>4.9</td>
<td>Library Management Subsystem</td>
<td>30</td>
</tr>
<tr>
<td>4.10</td>
<td>The Home Page of the Tool</td>
<td>32</td>
</tr>
<tr>
<td>4.11</td>
<td>High-Level Map of the Tool</td>
<td>35</td>
</tr>
<tr>
<td>4.12</td>
<td>Simulation Experiment1</td>
<td>36</td>
</tr>
<tr>
<td>4.13</td>
<td>Simulation Experiment2</td>
<td>37</td>
</tr>
<tr>
<td>4.14</td>
<td>Simulation Experiment3</td>
<td>38</td>
</tr>
<tr>
<td>4.15</td>
<td>Simulation Experiment4</td>
<td>39</td>
</tr>
<tr>
<td>4.16</td>
<td>Simulation Experiment5</td>
<td>40</td>
</tr>
<tr>
<td>4.17</td>
<td>Simulation Experiment6</td>
<td>41</td>
</tr>
<tr>
<td>4.18</td>
<td>Simulation Experiment7</td>
<td>42</td>
</tr>
</tbody>
</table>
Acronyms Used

CLD: Causal Loop Diagram
CM: Collection Management
CREW: Continuous Review, Evaluation and Weeding
DSM: Dynamic Synthesis Methodology
DSS: Decision Support System
ILMS: Integrated Library Management System
LDSS: Library Decision Support System
LIS: Library Information System
MCM: Managing From Clarity Methodology
MUSTIE:
  M= Misleading—factually inaccurate;
  U= Ugly—worn beyond mending or rebinding;
  S= Superseded—by a new edition of by a much better book on the subject;
  T= Trivial—of no discernible literary or scientific merit;
  I= Irrelevant to the needs and interests of the library’s Community;
  E= Elsewhere—the material is easily obtainable from another library
OPAC: Online Public Access Catalogue
RFID: Radio Frequency Identification
SD: System Dynamics
SM: Simulation Modeling
Definition of Key Terms

**Decision Support Systems (DSS)** are computer based frameworks that support managers in making semi-structured and unstructured decisions by capturing, organizing and analyzing of information from a variety of sources as well as facilitating the evaluation of assumptions underlying the use of specific models (Koutsoukis et al., 2000; Ssemaluulu, 2005, p. 2). Therefore a Library Decision Support System (LDSS) is a type of Library Information System (LIS) designed to provide informed decision making by Librarians (Needamangala, 2000, p. 1; Harrod’s librarians’ glossary, 1995, p.322, 192).

A Decision Support Tool is therefore a tool that uses models of a system depicting feedback loops, thereby providing information about system behavior over time so as to facilitate decision making by managers (Ssemaluulu, 2005, p. 2). This is done through scenario planning and introduction of various strategies and exploration of their impact over time (Ssemaluulu, 2005, p. 2).

**A library** is a collection of information resources, staff, technology and other resources organized in order to meet the information needs of given user groups (Feather and Sturges, 1997; Harrod’s librarians’ glossary, 1995, p.377). **An Academic Library** is the library of a college, university, junior college or other institution of higher education, organized to meet the information needs of students, faculty and staff (Feather and Sturges, 1997; Harrod’s librarians’ glossary, 1995, p.3).

**Library book inventory management or Collection Management (CM)** is the deliberate and carefully planned process of needs assessment, book selection and acquisition, collection organization and use control as well as collection evaluation. During CM books identified as old (torn), obsolete, outdated or inadequate for the user community are withdrawn (weeded out); thereby ensuring that the collection that remains is useful and useable (Holt, 2007; Harrod’s librarians’ glossary, 1995, p.146).
Abstract

For over 25 years now Decision Support Tools (DSTs) have been used to assist in operations research and information systems management (Greasley, 2004; Eom, 1999). However, managers of social systems such as libraries have lacked appropriate communication strategies causing a rift amongst stakeholders, with the latter questioning the validity of decisions made by managers (Holt, 2007).

This project developed a simulation Decision Support Tool for evaluating the impact of the important factors in library book inventory management. With the application of the dynamic synthesis methodology as developed by Williams (2002), it was possible to depict stakeholder input in decision making, thereby optimizing library inventory management performance.

Having examined the existing methods in library inventory management, they were found wanting in tackling book collection management complexities. The problem was therefore discovered to be a system dynamics problem because it exhibited characteristics such as failure of obvious solutions to respond to the inventory management problem. Various System Dynamics methodologies were evaluated and literature reviewed revealed that the Dynamic Synthesis Methodology was the best suitable for this project because of its clarity at data collection stage and its combinatorial advantage to employ both the case study technique and the power of simulation modeling. These two merits were not found in the other system dynamics approaches (Williams, 2002).

A dynamic hypothesis was developed based on a model suggested by Boon (1995) and with the input from the data collected. This dynamic hypothesis showed the interrelationships between key variables in library book inventory management. It was then used to derive a causal loop diagram. A simulation tool was then developed to evaluate the impact of these variables on library book inventory management. Analysis of the impact of these variables was made and it was concluded that the combination of all the factors gave a proper picture of what decisions needed to be made in order to manage library book stocks with optimization.
CHAPTER 1

INTRODUCTION

1.1 Background

Decision Support Systems (DSS) are increasingly becoming useful tools that have caught the attention of managers and operations research practitioners for over 25 years now (Eom, 1999). According to Bhargava and Noris (1996) managers of organizations face challenges in decision making because of the volatile and complex environment in which they operate. It requires careful examination of internal and external factors. This can be done in various ways, such as simulation modeling (SM) (Greasley, 2004).

Libraries face perpetual book inventory management challenges. This has aroused international research concern and response (Kempf, 2005; Shouse and Teel, 2006). While books are acquired by libraries with the aim of meeting information needs of their communities, a time comes when the management of the existing book stock becomes a challenge. Maintenance of relevant collections remains a mystery (Handis, 2007) because of inadequate information for decision support (Beals, 2006). Worse still, there is inadequate communication because of absence of input from library stakeholders (Oder, 2007).

According to Corrigan (2005) book stock inventory management involves a number of stakeholders who influence decisions (Corrigan, 2005). Library patrons (students and faculty), librarians, boards of parent institutions, donors and management staff are the stakeholders. The stakeholder, who controls the decision making process, influences inventory management, which introduces bias (Corrigan, 2005). It has been observed that inventory control takes on both subjective and objective approaches (L. Luboobi, personal communication, February 22, 2007; Massey, 2006). For example, the librarian may assess and identify books to weed out basing on a contentious factor such as age while faculty may assess the same books as resourceful basing on the content. This makes the book inventory management process unreliable and undermines some stakeholders’ interests (Grace and Bremner, 2004; Oder, 2007).
1.2 Sources of the Problem

With the background about the use of DSS in managing social systems and having recognized the library book inventory management problem the following have been cited as causes of the problem that necessitate application of DSS in library management (Needamangala, 2000, p.2). These have been cited as below (Oder, 2007; Holt, 2007; Ameen and Haider, 2007):

1. Difficulty in justifying decisions made by library managers
2. Lack of a communication strategy among stakeholders
3. Dynamic nature of libraries and their use over time
4. Misconceptions among librarians such as preference for ‘big size’ libraries and the view that books are “sacred”
5. Lack of management support and legal implications of disposing off books
6. Low library service visibility and competition with electronic/online resources
7. Low budgets that cannot support acquisition of more book-shelves and new books

However, this project will attempt to solve the complexity in justification and communication of decisions by library managers. The model intends to be a forum for attracting input from all library stakeholders. As a result it also intends to capture the dynamic nature and interacting subsystems within the library system.

1.3 Problem Statement

Consideration of the important factors pertinent to library evaluation has received little or no attention from many library managers (Alemna, 1999). Traditionally, librarians have made biased decisions on collection management issues, based on a limited perspective. Library stakeholders have been left out in decision making, leaving them persistently complaining about the way the library service has been run (Oder, 2007). Obvious solutions have ignored stakeholder input, leading to low visibility of the library service among its intended users (Ameen and Haider, 2007; Oder, 2007). There is therefore need to develop tools and models to assist library managers make informed decisions thereby promoting communication, of why things are the way they are in the library, to stakeholders (Needamangala, 2000, p.2).
1.4 Objectives

1.4.1 General Objective

To develop a book inventory management model as a decision support tool.

1.4.2 Specific Objectives

The specific objectives of the research project were:

1. To identify important factors which are prerequisite for effective book inventory management in libraries and establish requirements for the book inventory decision support tool
2. To design the book inventory decision support tool
3. To implement the book inventory decision support tool
4. To test the applicability of the book inventory decision support tool

1.5 Scope

There are various types of libraries but this project will focus on academic libraries and in particular, Makerere University Institute of Environment Library will be investigated. This project will focus on designing a computer-based tool that facilitates book inventory management of library collections that are in active use.

1.6 Significance of the Study

The proposed research had theoretical, practical, and methodological significance:

1.6.1 Benefits to Society

The project was intended to provide a basis for managers to measure collection strength. Evaluation of library book inventory is of utmost importance because library managers could ascertain the strength of their library collections, identify information gaps, and then promote the development of quality collections.
Secondly, the resultant tool of this project was seen as an authentic decision support tool useful for enabling library managers to evaluate available alternatives during the book inventory management decision processes. It optimized decision making in book stock control by library managers.

Developing models of the book inventory system was an attempt to provide a communication medium among library stakeholders. The tool bridges the communication gap amongst stakeholders because multiple stakeholder input was taken modeled. Divergent views of stakeholders were modeled and scenario planning was portrayed through simulation experiments.

Computer-based evaluation provided guidelines for the formulation of book inventory management policies and showed case for library funding. Therefore models of the system were viewed as helpful in defending library budgets that support the proposed policy.

1.6.2 Academic Contribution

This study contributes to the exploration of the application areas of Decision Support Systems in library management. Therefore it is a contribution to the literature on library decision support efforts, which Needamangala (2000, p. 2) has expressed need to advance. It is a way to harness the power of information technology in library management through a more aggressive discovery of organizational intelligence to support goals and objectives (Spletstioesser and Kimaro, 2000).

