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**Migrating from Proprietary to Open Source  
Learning Content Management Systems**

by

Owais Ahmed

A thesis submitted to the Faculty of Graduate Studies and Research  
in partial fulfillment of the requirements for the degree of  
Master of Engineering in Telecommunications Technology Management

Department of Systems and Computer Engineering

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September, 2005

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**Migrating from Proprietary to Open Source  
Learning Content Management Systems**

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September 2005

## **Abstract**

This exploratory research examines projects that colleges and universities undertake to migrate from proprietary to open source learning content management systems. Responses to questionnaires from eleven individuals involved in nine open source migration projects were used to identify the: (i) main reasons for migrating to open source software, (ii) obstacles encountered during the migration, (iii) key factors that contribute to the success of open source migration projects, and (iv) main organizational changes that result from migrating to an open source learning content management system. Based on research results, propositions are developed and recommendations are made to chief information officers (CIOs) and presidents of colleges as well as senior managers of suppliers of proprietary learning content management systems. Propositions are developed anchored around four models: (i) decision to migrate, (ii) LCMS selection, (iii) success of migration project, and (iv) outcomes from migrating to an open source learning content management system.

**Suggested key words:** Learning content management system, open source, migration projects, and managing migration projects.

## **Acknowledgement**

This thesis was developed as part of the *Competing in open environments* research program led by Tony Bailetti, Carleton University, and Peter Carbone, Nortel. The support received from Nortel for this research and the M.Eng. in Telecommunications Technology Management program is gratefully acknowledged.

This thesis would not have been completed without the supervision of Professor Tony Bailetti. His relentless efforts guided me through out the research work. I am indeed obliged and extend my thanks to him for all his support and encouragement that made the difference.

I also take this opportunity to thank my family that supported me throughout the research work and was a source of inspiration to me.

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## **1 Introduction**

This research examines migration projects undertaken by colleges and universities for the purpose of replacing a proprietary for an open source learning content management system (LCMS).

A LCMS is software that is used to create, store, assemble and deliver content over the Web in the form of learning objects (Brennan, Funke, and Anderson, 2001). Learning developers can create, store, reuse, manage, and deliver digital learning content from a central object repository (Internet Time Group, 2005). Most colleges and universities use LCMS to support the delivery of course content over the Web. An LCMS emphasizes content management and authoring and includes many features included in learning management systems such as administration, assessment, and course management (Commonwealth of Learning, 2003).

### **1.1 Research objectives**

The objectives of this research are two. The first is to identify the:

1. Main reasons why colleges and universities migrate from proprietary to open source learning content management systems
2. Main obstacles encountered during the migration from proprietary to open source learning content management systems

3. Factors that contribute to the success of migration projects that involve learning content management systems
4. Main organizational changes that result from migrating to an open source learning content management system.

The second objective of this research is to develop propositions anchored around models for the:

1. Decision to migrate from a proprietary to an open source learning content management system
2. Selection of an open source learning content management system
3. Success of open source migration projects
4. Organizational consequences of migrating to an open source learning content management system

## **1.2 Background**

### **Learning content management systems**

A LCMS can be open source software or proprietary software. Popular open source LCMS used in colleges and universities include Moodle, Dokeos, ILIAS, ATutor, Claroline, Mambo, Manhattan Virtual Class Room and OLAT. The two most popular proprietary systems used in universities and colleges are WebCT

and Blackboard. WebCT is used in more than 70 countries (WebCT, 2005) and Blackboard in 59 countries (Blackboard, 2005).

Appendices A, B and C provide links to: lists of open source and proprietary LCMS, resources on LCMS and learning, and home pages of popular open source LCMS.

### **Open source software**

Open source software is a software program that comes with a license that provides users the freedom to (i) run the program for any purpose, (ii) study and modify the program, and (iii) redistribute copies of either the original or modified program without having to pay royalties to those who developed the software (Wheeler, 2005). According to the Open Source Organization (2005), a software can be termed open source if the license associated with it permits: free distribution, easy access to the source code, modifications to the source code, distribution of modified software, no discrimination against persons or groups of persons, use of program in a specified field or endeavour, and redistribution of the program with the same rights.

OSS stands for open source software. Other alternative terms for OSS include open source software and free software (OSS/FS), free/libre and open source software (FLOSS), and free and open source software (FOSS). Frequently,

those who use the term *open source software* tend to emphasize the technical advantages of the software (e.g., security, reliability), while those who use the term *free software* tend to emphasize ethical issues or freedom from control by suppliers of software (Wheeler, 2005).

For the purpose of this thesis, open source software (OSS) is used instead of OSS/FS, FLOSS and FOSS.

### **Proprietary software**

The opposite to open source is closed or proprietary software. Proprietary software is a software program that is offered for sale and comes with a license that provides the supplier control over the source code. The supplier of proprietary software holds ownership or intellectual property rights over the proprietary software and restricts modifications and the distribution of the source code.

### **1.3 Relevance**

Many colleges and universities that are using proprietary LCMS are considering migrating to open source LCMS. However, there is little in the literature that can help these organizations successfully undertake open source migration projects. This research's outcomes are relevant to senior managers of educational institutions and managers of project teams who are considering the adoption of

an open source LCMS. These outcomes are also relevant to suppliers of proprietary LCMS. On the one hand, the insights gained from the research results will enable senior managers of educational institutions and managers of project teams to prepare and execute better migration projects leading to the adoption of open source solutions, and reduce the fear, uncertainty and doubt associated with the migration to an open source LCMS.

On the other hand, insights gained from the results of this research may help top management teams improve the products and services that they offer colleges and universities.

The research models developed in this thesis and the propositions anchored around them will be relevant to researchers examining what is unique about open source migration projects in general, and open source LCMS migration projects at colleges and universities in particular.

#### **1.4 Contribution**

This research makes at least four contributions. First, it provides insights that CIOs and senior managers of colleges and universities can use to set up and execute open source migration projects. These insights can help organizations reduce the likelihood of making costly mistakes and reduce the time, cost and surprises of open source migration projects.

The second contribution this research makes is that it identifies the changes in resources, processes and values that an educational organization needs to make as it migrates from a proprietary to an open source LCMS.

The third contribution of this research is that it identifies the factors perceived to lead to the success of migration projects. Project teams that incorporate these success factors into their migration projects may be able to improve their projects' efficiencies and effectiveness.

The fourth contribution this research makes is that it links two literature streams: migration projects and the organizational adoption of complex open source software systems.

## **1.5 Organization**

This thesis has been organized into seven chapters. Chapter 1 is the introduction. Chapter 2 provides the literature review. Chapter 3 describes the model used to anchor this research. Chapter 4 describes the research method. Chapter 5 synthesizes the responses to the questionnaire used in this research. Chapter 6 discusses the results. Finally, Chapter 7 provides the conclusions and limitations of this research as well as suggestions for future research.

## **2 Literature review**

The literature review has been organized into five sections. Section 2.1 reviews the literature on migration projects. Section 2.2 examines the literature on development project decisions. Section 2.3 discusses the literature on organizational changes in terms of resources, processes and values. Section 2.4 examines the literature on technology adoption. Section 2.5 provides the lessons learned from the literature review.

### **2.1 Migration projects**

A search for articles on the migration from proprietary to open source LCMS in the academic literature turned out empty. A Web search found two case studies on migration projects involving LCMS at academic institutions (DotLRN, 2005; McMullin and Munro, 2004).

Soon after a proprietary LCMS was launched in 2001, faculty and administrators of the Heidelberg Medical Center recognized that it was designed to support a North American educational approach and not European educational approaches (DotLRN, 2005). The university migrated to an open source LCMS because of (i) the inherent lack of flexibility of the proprietary software, (ii) the inaccessibility of the code (this prevented Heidelberg from customizing the software to meet its needs), (iii) a limiting one-to-one

translation of the software, and (iv) the sudden increase in annual licensing fees.