The research is an added brick on the application of system dynamics (SD) in the management of social systems. Libraries being social systems, the investigation of cause and effect relationships was possible. It encourages library managers to appreciate the role of systems thinking in managing their library services.
CHAPTER 2

LITERATURE REVIEW

2.1 State of the Art on Library Management Systems

According to recent studies (Adogbeji and Adomi, 2005), there is a steady increase in the development of library information systems (LIS), or Integrated Library Management Systems (ILMS) (Felstead, 2004). These are databases, which give an online presence of the library in form of online public access catalogues (OPAC). Radio Frequency Identification (RFID) technology has also been applied to monitor book movement (Yorkovich, 2001).

2.2 Library Decision Support System (LDSS) Projects in Literature

A library acquisitions decision support tool was developed by Uzoka and Ijatuyi (2005). It was developed to aid in deciding which books should be acquired within the library collection. Using the “pairwise comparison matrix” this tool produces eigenvalues, and a step by step mode is followed in order to refine the results of the conventional acquisition process in order to achieve some level of optimality. This method, however, assumes that the manager doing comparisons has a strong mathematical background.

Needamangala’s work (2000, p. 2) stresses the application of data warehousing and data mining technologies in building decision support systems. Top-level library management can query the LDSS and manipulate financial data to explore past expenditures. Book selectors can use the mining component of LDSS to generate domain rules and thereby, predict whether a particular book will be worth buying or not. However, it ignores the eventualities that could happen if variables change in the future (Needamangala, 2000, p. 3).

For a number of years group decision support systems (GDSSs) have been in use. In the library environment they enable groups of staff to exchange ideas in the context of a meeting
on a networked computer system (Aiken, Sexton & Chestman, 1994). GDSSs, such as GroupForum, therefore facilitate electronic communication and a means of arriving at decisions quickly. However, they are unable to offer scenario planning over time.

Geographic Information Systems (GIS) have also been used as decision support tools in Libraries. GIS have been applied in library information systems management to answer questions pertaining to better coordination of stock and services (Hawkins, 1994), data about books on loan as well as library architectural considerations and space availability management (Xia, 2000). It has been observed that data are geographically represented in the system as postal codes. The benefits of such DSS are limited only to provision of information about possible service areas (Martindale, 2004), but many other decision variables like user satisfaction, can not be spatially represented.

2.3 State of Practice of Book Inventory Management

A survey of the practice of collection management has depicted that book inventory management approaches vary from library to library (Ameen and Haider, 2007). There is no uniform agreed method that should guide librarians when making book inventory management decisions (Ameen and Haider, 2007). Each method has its own weaknesses but mainly owing to the subjective nature of decision making in collection management. Library collection management experts have pointed out the following methods being used in collection management (Agee, 2005; Slote, 1997; Boon, 1995):

Ameen and Haider (2007) suggest a user oriented library decision making approach, where the focus is on assessing a book in view of the reader information needs. If the content is useful, a book is marked as crucial for the collection (Ameen and Haider, 2007). It is this that drives library holdings stock-taking exercises. It does not cater for future needs because measurements of title suitability are based on present or past use statistics. This approach ignores all other stakeholders’ interests and only focuses on the end user (reader). This is a source of bias in management decision making.

Furthermore, library book inventory decisions have been made basing on the physical condition of books as the major variable (Ameen and Haider, 2007). Library managers rely on the data about the physical condition of the book by using a checklist to manually evaluate
a book and then decide whether it is fit to stay in the collection or to be withdrawn (Ameen and Haider, 2007). It is dependent on the library manager’s judgment to make decisions hence it is vulnerable to the librarian’s bias.

Some library managers solely focus on Content Adequacy as the yard stick for making decisions concerning book stocks (Ameen and Haider, 2007). With this approach, curriculum needs guide librarians on deciding whether titles are still useful with the changing curricula covered in particular subject areas. This has remained a challenge because of varying and ever-changing user needs as well as donor influence over gift books which are donated without consideration of their usefulness to the user needs (Ameen and Haider, 2007).

In other libraries, there is the use of the “Continuous” “Review”, “Evaluation” and “Weeding” ("CREW") library evaluation model proposed by Boon (1995). In the CREW method, only six aspects are considered when making decisions concerning a library collection (Course 4: Weeding the Collection, 2007; Boon, 1995). If a library stock has books that are “Misleading”, “Ugly”, “Superseded by a new edition”, “Trivial and of no discernible literary/scientific merit”, “Irrelevant” to user needs, or can be obtained Elsewhere”, then there would be great need for library evaluation (1995). In this case, library stock management is only limited to these variables, which are represented by the “MUSTIE” acronym. However with this method, there is no display of stakeholder input.

2.4 Conclusion

In a nutshell library decision support methods are pertinent to collection management (CM). Traditionally, these have remained largely manual and there is no common ground for setting book stock management policies (Ameen and Haider, 2007). Different libraries employ different methods depending on the library type and stakeholders’ interests (Ameen and Haider, 2007). The librarian’s knowledge and bias has been realized to be prime influences in decision making that have ignored the broader perspective of all stakeholder interests. Library managers therefore need an enabling environment that provides for input from all stakeholders.
CHAPTER 3

METHODOLOGY

3.1 Introduction

This section presents the methodology that was used to carry out the study. The study was done using system dynamics approach following the path of the model analysis methodology that combines two methods which complement each other’s qualities in terms of theory building, testing and extension (Rwashana, 2004, p.18); these are simulation modeling and case study, and when combined they form a problem solving paradigm which has come to be known as Dynamic Synthesis Methodology (Williams, 2002). Its details are in figure 3.2.

3.2 System Dynamics

In systems dynamics, real world systems are represented in form of models in order to study system behavior. This allows realization of system behavior over time and the influence of underlying decision variables. Simulation experimentation is applied on these variables in order to see how the system behaves in different environments. The model is explicitly developed so that values are given to every parameter used and all relationships are clearly modeled. Different scenarios are evaluated, without experimentation on actual systems thereby reducing risks that various decisions would introduce. The models are well depicted and it is easy to see their relationship with reality (Williams, 2002; Greasley, 2004; Richmond, 1994).

According to Rwashana (2008, p. 3, 144) System Dynamics (SD) uses system thinking methodologies. System thinking enables understanding of interrelationships between different parts of complex systems, thereby promoting understanding of the cause and effect factors pertinent to these systems under study. This eases understanding of behavior of the complex systems through the tools that are built using system thinking because managers can better understand why the system behaves the way it does under given conditions as well as due to specific system modifications. Within system dynamics, several methodologies can
employed depending on the suitability in solving given problems (Williams, 2002; Rwashana, 2008, p.49).

3.2.1 Iterative and Non Linear Approach

Richardson and Pugh (as cited in Rwashana, 2008, p. 41) argue that one begins System Dynamics modeling with understanding and ends it with more understanding of the problem being studied. It is made up of six phases: definition of the problem, conceptualization of the system, formation of model, policy analysis as well as policy implementation.

![Figure 3.1: Iterative and Non-Linear Modeling](Adapted from Richardson and Pugh, (as cited in Rwashana, 2008, p. 42))

3.2.2 Managing from Clarity Methodology (MCM)

This methodology relies mainly on System Dynamics Stock and Flow modeling to portray the dynamics around resources thereby offering deep insight into the system so that modelers can better understand the system (Ritchie-Dunham and Rabbino, 2001). When modeling using MCM one has to build the GRASP map depicting organization’s main goals, resources, actions, structure and people with qualitative description of the cause and effect linkages
(Ritchie-Dunham and Rabbino, 2001). This is followed by quantifying the dynamics of key resources, introducing policies and exploring their unintended effects. Strategies are recommended and hypotheses are quantitatively tested to show resource utilization over a period of time (Ritchie-Dunham and Rabbino, 2001).

Map integration and validation follows suit, then scenario planning and building strategic foresight, thereby enabling strategy integration and selection of the best strategies and structures (Ritchie-Dunham and Rabbino, 2001). This is followed by designing key assumptions that helps the system to take care of future changes (Ritchie-Dunham and Rabbino, 2001). Finally, there is the learning of interfaces designed to communicate the best strategies to all stakeholders (Ritchie-Dunham and Rabbino, 2001).

### 3.2.3 System Enquiry Approach

Simulation modeling and analysis of complex systems is carried out in this method (Wolstenholme, as cited in Rwashana, 2008, p. 41). However, this is facilitated if the complex systems are described qualitatively, having done an intensive exploration of their processes, information and definition of organizational boundaries and strategies (Wolstenholme, as cited in Rwashana, 2008, p. 41).

### 3.2.4 Structured Approach

According to Coyle (as cited in Rwashana, 2008, p. 40), time is an important aspect in analyzing problems. It looks at how a system can ‘be defended against or made to benefit from’ the changes in its environment. This approach takes on stages of: problem and stakeholder recognition, system description, building influences diagrams of inter-playing factors, qualitative analysis of information from key informants, constructing, testing and debugging of simulation model and policy testing and design.
3.2.5 Dynamic Synthesis Methodology (DSM)

Williams (2002) proposes the DSM approach which is endowed with the powerful combination of simulation modeling and case study methods that compliment each other. Simulation modeling allows scenario planning for a dynamic system (Williams, 2002; Rwashana, 2004, p.18). Working in a decision laboratory does not disrupt the operations of the system environment, while case studies gather as much qualitative data as possible about the system being modeled (Williams, 2002).

3.3 Analysis of System Dynamics Approaches

Rwashana’s (2008, p.49) point of view is that the System Dynamics methods proposed by Richardson and Pugh (1981) Wolstenholme (1990) and Ritchie-Dunhum and Rabbino (2001) are unable to guide researchers on how to gather the necessary data for model development. There is no stated way one can build effective models of the system under study because of inadequate information about the requirements (Rwashana, 2008, p.49). Therefore, the Dynamic Synthesis Methodology proposed by Williams (2002) is the most suitable in this study because it involves the case study technique that entails gathering information about the system, its users, requirements and stakeholders in the very environment of the system (Rwashana, 2008, p.49; Williams, 2002). However, the case study is coupled with simulation analysis for predictive and scenario planning by managers (Williams, 2002). This is the beauty of Dynamic Synthesis – its ability to combine both case study requirements gathering and the use of such data in simulating the dynamic variables involved in feedback oriented systems (Williams, 2002). Decision support in library book inventory management requires requirements gathering as well as scenario planning which can only be tackled by the dynamic synthesis methodology. Therefore in library book inventory management any attempt to separate the two techniques yields unsatisfactory research results because the problem is recurring and has not been successfully solved by other methods (Kempf, 2005; Oder, 2007; Handis, 2007)
### Table 3.1 Comparison Summary of System Dynamics Methodologies (Rwashana, 2008, p.50)

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<thead>
<tr>
<th>System Dynamics Approach</th>
<th>Stages of Analysis</th>
</tr>
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<tbody>
<tr>
<td>1. Iterative and Non Linear Approach (Richardson and Pugh, as cited in Rwashana, 2008, p. 41)</td>
<td>Problem definition&lt;br&gt;System conceptualization&lt;br&gt;Model formation&lt;br&gt;Simulation&lt;br&gt;Policy analysis&lt;br&gt;Policy implementation</td>
</tr>
<tr>
<td>2. Managing from Clarity Methodology (Ritchie-Dunham and Rabbino, 2001)</td>
<td>Building the GRASP map (goals, resources, actions, structure and people)&lt;br&gt;Quantification of key resources&lt;br&gt;Integration and validation of the map&lt;br&gt;Scenario planning and strategic foresight&lt;br&gt;Learning interfaces which are designed for communication</td>
</tr>
<tr>
<td>3. System Enquiry Approach (Wolstenholme, as cited in Rwashana, 2008, p. 41)</td>
<td>Problem structuring&lt;br&gt;Causal loop modeling&lt;br&gt;Dynamic modeling&lt;br&gt;Scenario planning and modeling&lt;br&gt;Implementation and organization&lt;br&gt;Problem definition&lt;br&gt;System conceptualization&lt;br&gt;Model formulation&lt;br&gt;Simulation&lt;br&gt;Policy analysis and implementation</td>
</tr>
<tr>
<td>4. Structured Approach (Coyle, as cited in Rwashana, 2008, p. 40)</td>
<td>Problem recognition&lt;br&gt;Problem understanding and system description&lt;br&gt;Qualitative analysis&lt;br&gt;Constructions, testing and debugging&lt;br&gt;Policy testing and design</td>
</tr>
<tr>
<td>5. Dynamic Synthesis Methodology</td>
<td>Problem statement&lt;br&gt;Field studies&lt;br&gt;System dynamics model building&lt;br&gt;Case studies&lt;br&gt;Simulation experiments&lt;br&gt;Model use and theory extension.</td>
</tr>
</tbody>
</table>
3.4 Proposed Methodology: Dynamics Synthesis Methodology (DSM) Research Design

Dynamic Synthesis Methodology (DSM) took on the following stages explained below

![Diagram of Dynamic Synthesis Methodology](image)

3.4.1 Problem statement

Literature was reviewed in order to analyze state of practice and existing theories on the problem as well as to derive understanding of vital variables, thereby defining the critical success factors of the book inventory management problem.

3.4.2 Field Studies

Field studies of the library book inventory system in an academic library were carried out in order to define the boundary of the model and highlight key variables, thereby refining the problem. Data was collected by direct interviews with librarians in charge of managing book collections/inventories. The researcher used interview guides as supporting research instruments during field visits. Use of archival research design was made by reviewing and analysis of existing library organizational literature containing historical and factual data.
Data collected and information acquired at this stage was used to develop the generic model.

Data collection took on the following stages:

a) **Selection of sample**
   The researcher used purposive sampling technique to pick 4 librarians in charge of collection management (CM), as respondents for interviews. Purposive sampling was used in order to collect credible data, facts and figures.

b) **Interviews**
   Four (4) expert/professional librarians were chosen for interview because of their roles and involvement in book stock management in the parent organization. Also 3 class representatives (student class leaders) were interviewed by the researcher because of their roles and ability to voice out reader opinions. With the help of an interview guide, the researcher carried out the interviews. Direct interviews enabled the researcher to collect relevant data since it was possible to ask probing questions and to clarify to respondents any interview question. By use of purposive sampling, from the population of 60 potential readers in a class 1 respondent was interviewed, that is, the class representative. However, interview questions had earlier been given to the entire class of 60 students so that they channeled their opinions through their leader, so that during the interviews, each of the 3 class representatives communicated the readers’ concerns. This helped in explaining causes and effects of key variables.

c) **Document Review**
   Also the researcher requested access to organizational documents about the operations of the library in order to get more information about library book inventory management. More facts and figures were obtained from such documents.

### 3.4.3 Data Analysis

Data was analyzed, concurrently with data collection, using MS Excel because of its ability to manipulate data which was exported into the modeling software chosen (STELLA).
3.4.4 System Dynamics Model Building

A descriptive model explaining interacting variables of the library system was the basis for building the dynamic hypothesis. This dynamic hypothesis was then translated into the causal loop diagram (CLD). The CLD was drawn using Vensim modeling software. The CLD promoted understanding of the problem. STELLA simulation software was used to develop the stock and flow diagrams in order to show the model structure with formal quantifiable variables. This way, the underlying mathematical rules inbuilt in the simulation software (STELLA) was able to aid measurement of the impact of interplaying variables.

3.4.5 Case Study

A case study was done in Makerere University Institute of Environment branch library. A branch library in Makerere University was purposively selected because of its prominence in academia in Uganda. A walk through the model showed the influence of crucial interrelationships, thus produced empirical evidence of system behavior over time.

3.4.6 Simulation Experiments

Having represented the abstract system of a real library book inventory system as stock and flow diagrams and having quantified the variables, ‘what if’ scenario experiments were conducted. The impact of modification of variable values and the introduction of various strategies, was studied. This promoted understanding of the behavior over time of the modeled system and guided in establishing decision rules for optimization. This assisted in scenario planning so that the model was regarded as useful for present and future library management planning.

3.4.7 Model Use and Theory Extension

The responses of the model to the introduction of different policies were tested and the understanding gained by the researcher was translated into policy recommendations for library managers.
Chapter 4

PRESENTATION OF RESULTS

4.1 Data Analysis

Reader Responses from the Makerere University Institute of Environment library users were routed through interviews with three class representatives of the three classes of the Bachelors degree – the only three-year taught course of the institute. Data gathered were used in the case study as it provided some of the key variables in book inventory management.

This target population was purposively selected as one of the faculties with a branch library that serves mainly the needs of the taught programmes in Makerere University.

Data analysis below was done using Microsoft Excel package.

4.1.1 About Reader Composition

On average, readers were 60 in each class as seen in table 4.1 below. In this case study therefore, reader population of 60 is assumed because it looks in detail the subjects taken by one class, the 1st Year class on the Bachelor of Environmental Science degree programme. Therefore experimentation purposes only 10 course units were included in the designed decision support tool. However, the tool can be customized to suit any library or to include more variables.

<table>
<thead>
<tr>
<th>Year of Study</th>
<th>Number of Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year</td>
<td>61</td>
</tr>
<tr>
<td>2nd Year</td>
<td>56</td>
</tr>
<tr>
<td>3rd Year</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
</tr>
<tr>
<td>Average</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 4.1: Number of Library Users
4.1.2 Use of Course Reference Lists in the Library

All readers had course reference lists which contain books that cover the curriculum of the study programme. Using these lists students sought for books to meet their information needs.

<table>
<thead>
<tr>
<th>Type of Response</th>
<th>Number of Responses</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3</td>
<td>100%</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total Responses</td>
<td>3</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.2: Reader use of course reference lists to access books

4.1.3 Curriculum Coverage Reflected by the Library Book Stock

Most of the books on student reference lists were available in the library collection but there were a few books that were not available in the Institute’s library.

<table>
<thead>
<tr>
<th>Type of Response</th>
<th>Number of Responses</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>2</td>
<td>67%</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>33%</td>
</tr>
<tr>
<td>Total Responses</td>
<td>3</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.3: Course reference Titles Reflected in the Library Book Stock
Every subject taught in the Institute of Environment was reflected in the library book collection, as seen in table 4.4 below. This was because in collection development every department kept ordering for books.

<table>
<thead>
<tr>
<th>Number of Responses</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Responses</td>
<td>3</td>
</tr>
<tr>
<td>Percentage Response</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.4: Subject/Curriculum Coverage of Books in the Library

4.1.4 Use of Books in Other Libraries

Most of the readers borrowed books in other libraries to meet their information needs or at least used books elsewhere to supplement what they were exposed to in their own library.

<table>
<thead>
<tr>
<th>Number of Responses</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Responses</td>
<td>3</td>
</tr>
<tr>
<td>Percentage Response</td>
<td>67%</td>
</tr>
</tbody>
</table>

Table 4.5: Use of Books in Other Libraries

4.1.5 Key Issues in Library Book Inventory Management

Looking at table 4.6 below, it was seen that access to the books in the library was the most important factor that readers highlighted in the interview because most of the readers gave issues that were access related or preconditions to access to books. Meanwhile, a few of the readers were of the opinion that security of their bags and other property was a problem that needed attention.

<table>
<thead>
<tr>
<th>Response</th>
<th>Number of Responses</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access related issues</td>
<td>14</td>
<td>93%</td>
</tr>
<tr>
<td>Security of readers’</td>
<td>1</td>
<td>7%</td>
</tr>
<tr>
<td>property</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Responses</td>
<td>15</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.6: Factors affecting Library Users
4.1.6 Retrieval Mechanism or Access of Books in the Library

All users of this library agreed that browsing of shelves guided by shelf subject-labels, asking for help from librarian, as well as reference to available lists of dissertations were the mechanisms they applied to retrieve books in the library. According to table 4.7, these factors all received equal importance since all the respondents named them during the interviews.

<table>
<thead>
<tr>
<th>Response</th>
<th>Number of Responses</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Browse the shelves</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Aided by subject labels on shelves</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Ask the librarian for help</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Use lists of dissertations and theses</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Total Responses</td>
<td>12</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.7: Retrieval of Books

4.1.7 Sharing of Few Copies of Books

It was discovered that all readers shared books. This was said to be an inconvenience to readers. All the three respondents (class representatives) listed it among the problems of access to books and the need for more books.