McMullin and Munro (2004) describe the rationale behind the decision made by Dublin City University to shift from the pilot deployment of WebCT, a proprietary LCMS, to the large-scale deployment of Moodle, an open source LCMS. They also outline the plan to deploy the open source LCMS.

McMullin and Munro (2004) explain that the deployment of the open source LCMS was more aligned with the university's aspiration to become "leaders in the development of effective learning technologies." The closed source architecture of proprietary LCMS made it difficult to achieve this aspiration. The open source LCMS offered flexibility to develop and experiment with innovative new functionalities, exploiting the common features of the underlying platform, and collaborate with the open source community.

Ranganathan, Manheim and Keeler (2004) identify four main challenges encountered when transforming an organization to use computers: changes to processes, adjusting to new systems that involve more human interaction (e.g., data entry), training staff, and shifting users' mindsets towards computers.

Ranganathan et al. (2004) report that they learned six lessons from their study:

- Top management must be the architects of change

- Business – IT partnerships are needed enterprise-wide
- Pace of change must match the rate of acceptance of the new technology
- Individual transformation precedes organizational transformation
- Change agents need to be diverse
- Organizational leaders need to sense, recognize, and respond to organizational politics

Skidmore (2005) argues that managers should find the proper fit between the organization and the software. They suggest managers to:

- Ensure that the code base is maintained
- Obtain support from multiple vendors, which would reduce risk of lock-in by a specific vendor
- Access, extract, extend and modify organizational data
- Add or modify software components to meet organizational needs
- Share software to reduce costs and mitigate business risk in being the only organization using a specific idea
- Improve both the functional and non functional aspects of software

Drozdik, Kovács and Kochis (2005) argue that decision makers should evaluate the risks inherent in the migration to open source. They also stress the need for organizations to find opportunities for savings through the use of open source.

Drozdik et al. (2005) identify three sources of risk: security, cost and users. Security should be considered a major risk due to software bugs and other threats from viruses, trojans, etc. An organization can introduce effective security through regular monitoring and timely upgrades.

Migration can be very expensive, especially when data is difficult to migrate. The cost of migrating data should be given as much consideration as the cost of development and maintenance.

Users are the most problematic aspect of migration. User skill and discomfort are difficult to quantify. Training may help but it may not increase the user level of comfort or skills.

Fitzgerald and Kenny (2003) describe the lessons learned during the course of migrating to an open source software solution. The two main obstacles encountered were: (i) change required in the mind-set of users when deploying the open source software solution and (ii) resistance from staff who feared being deskilled by moving away from a popular proprietary system.

Fitzgerald and Kenny (2003) report the following lessons learned:

- Flexibility and availability of additional features in open source software allowed the organization to offer extra functionality in comparison with proprietary software
- Cost reduction was the main reason driving the migration from proprietary to open source software
- Support from top management is critical to success of the migration project
- Maintenance and support costs are just as high for open source software as they are for proprietary software
- Reliance on a standard maintenance contract as in the case of proprietary software is not an option in case of open source software

Lineweaver (2003) identified the following lessons learned from one open source software deployment:

- It is possible to gain more capabilities using open source software than using proprietary software
- Open source software is less vulnerable to security threats and virus infections
- Open source software and their upgrades are free in comparison with proprietary software, this results in considerable cost savings
- The learning curve involved in migrating from proprietary software to open source software offers a road block for wide open source software deployment

- KBSt (2003) identified the critical factors that lead to the sustainable success of a migration project. A migration project is successful if the desired aims and results for all stakeholders are achieved within the planned and agreed time and budget frames. The factors that contribute to the success of migration projects that were identified by KBSt (2003) are:
  - Identification of clear-cut aims for the migration project
  - Involvement and positioning of management and decision-making level
  - Early information and involvement of target groups / staff
  - Creating a high degree of user acceptance for the target environment
  - Structured time, project and resource planning, including project controlling
  - Organizational measures to prepare the migration process, and establish a qualified project team
  - Detailed stock-taking, including a definition of functional requirements
  - Optimum project and service selection
  - Well-timed, sustainable training
  - Quality management and documentation

## **2.2 Selection of open source software**

Wheeler (2003) identifies the 14 attributes that affect the selection of open source software: (i) functionality, (ii) cost, (iii) market share, (iv) support, (v)

maintenance, (vi) reliability, (vii) performance, (viii) scalability, (ix) usability, (x) security, (xi) flexibility, (xii) customizability, (xiii) interoperability, and (xiv) and legal and license issues.

## **2.3 Development project decisions**

The product development literature can be organized around: (i) decisions to set up a project and (ii) decisions made within the migration project (Krishnan and Ulrich, 2001).

### **2.3.1 Decisions to initiate projects**

Krishnan and Ulrich (2001) categorize the decisions to initiate a development project into strategy and planning, product organizational development, and project management.

Strategy and planning entail decisions on project prioritization, resource allocation, technology selection, and target market. The approval of the plan depends on how well it meets the strategic goals, justification of product opportunity and how well the target market fits the company's image and vision (Krishnan and Ulrich, 2001).

The product organizational development relates to the social system and environment in which a firm's design and development work is carried out. The factors that need to be taken into consideration involve processes for product development, investment in productivity-enhancement tools and metrics for measuring performance (Krishnan and Ulrich, 2001).

Project management decisions include planned timings and sequence of development activities, major project milestones, mechanisms for coordination between team members, and ways to control and monitor the project (Krishnan and Ulrich, 2001).

### **2.3.2 Decisions within projects**

Krishnan and Ulrich (2001) organize the decisions taken within the project into the following categories: concept development, supply chain design, product design, performance testing and validation, and production ramp-up and launch.

Decisions on physical form and appearance allow the development of a product concept. Concept development decisions define not only product specifications and product basic physical configurations but also the extended product offering including services and supplies (Krishnan and Ulrich, 2001).

Supply chain design encompasses inbound and outbound flows of materials, as well as the supply of intellectual property and services to the organization (Krishnan and Ulrich, 2001).

The term product design refers to detailed design phase which is comprised of specification of design parameters and detailed design of components (Krishnan and Ulrich, 2001).

A design needs to be tested and validated to ensure that it meets specifications. A testing strategy should balance the cost of prototyping and the cost of redesign (Krishnan and Ulrich, 2001).

The decisions that an organization takes prior to product launch are critical and Krishnan and Ulrich (2001) emphasize launch timings.

## **2.4 Resources, processes and values**

Three capabilities affect what an organization can do or not do: resources, processes, and values (Christensen, Anthony, and Roth, 2004).

Resources are things or assets including people, equipment, technology, product designs and information. Access to abundant and high quality

resources enhances an organizational ability to cope with change (Christensen et al., 2004).

Processes define how an organization transforms inputs of resources into things of greater value. These are value added processes that support investment decisions. Inflexible processes through which organizations create value are themselves inimical to change (Christensen et al., 2004).

Values are the criteria or standards by which an organization imparts decision on priorities. For example whether the customer order is attractive or not, whether the new product idea offers high profit margin to proceed with development or not, and whether the market is large or attractive enough to enter or not. These values reflect a company's business model. In addition, they define what an organization cannot do (Christensen et al., 2004).

## **2.5 Adoption of technology**

Technology, organization and environment are the three factors that influence technology adoption decisions in an organizational setting (DePietro, Edith, and Mitchell, 1990).

### **2.5.1 Technology**

Rogers (1995) defines an innovation as an idea, object or practice that is perceived as new and diffusion as a process by which the innovation makes its way through a social system. Roger's diffusion of innovation theory explains how the perception of innovation, character of adopters and their environment impacts the decision to adopt new technology. Five attributes are identified by Rogers (1995): relative advantage, compatibility, complexity, trialability and observability.

Relative advantage is the level to which the new technology is perceived as being better than the one it replaces. This characteristic allows the adopter to compare the old and new technologies and draw conclusions on whether to continue with the existing technology or migrate to the new one.

Compatibility is the level to which the new technology is perceived as being consistent with existing values, past experiences and needs of adopters. The compatibility with existing applications, hardware interfaces, skills and services are critical for the adopter to maintain an adequate level of user satisfaction.

Complexity is the level to which the new technology is perceived difficult to understand or use. The more complex the technology is, the more difficult it is for the adopter to accept the new technology.

**Trialability** is the level to which the new technology may be experimented on a limited basis. Rogers (1995) argues that new technologies are more likely to be adopted if they can be tried or tested as it reduces the perceived risk of adopting the new technology.

**Observability** is the level to which the results of innovations are visible to the technology adopter. The organizations are more likely to adopt new technologies if their results or performances are visible.

### **2.5.2 Organization**

Technology adoption is influenced by organizational mechanisms for communication and control, available resources and the innovativeness of the organization (DePietro et al., 1990).

### **2.5.3 Environment**

Technology adoption decisions depend on industrial characteristics such as competitors and relationships. Tessmer (1991) stresses the need to analyze the environment in which the adopter intends to use the technology.

Tessmer (1991) defines the environmental analysis as “the analysis of the context in which the instructional product will be employed, of the physical and use factors of the instructional environment and its support environment.”

The two key aspects of environmental analysis are the instructional environment and support environments.

The instructional environment involves analyzing the place where the instruction occurs, such as the classroom, office, laboratory and home.

Perceived benefits are the advantages the new technology can provide in the instructional environment. The perceived benefits in terms of ease of use or usefulness of technology impact the decision to adopt new technology. An organization will be unlikely to adopt the new technology if the perceived benefits are not apparent (Kirby and Turner, 1993, and Iacovou, Benbasat, and Dexter, 1995).

The support environment involves studying factors that support the employment of the instructional product. Some of the factors include: organizational readiness and level of expertise/technological know-how.

Organizational readiness refers to level of preparedness of an organization to adopt new technology. Iacovou et al. (1995) explain that an organization is less likely to adopt new technology if it is not prepared to do so in terms of its internal processes.

An organization is unlikely to adopt new technology if it does not have sufficient skills and expertise to manage and support it (Thong and Yap, 1995; Kirby and Turner, 1993).

The external environment also affects technology migration decisions. External environment refers to factors that are external to the organization. External pressure is an important external factor.

Iacovou et al. (1995), Thong and Yap (1995), and Van Heck and Ribbers (1999) have identified two sources of external pressure: competitive pressure and imposition by partners. They argue that as competitors and partners acquire technology they are also inclined to do so in order to maintain their competitiveness and social status in the community.

Customers and users can also create external pressure on an organization to adopt new technology (Kirby and Turner, 1993).

## **2.6 Lessons learned**

The main lessons learned from the literature reviewed are:

- The migration from old to new technology requires shifting the mindsets of users towards the new technology (Ranganathan et al., 2004; Fitzgerald and Kenny, 2003)
- The role of top management is critical in bringing change to an organization (Ranganathan et al., 2004; Fitzgerald and Kenny, 2003)
- Business-IT partnerships are required to facilitate the implementation of new technology (Ranganathan et al., 2004)
- Migration from proprietary to open source software involves overcoming internal resistance to deploy new technology within an organization (Fitzgerald and Kenny, 2003)
- Support available from multiple vendors reduces the risk associated with vendor lock-in (Skidmore, 2005)
- While migration to open source offers cost savings in the long run, deploying the new technology may involve considerable expenses (Drozdik et al., 2005)

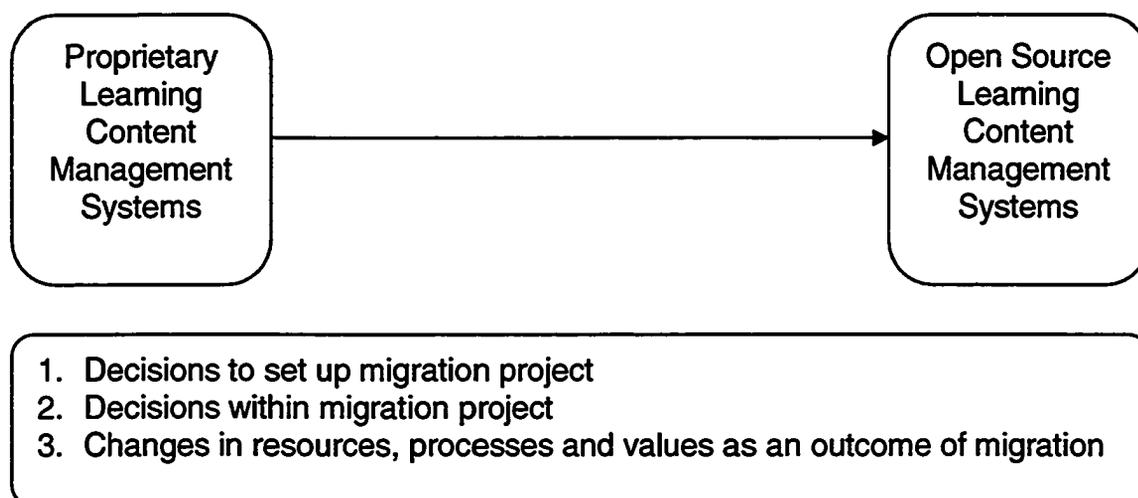
- The learning curve associated with moving from proprietary software to open source software offers a road block for open source software deployment (Lineweaver, 2003)
- Cost reduction is an important motive for organizations to migrate from proprietary to open source software (Skidmore, 2005)
- Involvement, positioning, and decision making levels of management affect the success of migration projects (KBSt, 2003)
- Well timed and sustainable training contributes to the success of migration project (KBSt, 2003)
- Developing a clear process for migration and involving a qualified project team contributes to the success of migration project (KBSt, 2003)

### 3 Research model and propositions

This chapter is organized into two sections. The first section describes the research model. The second section provides a list of the issues that arise in the domain that this research examines.

#### 3.1 Research model

The objective of this research is to examine educational institution's migration to open source LCMS. Figure 1 provides the three layers model used to anchor this research. The three layers are: (1) Decisions to set up migration project; (2) Decisions within migration project and (3) Changes in resources, processes and values due to migration to an open source LCMS.



**Figure 1 Research model used to examine open source migration projects**

### **3.2 Issues**

The following issues were identified as pertaining to the research model shown in Figure 1. These are listed in no particular order:

- Reasons that cause the educational institutes to reach the decision of migrating to open source LCMS
- Reasons that cause the organization to select the appropriate open source LCMS out of the many available
- Key phases of proprietary to open source migration projects
- Means to monitor and control proprietary to open source migration projects
- Factors that contribute in the successful outcome of migration project
- Obstacles in migration from proprietary to open source LCMS and their solutions
- Main changes in resources, processes and values as an outcome of migration to open source LCMS
- Important lessons that were learned during the course of migration project

## **4 Research method**

This chapter describes the unit of analysis, study period, and the method used to collect and analyze data.

### **4.1 Unit of analysis**

The unit of analysis is a project undertaken by a college or a university for the purpose of migrating from operating a proprietary LCMS to operating an open source LCMS.

### **4.2 Study period**

The study period is from January 1999 to June 2005.

### **4.3 Research method**

The research method was comprised of seven steps:

1. Specify research questions

2. Identify open source migration projects undertaken by colleges and universities
3. Design and validate a questionnaire
4. Approach individuals who participated in the open source migration with a request to complete the questionnaire
5. Analyze the questionnaire responses
6. Answer the research questions
7. Develop models and propositions anchored around the models
8. Generate recommendations for (i) CIOs and presidents of colleges and universities considering migrating from a proprietary to an open source LCMS and (ii) top management teams of suppliers of proprietary LCMS who wish to add value to their customers

#### **4.3.1 Specified research questions**

The original research questions were:

1. What are the main reasons why colleges and universities migrate from proprietary to open source learning content management systems?
2. What are the main obstacles encountered during the migration from proprietary to open source learning content management systems?
3. What are the factors that contribute to the success of migration projects that involve learning content management systems?

4. What are the main organizational changes that result from migrating to an open source learning content management system?