<table>
<thead>
<tr>
<th>Number of Responses</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Responses</td>
<td>3</td>
</tr>
<tr>
<td>Percentage Response</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.8: Sharing of Few Copies
### Table 4.9: Books Shared

<table>
<thead>
<tr>
<th>Response According to Year of Study</th>
<th>Number of Copies</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Year</td>
<td>2</td>
<td>29%</td>
</tr>
<tr>
<td>2nd Year</td>
<td>3</td>
<td>43%</td>
</tr>
<tr>
<td>3rd Year</td>
<td>2</td>
<td>29%</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>100%</td>
</tr>
<tr>
<td>Average Number of Books Shared by Readers</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

During the study, all the variables that were recognized to be critical to the success of library inventory management were highlighted by respondents during interviews with the readers, library managers and the faculty manager. These are listed in the appendices on pages 53-60.
4.2 Dynamic Hypothesis

A dynamic hypothesis was developed in line with the critical variables that were identified by the researcher.

![Figure 4.2: Dynamic Hypothesis for the proposed library inventory management tool]

4.3 Relationships Between Variables and the Type of Loops in the Dynamic Hypothesis

1. Loop R1 is a reinforcing loop that depicts the phenomenon that the increase in user needs causes library managers to evaluate their book stocks more, which reveals more user needs.

2. The reinforcing loop R2 shows that an increase in user needs reduces user satisfaction which causes an accumulation in user information needs.
3. However, loop B1 is a balancing loop, the increase in book acquisition causes library user satisfaction to increases up to a certain level only to reduce the rate of book acquisition.

4. Balancing loop B2 depicts an increase in book acquisitions that reduces user needs.

5. In the balancing loop B3, the more books that are acquired the more books that are placed on shelves. Like wise the increase in book shelving leads to an accumulation of the book stock, which increases user satisfaction, hence reducing book acquisition.

6. Loop B4, a balancing loop, explains the reduction of library space by the increase in shelves that are getting consumed by books being shelved.

7. Loop B5, a balancing loop, shows that the more the book shelving activity takes place, the more book stock is accumulated. However, the accumulation of the book stock leads to less shelving space.

8. A balancing loop B6 has portrayed that increased book acquisition leads to increased book stock thereby increasing user satisfaction. Consequently, this increased user satisfaction counteracts the book acquisition activity by reducing its rate.

9. It has also been observed in the balancing loop B7 that the increase in book stock increases stock evaluation thereby leading to the withdrawal of torn, obsolete and archival books.

10. Balancing loop B8 helps us see that the increase in the withdrawal of torn, obsolete, and archival books reduces the book stock, thereby increasing (saving) library space. This increase in library space also reduces evaluation of the book stock which, in the long run, causes an accumulation of obsolete, torn and archive books.

11. Another balancing loop B9 shows that an increase in obsolete, torn and archival books reduces user satisfaction which necessitates the reduction of the torn, obsolete and archival books.
12. However, loop R1 is a reinforcing loop that depicts the phenomenon that the increase in user needs causes library managers to evaluate their book stocks more, which reveals more user needs.

13. The reinforcing loop R2 shows that an increase in user needs reduces user satisfaction which causes an accumulation in user information needs.
4.4 Causal Loop Diagram

Using the Dynamic Hypothesis above a causal loop diagram was developed as in the figure 4.3 below:

Figure 4.3: Causal Loop Diagram for the Library Book Inventory Management Model
4.5 Modeling Decisions

Simulation software called STELLA was used to achieve the set goals of the project. It was used because the user can name the variables as sentences making it easy for one to communicate appropriately. STELLA also fills in the equations hence providing basis for simulations. Seven simulations were run and adjustments were made until satisfactory results were attained.

4.6 Model Structure

Figures 4.4 to 4.9 portray the internal structure of the system dynamics model used in dynamic analysis of the library inventory management system. It depicts six interacting subsystems, namely:- Book Management, Shelf-Space Management, Room-Space Management, Readers Satisfaction, Librarian Satisfaction and Faculty Management Satisfaction. These capture the critical success factors (actors) in the management of a library book management system. The model is endowed with equations so that mathematical analyses can be made in order to give measurable outputs. The equations are seen in the appendices (pages 53-60).
4.6.1 Book Management Sub-System

This subsystem has the following as the key variables: Book Acquisitions, Cataloguing, Shelving, Active Book Stock, Archiving, Repair & Binding and Obsolete Book Disposal.

Figure 4.4: Book Management Subsystem
4.6.2 Shelf Space Utilization Sub-System

Shelf Utilization Subsystem consists of Shelf Acquisition, Shelf Occupation, Shelves Consumed, Available Shelves, Proposed Shelves and Shelf Occupation Rate.

Figure 4.5: Shelf Space Utilization Subsystem
4.6.3 Floor Space Management Sub-System

Floor Space Management Subsystem consists of Floor Space Creation, Space Consumption Rate, Average Space Consumption, Available Floor Space, Reading Space and Proposed Space Creation.

Figure 4.6: Floor Space Management Subsystem
4.6.4 Readers Sub-System

There are three subsystems that reflect stakeholder influence on the library system. These are: Readers, Faculty Management and Librarian Subsystems. Readers’ subsystem entails variables such as New Book Accessibility, Accessibility of Processed Books, and Availability of a Copy of Critical Titles for Every Reader, Reader Satisfaction and Reader Percentage Satisfaction. These are the major variables that affect how readers interact with the library system.

Figure 4.7: Readers Subsystem
4.6.5 Faculty Management Sub-System

The main variables that make up the Faculty Management Subsystem include: Course Weights of Courses taught such as Basic Ecology, Influence of Readers on Faculty Management, Faculty Management Satisfaction, Highest Possible Faculty Management Satisfaction and Faculty Management Percentage Satisfaction.

Figure 4.8: Faculty Management Subsystem
4.6.6 Library Management Sub-System

Meanwhile, the crucial variables of the Library Management Subsystem are: Librarians, Influence of Faculty Management, Influence of Reader Satisfaction, Highest Possible Librarian Satisfaction, Librarian Satisfaction and Librarian Percentage Satisfaction.

Figure 4.9: Library Management Subsystem
4.7 Interaction with The Library Book Inventory Management Tool

The tool opens by double clicking on its file. When it opens, the user may then proceed to use the appropriate buttons to interface with the tool. However, certain features of the tool have been security locked with a password in order to limit structural changes of the model and changes in the variables to only the qualified and authentic library manager. The user therefore needs to open the notepad file named password. It is in the same folder as the tool file and it contains the password that will be used to fully open the model and tool. While at the opening page of the interface, the user selects Security from the File menu, then types in the given password and clicks Ok. Next, the user selects Full Access and clicks Ok. With this access is given to the model structure. Similarly the uses the same password to access the inputs table of the model because any changes made affect model behavior and therefore should be made by the qualified user. The graphical user interface is made up of five pages/interfaces, namely: home page, high-level map, inputs table, outputs table and library performance graph as seen in tables 4.10, 4.11, figures 4.10, 4.11 and 4.12 respectively. While at the home page, the user can click on the appropriate button, to explore the model. Each page of the model is endowed with buttons that help the user to navigate within the model and at any page the user can always come back to the Home Page.

At the home page, clicking “Overview” gives brief information about the model where as the High-level Map depicts the different subsystems of the library system and the relationships that exist among them. The model structure buttons include: Book management, Shelf space management, Floor space management, Readers, Faculty management and Library Management subsystems. Clicking any of these buttons takes the user to the internal system structure of the subsystems that make up the model. The user can toggle between the subsystems by clicking on the appropriate buttons that reflect the subsystem name.

The Inputs button takes the user to the interface page where they can adjust the inputs by using the Inputs Table and Switches of the model. The Outputs button is the door way for the user to view the events of the simulation as they happen. One can also click on the Output Graph button to see the simulation curves for the key variables. While at the Output Graph interface, the user has to click the Run button to view the simulations. At the interface layer
the user can therefore carry out simulations and view events of the library book management model as they unfold.

4.7.1 The Library Book Inventory Management Tool Home Page

Figure 4.10: The Home Page of the Tool
### 4.7.2 The Inputs Table of the Model

#### Table 4.10: Inputs of the Model

<table>
<thead>
<tr>
<th>Input Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RepairedBooks</td>
<td>80</td>
</tr>
<tr>
<td>InitiatorTac/BooksBought</td>
<td>1359</td>
</tr>
<tr>
<td>Books Catalogued by a Librarian Daily</td>
<td>24</td>
</tr>
<tr>
<td>Books Accessioned Annually</td>
<td>8000</td>
</tr>
<tr>
<td>Initial Room Space</td>
<td>equation</td>
</tr>
<tr>
<td>Proposed Shelves For Backlog Cleaning</td>
<td>equation</td>
</tr>
<tr>
<td>Nineteen Shelves For Annual Book Acquisitions</td>
<td>equation</td>
</tr>
<tr>
<td>Site Acquisition</td>
<td>equation</td>
</tr>
<tr>
<td>Disposal</td>
<td>equation</td>
</tr>
<tr>
<td>Archiving</td>
<td>equation</td>
</tr>
<tr>
<td>Available LibFloorSpace</td>
<td>1</td>
</tr>
<tr>
<td>Evaluated LibFloorSpace</td>
<td>equation</td>
</tr>
<tr>
<td>Binding</td>
<td>374</td>
</tr>
<tr>
<td>Book Accessioning</td>
<td>equation</td>
</tr>
<tr>
<td>Book Shelving</td>
<td>equation</td>
</tr>
<tr>
<td>From Supplier</td>
<td>equation</td>
</tr>
<tr>
<td>From Donors</td>
<td>equation</td>
</tr>
<tr>
<td>Shelf Assignment</td>
<td>equation</td>
</tr>
<tr>
<td>Shelved/Recovered</td>
<td>equation</td>
</tr>
<tr>
<td>FloorSpace Creation</td>
<td>equation</td>
</tr>
<tr>
<td>FloorSpace Consumption</td>
<td>equation</td>
</tr>
<tr>
<td>Satisfaction Of Potential Readers Of Unshelved Books</td>
<td>equation</td>
</tr>
<tr>
<td>Subject Support</td>
<td>equation</td>
</tr>
<tr>
<td>Courses Investigated</td>
<td>10</td>
</tr>
<tr>
<td>Potential Library Users in Class</td>
<td>50</td>
</tr>
<tr>
<td>Reader Percentage Satisfaction</td>
<td>equation</td>
</tr>
<tr>
<td>Faculty/Prof Percentage Satisfaction</td>
<td>equation</td>
</tr>
<tr>
<td>Unscheduled Books in C...</td>
<td>0.000320</td>
</tr>
<tr>
<td>Reader Percentage Set</td>
<td>88%</td>
</tr>
<tr>
<td>Faculty/Prof Percentage Set</td>
<td>78%</td>
</tr>
<tr>
<td>Jordan Percentage Set</td>
<td>95%</td>
</tr>
<tr>
<td>Jordan Percentage Set</td>
<td>equation</td>
</tr>
</tbody>
</table>