The four original questions did not change during the duration of this research. However, five questions were added to the original four. The additional questions were:

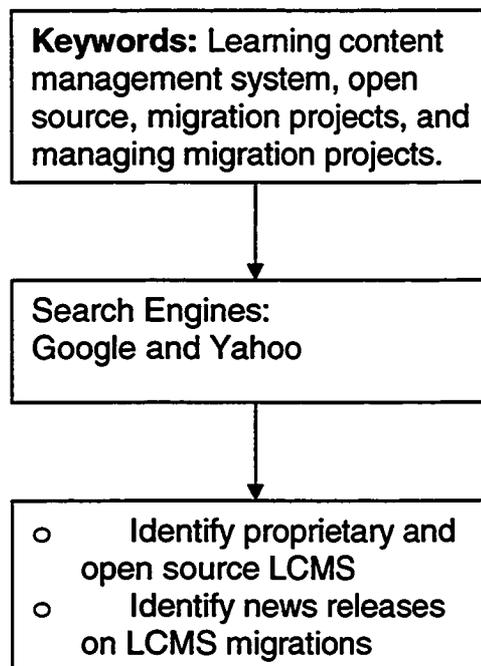
5. What makes the open source LCMS better than the proprietary LCMS it replaces? What made the replaced proprietary LCMS better than the open source LCMS?
6. What are the reasons for selecting the open source LCMS that was deployed?
7. What are the planned stages of the projects established for the purpose of migrating to an open source LCMS?
8. How are migration projects monitored and controlled?
9. What important lessons are learned during migration projects?

#### **4.3.2 Identified open source migration projects**

A Web search was undertaken to identify news releases on migrations from proprietary to open source LCMS undertaken by universities and colleges worldwide. Figure 2 illustrates the keywords and the search engines used to identify news releases on these migration projects.

Each news release was examined to:

- Assess whether or not the migration was undertaken by a college or university
- Assess whether or not the academic institution indeed migrated from a proprietary LCMS to an open source LCMS
- Identify the names of the people who were involved in the migration projects



**Figure 2 Identification of LCMS migrations undertaken by universities and colleges**

### 4.3.3 Designed and validated a questionnaire

A questionnaire was used to collect the data used in this research. Two individuals with experience with open source projects and the product

development literature examined the first draft of the questionnaire. Their feedback was incorporated into a second draft of the questionnaire. The Director of Carleton University's Research Ethics Committee provided feedback on the second draft of the questionnaire. The third draft of the questionnaire was sent via email to people who agreed to participate in the research study.

Appendix D provides a copy of the questionnaire used in this research. The questionnaire is comprised of open ended questions for capturing information from individuals who were involved in migrations from proprietary to open source LCMS at colleges and universities. The questionnaire is organized into three sections:

1. Decisions to setup migration project
2. Decisions within migration project
3. Changes in resources, processes and values

The first section of the questionnaire included 15 questions that focused on the decisions made to setup the migration project. These questions sought to learn about strategy and planning, project organization and project management (Krishnan and Ulrich, 2001). These 15 questions asked about the main reasons for migrating to an open source LCMS, who championed the migration, who led the migration project, project team membership, planned and actual outcomes from the migration, benefits gained, project duration, project stages

and key milestones, main obstacles encountered, project control and lessons learned.

The second section of the questionnaire included 14 questions that focused on decisions made within the migration project. These questions sought to learn about concept development, product design, supply chain design, performance testing and validation, and ramp up (Krishnan and Ulrich, 2001). The 14 questions asked about the main reasons for selecting the open source LCMS, what made the LCMS selected better than other LCMS, content outputs, external resources, interactions between the team and the open source community, testing, migration path followed, problems encountered, support, organizational learning, project completion, and factors that contributed to project success.

The third section of the questionnaire included three questions that focused on changes in resources, processes and values (Christensen, Anthony and Roth, 2004).

#### **4.3.4 Collected data**

The questionnaire was the primary source of data collection. From the news releases and information posted in the websites of colleges and universities, a list of names of people involved in the open source migration projects was

assembled. These individuals were contacted via email and asked to complete the questionnaire in January and February 2005. Responses to the questionnaire were returned via email. In some cases respondents were approached again to seek clarification of their replies.

Responses to the questionnaires were the main source of data for this research.

#### **4.3.5 Analyzed data and answered research questions**

The steps used to analyze the data were:

**Step 1:** Important statements were transcribed from the responses to the questionnaire. This is consistent with the process of horizontalization described by Creswell, 1998.

**Step 2:** The codes shown in Table 1 were used to organize responses to the questionnaire. These codes include the three adoption elements identified by DePietro et al. (1990), (i) technology, (ii) organization and (iii) environment and the five characteristics of innovation adoption identified by Rogers (1995), (iv) relative advantage, (v) complexity, (vi) compatibility, (vii) trialability and (viii) observability.

**Step 3:** Responses received from the research participants were analyzed

**Step 4:** For each variable, means were calculated in a way that was consistent with the process described by Creswell (1998)

**Step 5:** If the value corresponding to a variable was greater than the mean for the factor, the variable was considered as being significant.

**Step 6:** Based on the results, answers to the nine research questions were prepared.

#### **4.3.6 Developed models and propositions**

Based on a synthesis of the data extracted from the questionnaire and the lessons learned from the literature review, four research models were developed. Propositions anchored around these models were also developed.

The four models developed were:

1. Model that identifies what motivates colleges and universities to make the decision to migrate from a proprietary LCMS to an open source LCMS.
2. Model that attempts to explain why colleges and universities select the open source LCMS to which they migrate
3. Model that identifies the factors that lead to the success of open source migration projects
4. Model that identifies the organizational changes that occur as a result of migrating to an open source LCMS.

#### **4.3.7 Prepared recommendations**

Based on a synthesis of the data extracted from the questionnaire and the lessons learned from the literature review, a set of recommendations were prepared for:

1. CIOs and presidents of colleges and universities considering the migration from a proprietary to an open source LCMS
2. Top management teams of suppliers of proprietary software who wish to add more value to their customers

## 5 Results

This chapter is organized into ten sections. The first section describes the sample used in this research. The second section identifies the reasons why colleges and universities migrate from proprietary to open source LCMS. The third section identifies the main obstacles encountered during migration to an open source LCMS. The fourth section identifies the factors that contribute to the success of open source LCMS migration projects. The fifth section identifies the main organizational changes that result from migrating to an open source LCMS. The sixth section identifies the reasons that made the selected open source LCMS better than the proprietary LCMS it replaced as well as the reasons that made the proprietary LCMS better than the open source LCMS which replaced it. The seventh section identifies the reasons colleges and universities selected the open source LCMS that was deployed. The eighth section identified the planned stages of the migration projects examined. The ninth section identifies the means used to monitor and control migration projects. Finally, the tenth section identified the important lessons learned by those who were involved in the migration projects.

## 5.1 Sample

A Web search was used to identify the academic institutions that migrated from proprietary to open source LCMS. Table 2 shows the 20 institutions identified by this Web search.

The Web search also identified twenty-five individuals who had participated in the 20 migrations in Table 2. These individuals were requested to complete the questionnaire. Eleven of the 25 people contacted completed 10 questionnaires. Two people responded jointly to one questionnaire and two respondents were involved in the same migration project. Thus, the sample is comprised of data on nine open source LCMS migration projects.

Of the nine migration projects in the sample, universities undertook four projects, a large school at a university undertook one project, a university department undertook one project, a college undertook one project, and polytechnics undertook two projects.

Table 2 identifies the colleges and universities included in the sample as well as the number of responses received from individuals at each academic institution.

Academic institutions in the United States undertook five of the nine migration projects. One academic institution in each of Ireland, Switzerland, Finland, and New Zealand undertook the other four migrations included in the sample. For each institution in the sample, the migration project was the first instance of a migration to an open source enterprise system.

The 11 respondents identified their roles in the migration projects. Five of the 11 respondents led the migration project teams at their institutions. One was a system administrator, two were instructional developers, one was an advisor to the migration project team, one was the chair of an academic program, and one was a technical expert.

The average duration of the migration projects in the sample was 13 months. The minimum duration was four months and the maximum 24 months.

The response rate for the questionnaire was 40% (10 completed questionnaires out of 25 people contacted). The sample represents 45% (9 of 20) of the open source migration projects identified by the Web search.

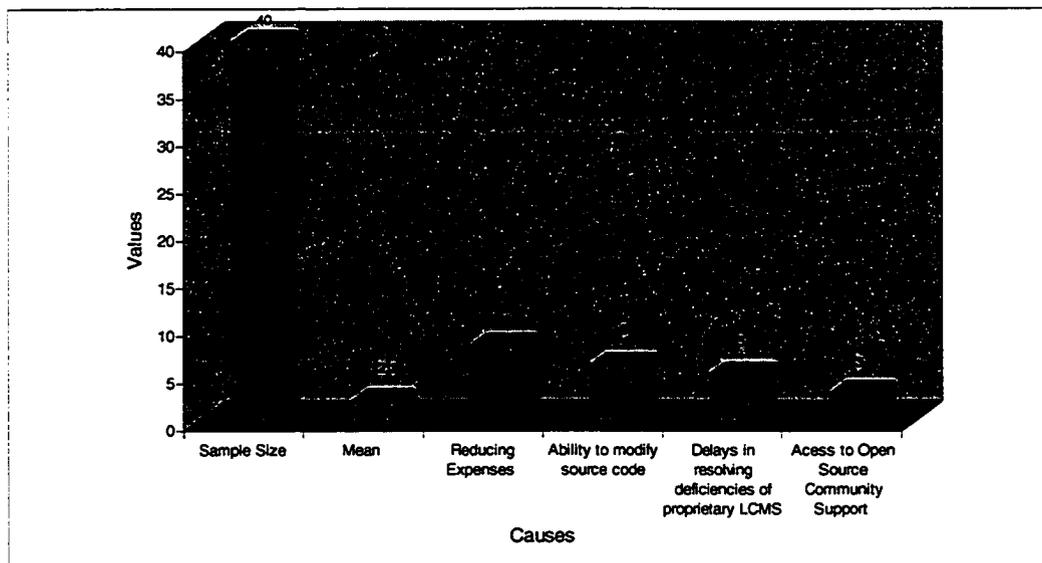
## **5.2 Reasons for migrating from proprietary to open source LCMS**

Question 1 in the questionnaire asked for the reasons the college or university migrated from a proprietary to an open source LCMS. Table 3 provides the

synthesis of 10 answers to question 1 received from respondents who were involved in the nine migration projects in the sample. Table 3 organizes the answers to question 1 based on the codes shown in Table 2.

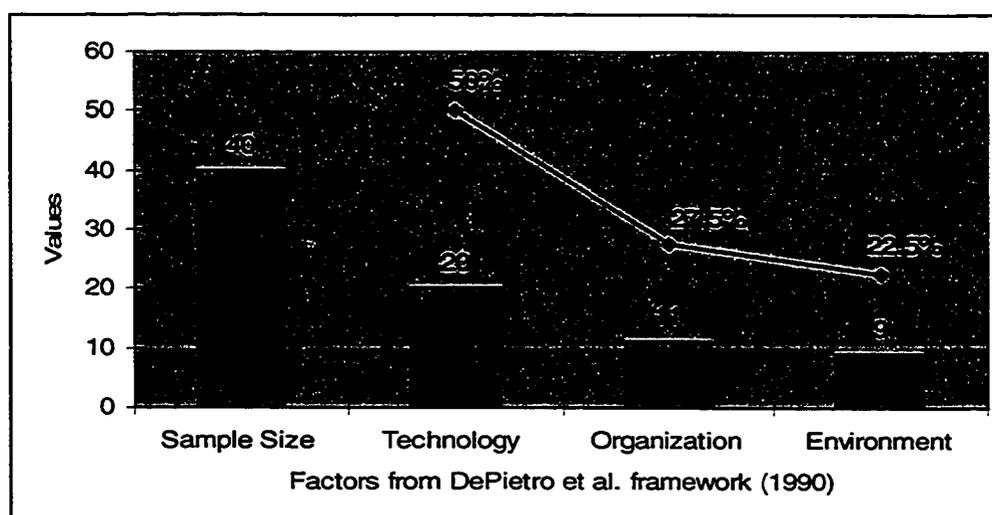
The results shown in Table 3 suggest that there are four major reasons why academic institutions migrate from a proprietary to an open source LCMS. They migrate to: (i) reduce expenses, (ii) modify source code, (iii) avoid the delays in fixing bugs and adding functionality experienced with suppliers of proprietary software, and (iv) benefit from interactions with developers of open source software.

Figure 3 illustrates the result shown in Table 3. Figure 3 provides the number of times respondents identified a reason for migrating to an open source LCMS. These counts were compared to the mean for all reasons.



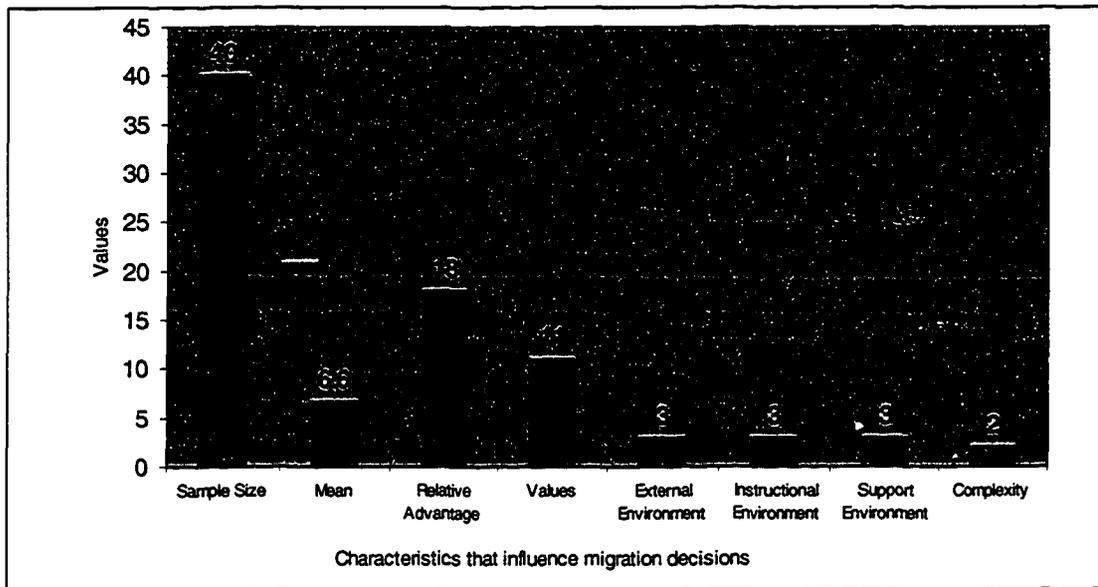
**Figure 3 Reasons to migrate from a proprietary to an open source LCMS**

When the reasons for migration are grouped in terms of technology, organization and environment factors, Figure 4 and Table 3 suggest that 50% of the reasons for migration to an open source LCMS are grouped under the technology factor, 27.5% under the organization factor and 22.5% under the environment factor.



**Figure 4 Reasons to migrate from proprietary to open source LCMS organized into technology, organization, and environment factors**

Figure 5 illustrates the results in Table 3 for when the reasons for migration are organized into: relative advantage, values, external environment, instructional environment, support environment, and complexity factors. Figure 5 and Table 3 show that the reasons for open source migration pertaining to relative advantage and values are more frequently cited than reasons pertaining to complexity and external, instructional and support environments.