![Diagram of the model](image-url)
### 4.7.3 The Library Performance Output Table

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Unshelved Books in Cataloging Section</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>New Books in Acquisitions Dept</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Active book stock</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Available book space</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Floor space available</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Floor space utilization</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Shelf space</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
<tr>
<td>Shelf occupation</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
<td>44.75</td>
</tr>
</tbody>
</table>

**Table 4.11: Output Table of the Model**
4.7.4 The High-Level Map of the Library Book Inventory Model

The user can use the high-level map to view the subsystems or sectors that make up the model as well as the relationships that exist among them. Clicking the question mark on each sector gives you a brief description about the subsystem represented by that sector. Clicking the navigation arrow in the sector header of each sector takes you to that internal subsystem structure. While there the user can come back to the high-level map by clicking the navigation arrow in the header of the subsystem.

![High-Level Map of the Tool](image)

Figure 4.11: High-level map of the Tool
4.8 Initial Conditions

During modeling, the initial conditions were set to 10 years, reflecting a 10-year strategic plan. DT of 0.25 was used and Euler’s method was employed for the integration. By adjusting variable inputs, 7 experiments were performed in order to realize the one that gave the most appropriate results.

4.8.1 Experiment 1

![Figure 4.12: Simulation Experiment 1](image)

**Findings**

As seen in the graph above, in figure 4.12, as long as the available shelves remain at 0 for the entire 10 years, active book stock and floor space creation, remain unchanged at initial levels. This causes a build-up in un-shelved books in the cataloguing section. At the same time the numeric displays below the graph show that reader percentage satisfaction, faculty management percentage satisfaction and librarian percentage satisfaction are way below average. This means that increase in un-shelved books increases dissatisfaction among library
stakeholders. That is why the numerical displays just below the graph, show that initial stakeholder percentage satisfaction is below average. Reader percentage satisfaction stands at 29%, faculty management at 22% and librarian percentage satisfaction is at 38%.

4.8.2 Experiment 2

![Graph showing changes in book stock, shelves, and stakeholder satisfaction over years.]

Figure 4.13: Simulation Experiment 2

Findings

Figure 4.13 shows that because of the proposed rise in withdrawal of unused books for archival storage and disposal of the obsolete/irrelevant books, there is a corresponding increase in shelving hence a corresponding growth of the active book stock. It implies that continuous weeding of library collections saves shelf space for newer books. However, because shelf acquisition remains at zero, available capacity keeps reducing and so there is still a high backlog accumulation in un-shelved books. There is an increase in stakeholder satisfaction as indicated on the numerical displays for reader percentage satisfaction (from 29% to 43%), faculty management percentage satisfaction (from 22% to 33%) and librarian percentage satisfaction (from 38% to 63%). However it is the librarian percentage satisfaction
that increases above average, while readers and faculty management are still below average.

4.8.3 Experiment 3

Figure 4.14: Simulation Experiment 3

Findings

According to the graph in figure 4.14, the initial increase in available capacity prompted an initial increase in active book stock but because capacity increase was caused by the increase in shelf acquisition in order to clear the initial backlog of un-shelved books, it could not surmount the overwhelming continuous new book acquisition. This is because of the continuous ordering of books by the faculty and the persistent book donations. At this point, the satisfaction levels of the readers and faculty management remain un-moved (43% and 33% respectively) and so are still below average, while that of the librarian remains at the previous 63%.
4.8.4 Experiment 4

Findings

The graph in figure 4.15 proposes an approach of increasing the capacity in proportion to the annual book acquisitions of the library. Therefore it is seen that an increase in capacity causes active book stock to grow because shelf acquisition has also grown. However this proposed annual increase in capacity does not cater for the existing backlog of un-shelved books. Shelving is limited to the number of books acquired annually. As a result, there is a continuous build-up of inaccessible books that remain accumulating in the cataloguing section.

In experiment 3 (figure 4.14), the un-shelved book backlog had been cleared giving readers access to all the books in the library, however there was a recurrence of un-shelved book backlog building up because there was no corresponding increase in capacity. In contrast with experiment 4 (figure 4.15), the un-shelved books instead grew more with time denying readers access to them. This was because since there was initially a backlog, the proposed shelving capacity could only cater for the books that were annually acquired but by the end of the experiment there were still in-coming book acquisitions, meaning that clearing of the backlog...
of un-shelved books was limited to the same number of books whose space had been created annually. Satisfaction levels of stakeholders therefore were not improved at all.

4.8.5 Experiment 5

![Graph showing findings of Experiment 5](image.png)

Figure 4.16: Simulation Experiment 5

**Findings**

As seen on the graph in figure 4.16, the proposed shelves for both the backlog of un-shelved books and the annual book acquisitions increase. There is therefore a drastic drop in the un-shelved books in the cataloguing section as well as a corresponding increase in active book stock. The proposed increase in shelving capacity catered for the annual book acquisitions and also offset the un-shelved book backlog drastically, so that in less than two years there was no more un-shelved books. Because of increase in shelving capacity, to both offset the backlog of un-shelved books and also provide enough space for books acquired annually, reader percentage satisfaction and faculty management percentage satisfaction shot above average (from 43% to 71% and from 33% to 56% respectively), as seen on the numeric displays just below the graph.
4.8.6 Experiment 6

Figure 4.17: Simulation Experiment 6

**Findings**

Figure 4.17 above demonstrates that the input of the withdrawal of irrelevant and unused books not only saves shelf space but also causes an increase in faculty management and librarian percentage satisfaction (from 56% to 67% and from 63% to 75% respectively), as seen on the numerical displays just below the graph. This means that a combination of factors contribute to stakeholder satisfaction.
4.8.7 Experiment 7

Figure 4.18: Simulation Experiment 7

Findings

Figure 4.18 shows that when the library catalogue is switched on (available in the library), there is an increase in reader percentage satisfaction (from 71% to 86%), faculty management percentage satisfaction (from 67% to 78%) and librarian percentage satisfaction (from 75% to 88%). This is because of increased awareness of library holdings among readers and also increased book accessibility.
CHAPTER 5

DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

5.1 Introduction

In this chapter, the researcher addresses how the objectives of the project have been met using the dynamic synthesis method. The researcher gives the way the model has been validated, thereafter the project contributions towards library management are given and conclusions are made.

5.2 Discussion

A combination of research techniques was used in order to realize the set goals of the project. The researcher did a literature review which revealed challenges experienced by librarians involved in library book inventory management. Literature reviewed gave birth to a number of key factors that influenced effective book inventory management. These were used in building the system dynamics decision support tool.

Literature review also revealed five approaches used in system dynamics methodology and the researcher opted for dynamic synthesis methodology because of its ability to combine a clear data collection strategy as well as simulation modeling to make a very powerful method of research.

By way of the dynamic hypothesis, the problem at hand was illustrated through the depiction of the main variables involved in library book inventory management. The cause and effect relationships among these variables were also portrayed.

It was also realized during literature review that the issues of emphasis about library book inventory vary from library to library bearing in mind the stakeholder influence. Therefore library managers and faculty management did not have a common ground when it comes to decisions concerning book stock management. As thus this project
attempted to provide a communication platform for library stakeholders, thereby offering
decision support to library managers.

STELLA modeling software was employed to develop the simulation-based tool and the
variables used in the model were co-opted from the various schools of thoughts that exist
in literature concerning library book inventory management (library collection
management and development issues)

5.3 The Library Book Inventory Decision Support Tool

The graph pad of the tool can take on up to five variables. This way the user needed to
determine what they wanted to discover about book inventory management. After
ascertaining the kind of information the library manager wanted to know about library
management, they could select the variables of interest. The user simply double clicks in
the graph pad, and then selects the arrow that changes the graph page. With the new page
the user could add any variables from those in the model, and then click ok. After this the
user had to click run in order to view the performance, based on the values that were set
in the input table.

However, the tool also offered users the option of retrieving library performance output in
a table that accommodated all the variables in the model. The statistical output provided
measurable inferential values that library managers saw to be helpful in decision making.

The run results of the tool give us the proposed scenarios in book inventory management
in the next 10 years. These results are based on the policies reflected in the tool. These
can be changed by adjusting variable values in the input table in order to suit the strategic
direction library management would like to take. These experimentations give the library
manager the advantage of exploring the implications of proposed decisions, in a
laboratory setting without actually taking the risk of implementation in the real library
system.

Experiment 7 is the most favorable in terms of library capacity planning and also shows
the highest percentage satisfaction for readers, faculty management and library managers.
This was because accessibility to all available library books was seen to be the key
variable to the readers. Therefore all decisions taken to grant increased access for readers to books were seen to have a positive impact.

5.4 Validation

According to Ssemaluulu (2005, p.43) it is of utmost importance, though challenging, that during simulation analysis, the researcher needs to explore the accuracy level of the simulation model in trying to mimic the actual system being studied. The researcher applied the following validation techniques on the model.

The researcher did a walk-thru comparing the causal loop diagram and the model. It showed that there was consistence in variables. Similarly, the researcher checked the model structure of all the 6 subsystems and found no syntax errors.