**Figure 5 Reasons to migrate from proprietary to open source LCMS organized into relative advantage, values, external environment, instructional environment, support environment, and complexity factors**

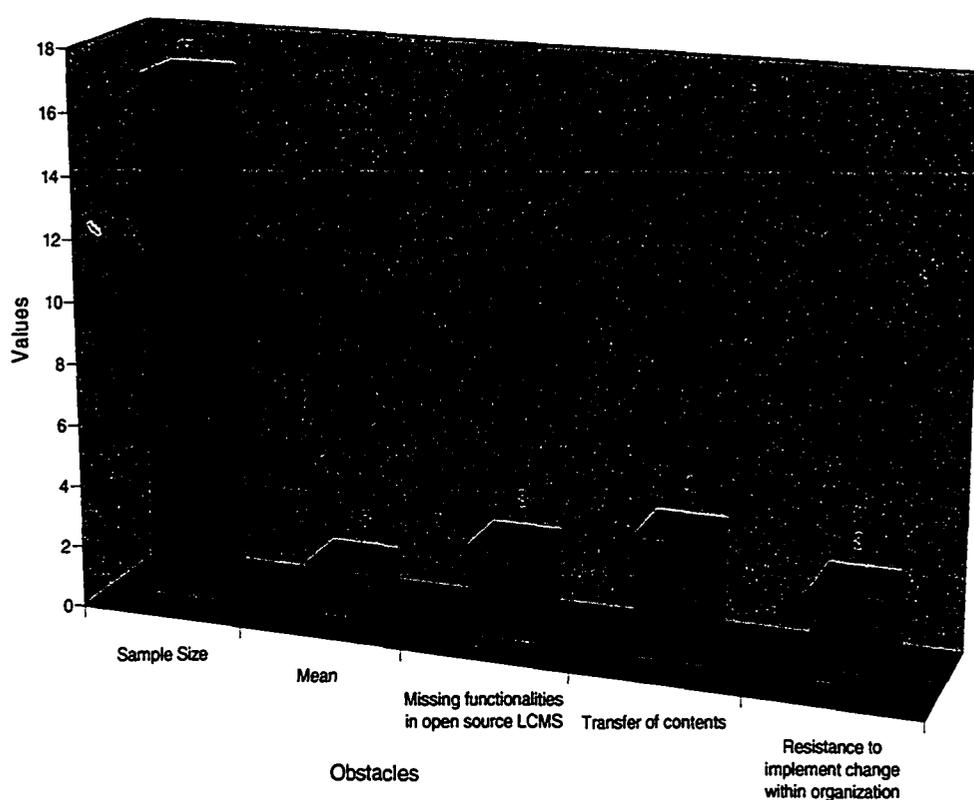
### 5.3 Obstacles encountered during the migration from proprietary to open source LCMS

Question 13 in the questionnaire asked what were the main obstacles encountered during the migration project. Table 4 provides the codes used to organize the responses to question 13.

Table 5 synthesizes nine answers to question 13 supplied by individuals who were involved with eight migration projects.

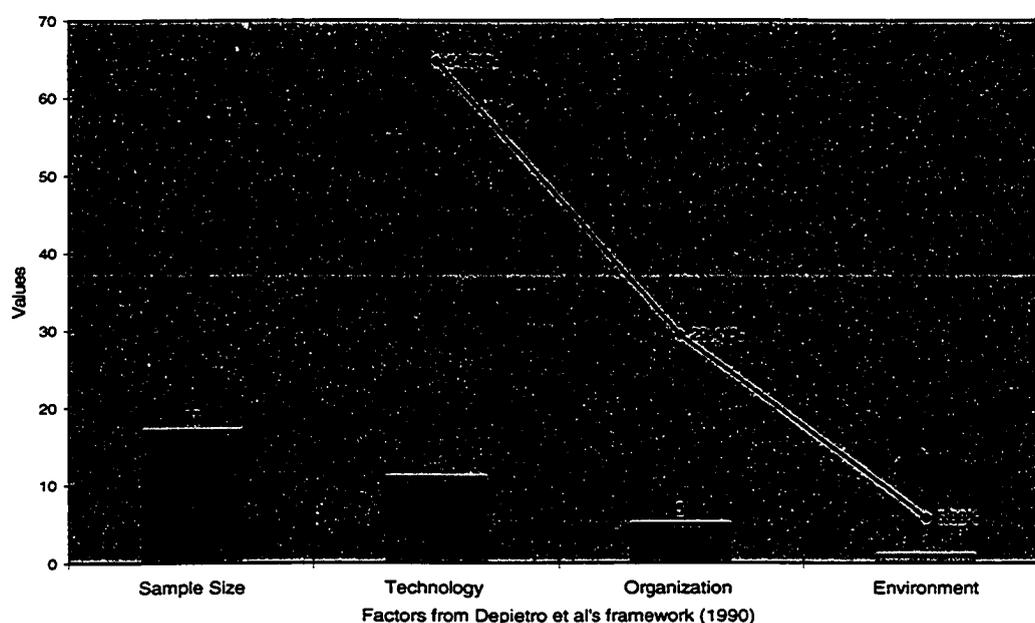
The results in Table 5 suggest that the three major obstacles encountered when migrating from proprietary to open source LCMS are: (i) the migration of content, (ii) need to develop functionality that is missing in the open source LCMS, and (iii) resistance to implement change within the organizations.

Figure 6 illustrates the frequency with which the three major obstacles encountered in open source project migrations were identified in the answers to question 13.



**Figure 6 Major obstacles encountered when migrating from proprietary to open source LCMS**

Figure 7 shows that when the obstacles encountered during migrations are grouped based on the three factors used in DePietro et al. (1990), technology related obstacles account for 64.7% of the total obstacles identified. Organizational and environment related obstacles account for 29.4% and 5.9% respectively.



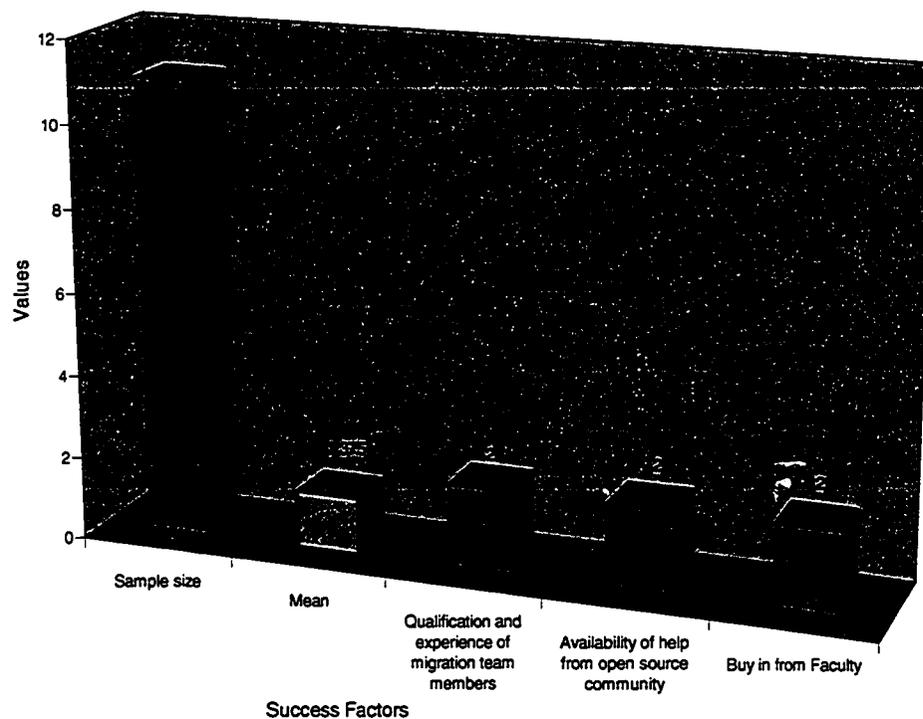
**Figure 7 Major obstacles encountered during the migration from proprietary to open source LCMS**

#### 5.4 Factors that contribute to the success of migration projects

Question 29 in the questionnaire asked respondents to identify the factors that most contributed to the success of migration projects. Table 6 provides the

synthesis of the answers to question 29 provided by 9 individuals. These nine respondents were involved with eight migration projects.