Running simulations of the stock and flow diagrams for 10 years or less or more was done and the model gave neither errors nor ridiculous values. This provided confidence in the model.

The events of the simulations were similar to the events of the real system according to historical behavior. At the same time, the researcher did a parameter sensitivity check. The parameters that were vital in producing expected behavior were identified and any change in them would yield problematic behavior. Therefore the researcher realized the optimized parameter condition and set necessary algorithms in order to give expected system behavior. This helped to see the predictive capabilities of the tool.

The researcher presented the tool to three expert librarians for evaluation. These were professional librarians, in-charge of collection development and management in the case study library (Institute of Environment Library) as well as from the parent institution (Makerere Main library). They were interviewed and all of them concurred that the tool reflected current needs in library management, as seen below.
<table>
<thead>
<tr>
<th>Evaluation Variable</th>
<th>Responses</th>
<th>Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptionally useful</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Very Helpful to our needs</td>
<td>3</td>
<td>100%</td>
</tr>
<tr>
<td>Slightly Helpful Tool/Model</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Can not Understand it</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total Response</td>
<td>3</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5.1 Evaluation of the Tool/Model

5.5 Limitations of the Study

- The study was limited to a case study of a small academic library because of the time constraints allocated for the project. Therefore the results may be different with a larger academic and research library. Similarly it is limited to academic settings and so excludes issues in a public library.

- The model uses many variables which could not be studied in detail because of time limitations. A more critical look at variables yields more intricate variables that could not be included in the study.

- There were variables that could not be quantified in measurable terms. Therefore the study makes certain assumptions and estimates of variables whose statistical measure could not be ascertained. These variables included: Availability of a Catalogue, Availability of a Finding Aid, Reader Satisfaction and others as seen in the appendices (pages 53-60).

- The simulation tool is also limited to 10 year scenario planning experiments. Therefore, the experiments were done and the findings were based on simulations in a 10-year period. The assumption that was made by the use was that for meaningful library inventory management and planning could be attained in 10 years. However, this may be changed if the user so wishes.
5.6 Recommendations for Library Book Inventory Management

According to the results of model simulations and the study carried out, the researcher has suggested the following:-

Library managers need to have the bigger picture in perspective if they are to satisfy library users and stakeholders. Therefore all the necessary information about the possible effects of management decisions on stakeholders should be at the library managers’ disposal. In a nutshell, all stakeholders should be involved in decision making. There should be communication among stakeholders. Librarians should seek the input of all stakeholders before making decisions. In other words, there should be a feedback provision in the library, in order to get the opinions of library stakeholders. Another possibility is for library directors to enhance their information seeking capabilities by getting all necessary information regarding stakeholder interests in library management.

Weeding or withdrawal of books that are either torn or irrelevant to user needs should be an issue to be considered in library management. This is because according to findings of the simulations, it could save space and thereby increasing accessibility to more books in the library.

The findings of the simulations that were done also indicate that since collection growth drives space utilization, space should be planned according to expected new books. Having considered possible variations in book acquisitions, it was discovered that levels of library capacity should be monitored using historical data. This means that library directors have to keep data on all acquisitions.

The importance of a library catalogue was emphasized by both readers and simulation experiments during the study. Many of the reader problems pointed towards the need to access books easily. It is a necessity to have a professionally done library catalogue in any library that is to serve its users satisfactorily.

Consistent evaluation of a library book stock needs to be done. It is from this effort that book weeding and the need for more books that cover curriculum needs, would be
realized. Archival materials could also be discovered as a result of collection evaluation. The application of records management theory could be useful for small and size-limited libraries. It is therefore recommended that the use of an archive could be implemented in library management. Weeding of books that may not be currently used could not only save space for active book stocks stack areas but also reveal the need to keep away rare books and future reference materials. This would save otherwise disposal candidates.

Further studies could also engage in the dynamics involved in book archiving thereby extending the model to include an archival subsystem. This would examine the case for investing in more library space for storage of rarely used books.

Further still, the number of stakeholders could grow depending on the library type. Therefore more stakeholders could be added in the stakeholder subsystem and the dynamics of dealing with their interests could result in a study into more variables.

5.7 Conclusion

The system dynamics model offered decision support to library managers by providing useful information regarding optimization of library book stock management in the light of available resources like library staff and space utilization. Similarly, the model was seen to promote communication among library stakeholders.

On another hand, the tool facilitated book inventory management planning by offering useful predictions, thereby offering arguable defense for library budgets. This was because the simulation tool provided analyses of the various scenarios.
References


APPENDICES

APPENDIX A: Key Variables and Model Equations

Book Mgt. Sub-System

INFLows:
- Binding = 374
- Book Shinging = IF (AvailabilityOf_A_Catalogue + AvailabilityOf_OtherFindingAids = 0) THEN (Cataloguing_Rate = 0) ELSE (Available_Capacity)

OUTFLows:
- Archiving = AvgBooksNotInUse
- Evaluated & Withdrawn for Binding = Wear & Tear Rate * Active BookStock
- Disposal = AvgEvaluated_Unit_Material

ARCHIVES(t) = ARCHIVES(t - dt) + (Archiving) * dt
INIT Archives = 0

INFLows:
- Archiving = AvgBooksNotInUse

BOOKS_in_Binding(t) = BOOKS_in_Binding(t - dt) + (Evaluated & Withdrawn for Binding - Binding) * dt
INIT Books_in_Binding = 0

INFLows:
- Evaluated & Withdrawn for Binding = Wear & Tear Rate * Active BookStock

OUTFLows:
- Binding = 374

Disposal_Candidates(t) = Disposal_Candidates(t - dt) + (Potential_Disposal) * dt
INIT Disposal_Candidates = 0

INFLows:
- Potential_Disposal = AvgEvaluated_Unit_Material

DisposedFrom_ActiveStock(t) = DisposedFrom_ActiveStock(t - dt) + (Disposal) * dt
INIT DisposedFrom_ActiveStock = 0

INFLows:
- Disposal = AvgEvaluated_Unit_Material

NewBooks_in_AcquisitionsDept(t) = NewBooks_in_AcquisitionsDept(t - dt) + (From_Supplier + From_Donors - Book_Acquisitioning) * dt
INIT NewBooks_in_AcquisitionsDept = 1035

INFLows:
- From_Supplier = Book_Order_Rate * TotalBooks_Bought
- From_Donors =
APPENDIX B: Key Variables and Model Equations

\( F_{\text{From_Donors}} = \begin{cases} 0 & \text{IF}(\text{Total Books Donated}) < 0 \end{cases} \) THEN (0) ELSE (Book Donation Rate \times Total Books Donated)

OUTFLOWS:

\( F_{\text{Book_Accessioning}} = \text{Books Accessioned Annually} \)

\( F_{\text{PotentialArchiving}} = \text{PotentialArchiving} \times (\text{PotentialArchiving} - \text{Archiving}) \times dt \)

INIT: PotentialArchiving = 0

INFLOWS:

\( F_{\text{PotentialArchiving}} = \text{Avg.Books Not In Use} \)

\( F_{\text{UnshelvedBooks In Cataloguing Section}} = \text{UnshelvedBooks In Cataloguing Section} \times (\text{Archiving} - \text{Shelving}) \times dt \)

INIT: UnshelvedBooks In Cataloguing Section = 0

INFLOWS:

\( F_{\text{Book_Accessioning}} = \text{Books Accessioned Annually} \)

OUTFLOWS:

\( F_{\text{Shelving}} = \begin{cases} 0 & \text{IF}(\text{Availability of A Catalogue} \times \text{Availability of Other Finding Aid}) = 0 \end{cases} \) THEN (Cataloguing Rate = 0) ELSE (Available Capacity)

Available Capacity = BookStock on One Shelf \times \text{Available Shelves}

Avg. Annual Total Books = Repaired Books / Historical Evaluation Period

Avg. Annual Donations = Total Books Donated / Historical Evaluation Period

Avg Books Not In Use = 0

Avg. Evaluated Unfit Material = 0

Avg. Faculty Orders = \begin{cases} 0 & \text{IF}(\text{Faculty} \times \text{Percentage Satisfaction}) = 100 \end{cases} \) THEN (Total Books Bought / Historical Evaluation Period) ELSE (0)

\( F_{\text{BookCataloguing_Potential}} = \text{Catalogued Monthly} \times \text{Cataloguing Months} \)

\( F_{\text{Books Accessioned Annually}} = 9000 \)

\( F_{\text{Books Catalogued Claimed by A Librarian Daily}} = 24 \)

\( F_{\text{Book_Donation Rate}} = \begin{cases} 0 & \text{IF}(\text{Total Books Donated}) = 0 \end{cases} \) THEN (0) ELSE (Avg. Annual Donations / Total Books Donated)

\( F_{\text{Book Need}} = 1 \)

\( F_{\text{Book_Order Rate}} = \begin{cases} 0 & \text{IF}(\text{Total Books Bought}) = 0 \end{cases} \) THEN (0) ELSE (Avg. Faculty Orders / Total Books Bought)

\( F_{\text{Catalogued Daily}} = \text{Librarians} \times \text{Books Catalogued Claimed by A Librarian Daily} \)

\( F_{\text{Catalogue Monthly}} = \text{Catalogued Daily} \times \text{Monthly Cataloguing Days} \)

\( F_{\text{Cataloguing Months}} = 3 \)
APPENDIX C: Key Variables and Model Equations

Cataloguing_Rate = IF(Book_Accessioning=0)THEN(0)ELSE(BookCataloguing_Potential/Book_Accessioning)
HistoricalEvaluation_Period = 0
InitialBookDonations = 3276
InitialTotalBooksBought = 1359
Monthly_Cataloging_Days = 20
RateOfBacklogAccumulation = UnshelvedBooks_in_Cataloguing_Section/Active_BookStock
RateOfShelfAvailability = Available_Shelves/ExistingShelves
RepairedBooks = 60
TotalBooks_Bought = IF(Book_Need=1)THEN(InitialTotalBooksBought)ELSE(0)
TotalBooks_Donated = IF(Book_Need=1)THEN(InitialBookDonations)ELSE(0)
Wear_Tear_Rate = IF(Active_BookStocks=0)THEN(0)ELSE(AvgAnnualTomBooks/Active_BookStock)
Withdrawn_Candidates = Disposal_Candidates+PotentialArchives+AvgAnnualTomBooks
WithdrawnBooks = Archives+DisposedFrom_ActiveStock