Table 6 suggests that three factors contribute to the success of migration projects: (i) the use of qualified and experienced team members, (ii) help from open source community, and (iii) buy-in from faculty members.



**Figure 8 Factors that contribute to the success of open source LCMS migration projects**

## **5.5 Organizational changes that result from migrating to an open source LCMS**

Table 7 synthesizes the answers from eight respondents to the three questions that asked about organizational changes resulting from migrating to an open source LCMS (questions 30, 31 and 32). These eight respondents were involved in seven migration projects.

The results reported in Table 7 suggest that the main changes due to the migration to an open source LCMS are: (i) cost savings, (ii) recruitment of new staff with experience in open source, (iii) introduction of new learning-related services, (iv) adoption of best practices to operate the institution's IT infrastructure, and (v) adoption of other systems that interoperate with the open source LCMS.

## **5.6 Comparing proprietary and open source LCMS**

Table 8 provides the synthesis of ten answers to questions about what made the open source LCMS better than the proprietary LCMS it replaced (question 17) and what made the proprietary LCMS better than the open source LCMS (question 18). The individuals who provided the ten responses were involved with nine migration projects.

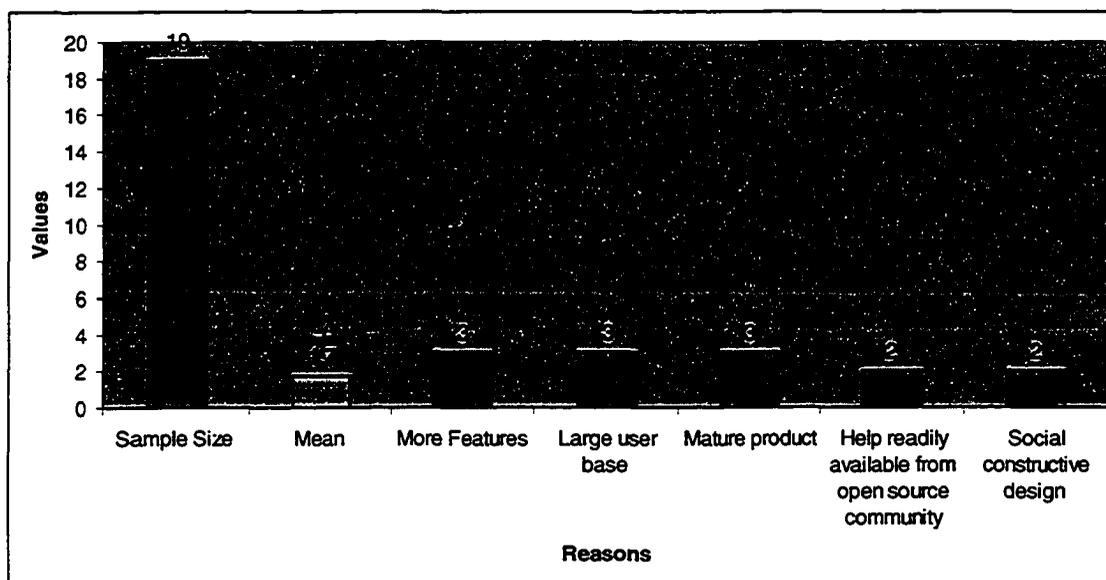
The results in Table 8 suggest that open source LCMS are preferred over proprietary LCMS because they are: more flexible, cheaper, enable customization, and offer more functions.

The results in Table 8 suggest that proprietary LCMS are preferred over open source LCMS because they have features and functionalities not available in open source LCMS such as quizzes, grade books, course cartridges and better report generating capability.

### **5.7 Reasons for selecting the open source LCMS that was deployed**

Question 16 asked what were the main reasons for selecting the open source LCMS that was deployed. Table 9 provides the synthesis of the answers to question 16. Table 9 provides the synthesis of six answers from seven respondents who were involved with six migration projects. Results in Table 9 suggest that the main reasons for selecting an open source LCMS over others are: (i) more features, (ii) larger user base, (iii) maturity of the product, (iv) help readily available from open source community, and (v) implementation of social constructive design.

Figure 9 illustrates the synthesis presented in Table 9.



**Figure 9 Reasons for selecting the open source LCMS that was deployed**

### 5.8 Planned stages of migration projects

Nine respondents provided answers to the two questions that asked about the planned stages and milestones of the open source migration projects (questions 11 and 12) for eight migration projects. The nine responses suggest that the migration from proprietary to open source LCMS takes place in two stages. In the first stage, the educational institutions assesses whether or not the migration from proprietary to open source LCMS is worthwhile. The work assignments undertaken during the first stage include:

- a team reviews different open source LCMS and recommend a few that could replace the existing proprietary LCMS

- the short listed LCMS are compared and a recommendation is made to select one that is the better candidate to replace the existing proprietary LCMS
- IT staff and a few instructors and students are invited to test the open source LCMS that has been tentatively selected in an alpha trial
- feedback from the alpha trial is used to decide whether or not to proceed with a beta trial
- a larger number of students and faculty are invited to test the open source LCMS that has been tentatively selected in a beta trial
- feedback from the beta trial is used to decide whether or not to proceed with the migration
- senior management commits to a migration project and appoints a leader for the migration project
- a team that represents the various stakeholders prepares a migration plan and submits the plan for approval

The actual migration from proprietary to open source LCMS takes place during the second stage. The second stage has two parts: limited scale deployment and full-scale deployment.

During the limited scale deployment, courses are delivered using both the proprietary and open source LCMS. The limited scale deployment affects only a segment of the student population. During the full-scale deployment all

segments of the student population are affected. During full-scale deployment both the proprietary and the open source LCMS operate concurrently. After a period of time the proprietary LCMS is discontinued.

### **5.9 Means of monitoring and controlling migration projects**

Nine respondents provided answers to question 14 that asked about the means used to control and monitor migration projects. These respondents were involved with eight migration projects.

The nine responses suggest that a broad range of techniques is used to monitor and control the migration from proprietary to open source LCMS. These techniques include: project leader's directives, project management tools, project blue print, weekly meetings with project stakeholders, issues tracking systems, electronic work request systems, frequent meetings and correspondence with main actors, critical path planning, building a database containing information on all the courses that need to be migrated, and meeting frequently with representatives of different departments and faculties to provide updates on the migration project.

### **5.10 Lessons learned by participants in migration projects**

Question 15 asked about the lessons learned while participating in open source migration projects. Table 10 provides a synthesis of the answers to question 15 from eight individuals. The eight respondents were involved in seven migration projects.

The lessons learned by the respondents to the questionnaire were anchored around the following issues: planning, testing, training, content transfer, user administration, required interaction between academic institution's staff and developers of open source LCMS, learning needs, and resource commitments.