Faculty Management SubSystem

Accumulated_MgtSatisfaction(t) = Accumulated_MgtSatisfaction(t - 1) + (RESupport + CSPupport + AP_Support + IRSupport + HESupport + SSSupport + EMSupport + VRSupport + LFRSupport + ESO_Support) * dt
INIT Accumulated_MgtSatisfaction = 0

INFLOWS:

<table>
<thead>
<tr>
<th>BE_Support</th>
<th>IF(BooksOnBasicEcology=0)THEN(SubjectHigh)ELSE(Low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSPupport</td>
<td>IF(BooksOnChemicalProcesses=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>AP_Support</td>
<td>IF(BooksOnAtmosphericProcesses=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>IR_Support</td>
<td>IF(BooksOnInvertebrateResources=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>HE_Support</td>
<td>IF(BooksOnHumanEcology=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>SS_Support</td>
<td>IF(ScienceBooks=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>EMSupport</td>
<td>IF(BooksOnEnvironmentalMicrobiology=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>VRSupport</td>
<td>IF(BooksOnVertebrateResources=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>LFRSupport</td>
<td>IF(BooksOnLow)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
<tr>
<td>ESO_Support</td>
<td>IF(BooksOnEarthStructure&amp;SoilProcesses=0)THEN(SubjectHigh)ELSE(Low)</td>
</tr>
</tbody>
</table>

AnnualMgtSatisfaction = IF(Accumulated_MgtSatisfaction=0)THEN(0)ELSE(Accumulated_MgtSatisfaction/HistoricalEvaluation_Period)

APPENDIX D: Key Variables and Model Equations

- BooksOnInvertebrateResources = Initial_BooksOnInvertebrateResources * Share_on_NewBooks
- BooksOnLowPlantResources = Initial_BooksOnLowPlantResources * Share_on_NewBooks
- BooksOnVertebrateResources = Initial_BooksOnVertebrateResources * Share_on_NewBooks
- BooksOnEnvironmentalMicrobiology = Initial_BooksOnEnvironmentalMicrobiology * Share_on_NewBooks
- Courses_Investigated = 10
- EachCourseOnNewBooks = From_Supplier / Total_Courses_Taught
- FacultyMgt_PercentageSatisfaction = (FacultyMgt_Satisfaction / HighestPossible_FacultyMgtSatisfaction) * 100
- FacultyMgt_Satisfaction = SubjectSupport + ReaderInfluenceOnFacultyMgt + NewBookAccessibility + LibrarianSatisfactionInfluenceOnFacultyManagement + SalvagingSpace + SatisfactionOfPotentialReadersOfUnshelvedBooks + AvailabilityOfACatalogue + AvailabilityOfOtherFindingAid + ReductionInShelfNeed
- Half_of_HighestPossible_FacultyMgtSatisfaction = 0.5 * HighestPossible_FacultyMgtSatisfaction
- HighestPossible_FacultyMgtSatisfaction = High * NumberOfFacultyMgtSatisfactionINPUTS
- Initial_BooksOnBasicEcology = 45
- Initial_BooksOnAtmosphericProcesses = 15
- Initial_BooksOnEarthStructure & GeoProcesses = 60
- Initial_BooksOnHumanEcology = 15
- Initial_BooksOnLowPlantResources = 30
- Initial_BooksOnSoilScience = 30
- Initial_BooksOnVertebrateResources = 3
- Initial_BooksOnInvertebrateResources = 3
- Initial_ShareOnNewBooks = 1.3
- Initial_BooksOnChemicalProcesses = 5
- Initial_BooksOnEnvironmentalMicrobiology = 5
- LibrarianSatisfactionInfluenceOnFacultyManagement = IF(LibrarianPercentageSatisfaction = 100) THEN(High) ELSE(Low)
- NumberOfFacultyMgtSatisfactionINPUTS = 8
- PercentageCoverageOfBasicEcology = (Initial_BooksOnBasicEcology / Total_BooksOnCourses) * 100
- PercentageCoverageOfEarthScience = (Initial_BooksOnEarthStructure & GeoProcesses / Total_BooksOnCourses) * 100
APPENDIX E: Key Variables and Model Equations

- **Percentage Coverage Of INVERTEBRATE RESOURCES**
  \[ \text{Percentage Coverage} = \left( \frac{\text{Initial Books On Invertebrate Resources}}{\text{Total Books On Courses}} \right) \times 100 \]

- **Readers Influence On Faculty Mgt**
  \[ \text{Readers Influence} = \begin{cases} \text{ASH} & \text{IF(Reader Satisfaction) < 100) THEN(Low) ELSE(High)} \\ \text{ASH} & \text{IF(Reader Satisfaction) > 100) THEN(High) ELSE(Low)} \end{cases} \]

- **Reduction In Shelf Need**
  \[ \text{Reduction In Shelf Need} = \begin{cases} \text{Ash} & \text{IF(Readers Satisfaction) = 0) THEN(High) ELSE(Low)} \end{cases} \]

- **Share On New Books**
  \[ \text{Share On New Books} = \text{Initial Share On New Books} \times \text{Simulation Period} \]

- **Simulation Period**
  \[ \text{Simulation Period} = 0 \]

- **Soil Science Books**
  \[ \text{Soil Science Books} = \text{Initial Books On Soil Science} \times \text{Share On New Books} \]

- **Subject High**
  \[ \text{Subject High} = \text{High} \times \text{Courses Investigated} \]

- **System Support**
  \[ \text{System Support} = \begin{cases} \text{AP Support} + \text{BS Support} + \text{CS Support} + \text{EM Support} + \text{EGO Support} + \text{HE Support} + \text{IR Support} + \text{LFS Support} + \text{MSS Support} + \text{VR Support} \end{cases} \]

- **Total Courses Taught**
  \[ \text{Total Courses Taught} = 50 \]

- **Total Percentage Coverage**
  \[ \text{Total Percentage Coverage} = \begin{cases} \text{IF(Active Books Stock = 0) THEN(0) ELSE(Total Books On Courses / Active Books Stock) \times 100} \end{cases} \]

- **Total Books On Courses**
  \[ \text{Total Books On Courses} = \begin{cases} \text{Initial Books On Atmospheric Processes} + \text{Initial Books On Basic Ecology} + \text{Initial Books On Chemical Processes In The Environment} + \text{Initial Books On Earth Structure & Geoprocesses} + \text{Initial Books On Environmental Microbiology} + \text{Initial Books On Human Ecology} + \text{Initial Books On Invertebrate Resources} + \text{Initial Books On Low Piant Resources} + \text{Initial Books On Soil Science} + \text{Initial Books On Vertebrate Resources} \end{cases} \]

**Floor Space Mgt. Sub System**

- **Available Library Floor Space**
  \[ \text{Available Library Floor Space} = \text{Available Library Floor Space} - \text{Floor Space Creation} - \text{Floor Space Consumption} \times dt \]

- **INIT Available Library Floor Space**
  \[ \text{INIT Available Library Floor Space} = 0 \]

- **Outlet**
  \[ \text{Floor Space Creation} = \text{Floor Space Creation} \times \text{Floor Space For One Shelf} \]

- **Floor Space Creation = Floor Space Creation**

- **Online Floor Space**
  \[ \text{Online Floor Space} = \text{Existing Floor Space} - \text{Floor Space For One Shelf} \]

- **INIT Existing Floor Space**
  \[ \text{INIT Existing Floor Space} = \text{INIT Room Space} \]

- **INFLOWS**
  \[ \text{Infloows} = \text{Floor Space Creation} \]

- **Floor Space For One Shelf**
  \[ \text{Floor Space For One Shelf} = \text{Length Needed For One Shelf} \times \text{Width Needed For One Shelf} \]

- **Floor Space Needed For Books Processed Annually**
  \[ \text{Floor Space Needed For Books Processed Annually} = \text{Floor Space For One Shelf} \times \text{Number of Books Processed Annually} \]
APPENDIX F: Key Variables and Model Equations

FloorSpacePerOneShelf*ShelvesForBooks/ProcessedAnnually
InitialRoomSpace = InitialShelves*FloorSpacePerOneShelf
LengthNeeded_forOneShelf = ShelfLength*BrowsingLength
ProposedSpaceToBeOccupied_byNewShelves = FloorSpacePerOneShelf*ProposedNewShelves
ShelfLength = 10
ShelfWidth = 2
TotalSpaceConsumed = FloorSpacePerOneShelf*ExistingShelves
WidthNeeded_forOneShelf = ShelfWidth*BrowsingWidth

Library Management Sub-System

INIT Librarians = Librarians - cb

 Librarians = Librarians - cb

Actual_Cataloguing = AvailabilityOf_ACatalogue
AvailabilityOfACatalogue = 1
AvailabilityOfOtherFindingAid = 1
CataloguingCapacity = IF(Cataloguing_Potential=UnshelvedBooks_in_Cataloguing_Section THEN(High)ELSE(Low)
HighestPossibleLibrarian_Satisfaction = HighestPossibleLibrarian_Satisfaction
Influence_of_LibrarySatisfaction_on_Librarian =
IF(ReaderPercentageSatisfaction=100) THEN(High) ELSE(Low)
LibrarianPercentageSatisfaction = (LibrarianSatisfaction*HighestPossibleLibrarian_Satisfaction)*100
LibrarianSatisfaction = Actual_Cataloguing*AvailabilityOfOtherFindingAid+CataloguingCapacity*Influence_of_LibrarySatisfaction_on_Librarian+LongTermSpace_Planning+SalvagingShelves+ShelvingCapacity*SubjectSupport
LongTermSpace_Planning = IF(SkeletalCollection=0) THEN(Low) ELSE(High)
Number_of_InputsForLibrarian_Satisfaction = 0
SalvagingShelves = IF(WithdrawnBooks=0) THEN(High) ELSE(Low)
SalvagingShelves = SalvagingShelves
ShelvingCapacity = IF(AvailableCapacity=0) THEN(High) ELSE(Low)
APPENDIX G: Key Variables and Model Equations

**Readers Sub-System**

\[
\text{AccumulatedReaderSatisfaction}(t) = \text{AccumulatedReaderSatisfaction}(t - 1) + (\text{NewBookAccessibility} + \text{Reader_Convenience_in_Use_of_a_Critical_Book} + \text{SatisfactionOfPotentialReaders_of_UnshelvedBooks} + \text{Access_by_Catalog} + \text{AvailabilityOf_CriticalTitles} + \text{HopeForAccess_to_Long Awaited Books} + \text{Access_by_FindingAid}) \times dt
\]

INIT: AccumulatedReaderSatisfaction = 0

**INFLOWS:**

- NewBookAccessibility = IF(UnshelvedBooks_in_Cataloguing_Section = 0) THEN(High) ELSE(Low)
- Reader_Convenience_in_Use_of_a_Critical_Book = IF(Readers_WhoShare_OneCopyOf_Critical_Title = 1) THEN(High) ELSE(Low)
- SatisfactionOfPotentialReaders_of_UnshelvedBooks = IF(PotentialReaders_of_InaccessibleBooks = 1) THEN(Low) ELSE(High)
- Access_by_Catalog = AvailabilityOf_A_Catalogue
- AvailabilityOf_CriticalTitles = SubjectSupport
- HopeForAccess_to_LongAwaitedBooks = ShelvingCapacity
- Access_by_FindingAid = AvailabilityOf_OtherFindingAid

- Avg_Copies_of_Critical_Title = 5
- High = 1
- HighestPossible_ReaderSatisfaction = High \times \text{ReaderSatisfactionDirectInputs}
- Low = 0
- PotentialLibrary_Users_in_Class = 50
- PotentialReaders_of_InaccessibleBooks = IF(UnshelvedBooks_in_Cataloguing_Section = 0) THEN(0) ELSE(ReaderRequestsFor_UnshelvedBooks)
- ReaderPercentageSatisfaction = (ReaderSatisfaction/HighestPossible_ReaderSatisfaction) \times 100
- ReaderRequestsFor_UnshelvedBooks = 20
- ReaderSatisfactionDirectInputs = 7
- Readers_WhoShare_OneCopyOf_Critical_Title = PotentialLibrary_Users_in_Class/Avg_Copies_of_Critical_Title

60
APPENDIX H: Key Variables and Model Equations

Shelf Space Utilization Sub-System

\[ \text{Available Shelves}(t) = \text{Available Shelves}(t-\Delta t) + (\text{Shelf Acquisition} + \text{Shelves Recovered} - \text{Shelf Occupation}) \times \Delta t \]

INIT: \text{Available Shelves} = 0

INFLOWS:
- \text{Shelf Acquisition} =
  - \text{IF (Book Need = 1) THEN (Proposed Shelves For Annual Book Acquisitions + Proposed Shelves For Backlog Clearing) ELSE (0)}
- \text{Shelves Recovered} = \text{Shelves Reclaimed}

OUTFLOWS:
- \text{Shelf Occupation} = \text{Shelves Occupied \_ by One Book} \times \text{Book Shelving}

\[ \text{Existing Shelves}(t) = \text{Existing Shelves}(t-\Delta t) + (\text{Proposed Shelves For Annual Book Acquisitions} + \text{Proposed Shelves For Backlog Clearing}) \times \Delta t \]

INIT: \text{Existing Shelves} = \text{Initial Shelves}

INFLOWS:
- \text{Proposed Shelves For Annual Book Acquisitions} =
  - \text{Shelves Occupied \_ by One Book} \times \text{Book Accessioning}
- \text{Proposed Shelves For Backlog Clearing} =
  - \text{Unshelved Books In Cataloguing Section} \times \text{Shelves Occupied \_ by One Book}

\[ \text{Proposed New Shelves}(t) = \text{Proposed New Shelves}(t-\Delta t) + (\text{Annual Shelves} + \text{Backlog Shelves}) \times \Delta t \]

INIT: \text{Proposed New Shelves} = 0

INFLOWS:
- \text{Annual Shelves} = \text{Proposed Shelves For Annual Book Acquisitions}
- \text{Backlog Shelves} = \text{Proposed Shelves For Backlog Clearing}

odos
- BookStock on One Shelf = 1200
- Initial Shelves = 2
- Max Shelving Capacity = BookStock on One Shelf \times \text{Existing Shelves}
- OneBook = 1
- Potential Saved Shelves = Withdrawal Candidates \times \text{Shelves Occupied \_ by One Book}
- Shelves Filling In Available Floor Space = Available Lib Floor Space \times \text{Floor Space For One Shelf}
- Shelves For Books Processed Annually = Book Cataloguing Potential \times \text{Shelves Occupied \_ by One Book}
- Shelves Occupied by One Book = OneBook \times BookStock on One Shelf
- Shelves Reclaimed = Shelves Occupied \_ by One Book \times \text{Withdrawn Books}
- Total Shelves Consumed = Shelves Occupied \_ by One Book \times \text{Active BookStock}

Net in sector
APPENDIX I

Interview Guide

Key Informant: Faculty Manager (Lecturer/Library Coordinator)

1. Who are the stakeholders as far as your library is concerned? Please list

2. Are they always involved in decision making on issues that affect the library?

3. If yes (per stakeholder) how? If no (per stakeholder) why?

4. Do you have a strategic plan for library management?

5. If yes? What period does it cover

6. How many books, in total, are there in the library collection?

7. Do readers always find the books they need, in this library?

8. What are the key issues that you consider when evaluating your library collections (List)

9. In your capacity, what challenges have you experienced in regards to managing library book stock?

10. How many students use the library?
11. How many students are there in one class of the classes taught in this faculty?

12. Does the library book stock adequately cover your faculty curriculum?

13. If not, what strategies have you put in place to ensure the needs of your faculty staff and students are met?

14. Do you have a book inventory management policy?

15. How do you reach decisions such as book withdrawal/weeding? the books to buy and which donations to solicit?

16. In your use of the library have you come across any books you would deem irrelevant to the needs of the Faculty?

17. When making the course reference lists, does your faculty staff always find the books needed in your library collection?

18. How many courses are taught in this Faculty? Please list:

19. And how many course units are there per course?

20. What problems have you faced in using books in the library?
21. How many books are currently in the book stock?

22. do you have books that are relevant but are not read by readers?

23. if yes, what do you do for books that are not in use but may be useful in future?

24. is the current space / shelves enough for your current book stock?

25. looking at the future and the changes in your book stock is the current space / shelves enough for your future book stock?

26. do you have a space management policy for the library?

27. what suggestions do you have to tackle space problems/management in your library?

Thank you for your cooperation
APPENDIX J

Interview Guide

Key Informant: Readers (3 Class Representatives, one for each class)

Please answer as honestly as possible and tick appropriately

1. How many are you in your class?

2. Were you given book reference lists by your lecturers?
   Yes         No

3. Were all these titles available in your library?
   Yes         No
   b) If No, what do you do to meet your information need

4. What problems have you experienced in using books in the library?

5. What other issues do you think are crucial to improve the library service to readers?

6. Do you think this library needs more books? And why?

Thank you for your cooperation
APPENDIX K
Interview Guide
Key Informant: Librarians

1. Designation: ……………………………………………………………

2. Who are the stakeholders as far as your library is concerned? Please list

3. Are they always involved in decision making on issues that affect the library?

4. If yes (per stakeholder) how? If no (per stakeholder) why?

5. Do you have a strategic plan for library management?
6. If yes? What period does it cover
7. How many books, in total, are there in the library collection?

8. Do readers always find the books they need, in this library?

9. Do you have a library collection management policy, which guides book withdrawal/weeding, book acquisitions, archiving?

10. What are the key issues you have found to be influential in book stock management?

11. What are the key issues you have found to be influential in meeting reader needs?

12. Do you think this library needs more books? And why?

13. Do you evaluate your book stock/collection? Yes No
14. How frequent do you do it and why?

66
15. Have you found any books that are no longer in use/circulation? What do you do to them?

16. Have you ever found yourself wanting to remove some books from the shelves (carrying out book weeding/withdrawal)?
   Yes  No  (Why?)

17. How many books do you find torn every year?

18. Do you have a repair/binding/conservation plan/policy? (What do you do for torn books?) Yes  No

19. How many shelves do you have in the library?

20. Are they enough for the books currently in the library as well as for future collection growth? Yes  No

21. If not, do you have a policy on library capacity development?(for shelf acquisition)

22. How much floor space (area) does your library cover? (How big is your library – in square feet)

23. How much of this space is covered by the shelves?

24. How much floor space does each shelf occupy?

25. What is the book capacity for one shelf?

26. Have you been expanding or have you ever expanded your library floor space?

27. Are there plans to expand your library space in the future?

28. What suggestions do you have to tackle space problems/management in your library?

Thank you for your cooperation
APPENDIX L

1. Project Time Frame

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb-March 2009</td>
<td>Proposal writing, Hands-on revision of use of relevant modeling software, Dynamic Hypothesis representation in Vensim, Examination of Behavior Over Time graphs, Conducting a feasibility study (baseline data collection)</td>
</tr>
<tr>
<td>April 2009</td>
<td>Data Collection &amp; Document Review, System modeling with STELLA</td>
</tr>
<tr>
<td>May-June 2009</td>
<td>Data Collection, Interface design</td>
</tr>
<tr>
<td>July-Aug. 2009</td>
<td>Proposal Presentation, Simulation experimentations and System testing, validation</td>
</tr>
<tr>
<td>Aug.-Sept. 2009</td>
<td>Project presentation, final report compilation and submission</td>
</tr>
</tbody>
</table>

2. Research budget (UGShs.)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop hire and softwares</td>
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<td>1,000,000</td>
</tr>
<tr>
<td>Facilitation for respondents</td>
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<td>300,000</td>
</tr>
<tr>
<td>Research Assistants</td>
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<td>600,000</td>
</tr>
<tr>
<td>Professional meetings</td>
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<tr>
<td>Stationery</td>
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<tr>
<td>Communication</td>
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<tr>
<td>Miscellaneous</td>
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<tr>
<td>Total</td>
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