## **6 Propositions**

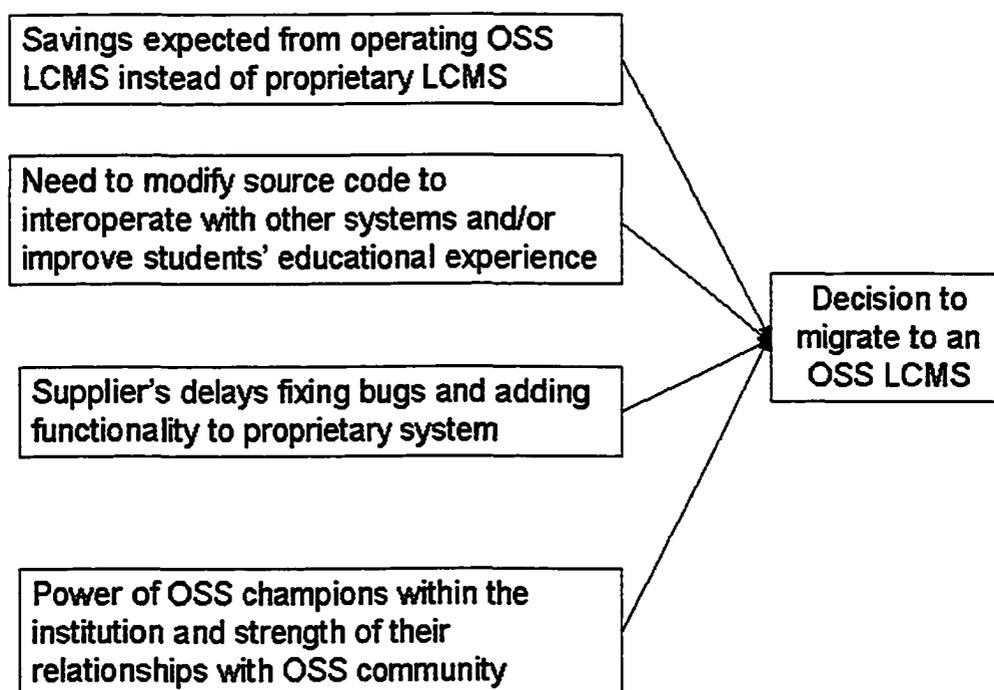
This chapter is organized into five sections. The first section develops propositions anchored on a model that identifies what motivates colleges and universities to make the decision to migrate from a proprietary LCMS to an open source LCMS. The second section develops propositions anchored around a model that attempts to explain why colleges and universities select the open source LCMS to which they migrate. The third section develops propositions anchored around a model that identifies the factors that lead to the success of open source migration projects. The fourth section develops propositions anchored around a model that identifies the organizational changes that occur as a result of migrating to an open source LCMS. The fifth section provides a list of the propositions developed in this thesis.

The objective of the propositions developed in this chapter is to examine the migration to open source LCMS by academic institutions. The focus is not to use LCMS data as a representative sample of the more general problem of migration to open source software at the enterprise level.

### **6.1 Motives for migration**

Figure 10 provides a model that identifies the motives for a college and university migrating from a proprietary LCMS to an open source LCMS.

Four motives drive migration: (i) savings expected from operating an open source LCMS instead of a proprietary LCMS, (ii) need to modify the source code of the LCMS to interoperate with other systems and/or improve students' educational experience, (iii) supplier's delays fixing bugs in their proprietary systems and adding new functionality, and (iv) power of the champions of open source within the academic institution and the strength of their relationships with the open source community.



**Figure 10 Motives for migrating from a proprietary to an open source LCMS**

The following propositions are offered to examine the factors that distinguish the academic institutions that decide to migrate to an open source LCMS from those that consider it but decide against migration:

**Proposition 1 Savings expected from operating an open source LCMS distinguish the colleges and universities that make the decision to migrate from those that do not.**

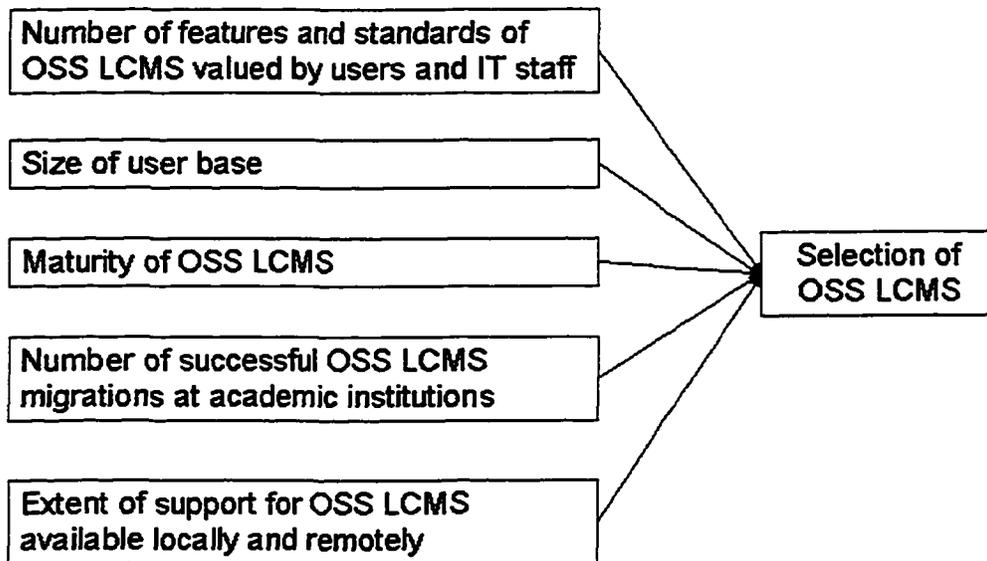
**Proposition 2: Need to modify the proprietary system's source code distinguish the colleges and universities that make the decision to migrate from those that do not.**

**Proposition 3: Delays when fixing bugs and adding functionality to the proprietary system distinguish the colleges and universities that make the decision to migrate from those that do not.**

**Proposition 4: Power of champions of open source within their institutions and strength of their relationships to open source communities distinguishes the colleges and universities that make the decision to migrate from those that do not.**

## **6.2 Selection of open source LCMS to which migrate**

**Figure 11 identifies the factors that influence colleges and universities to migrate to a specific LCMS.**



**Figure 11 Factors that influence the selection of an open source LCMS**

Five key factors influence colleges and universities to select an open source LCMS to which migrate: (i) number of features and standards of the open source LCMS valued by users and IT staff, (ii) size of user base (i.e., number of academic institutions that use the open source LCMS), (iii) maturity of the LCMS, (iv) number of successful open source LCMS migrations reported by academic institutions, and (v) extent of support for the open source LCMS available locally and remotely.

The following propositions are offered:

**Proposition 5:** Number of features and standards of the open source LCMS valued by the users and IT staff increases the likelihood of its adoption.

**Proposition 6:** Size of the user base of the open source LCMS increases the likelihood of its adoption.

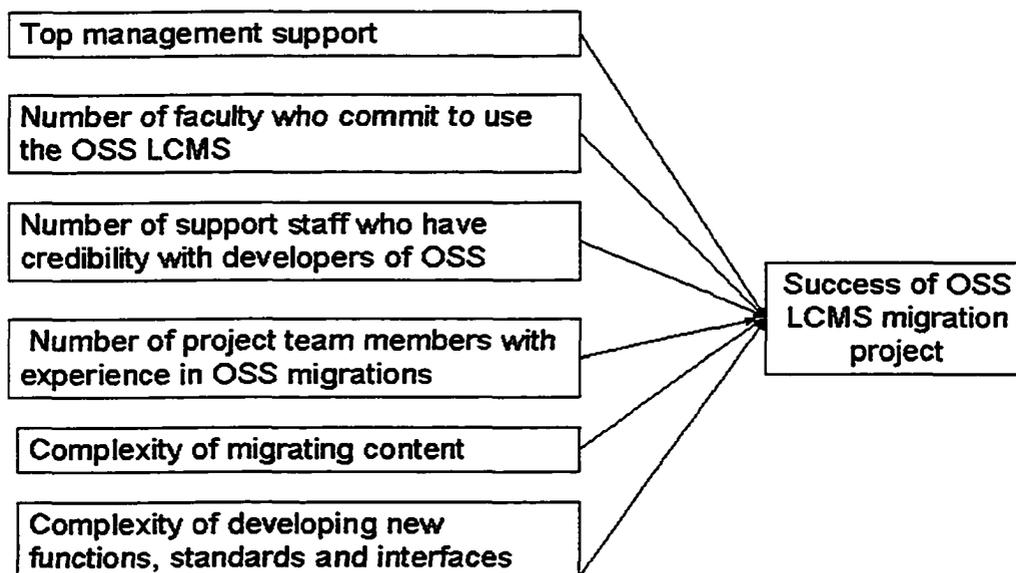
**Proposition 7:** Maturity of the open source LCMS increases the likelihood of its adoption.

**Proposition 8:** Number of successful migrations to the open source LCMS at other academic institutions increases the likelihood of its adoption.

**Proposition 9:** Extent of local and remote support for the open source LCMS increases the likelihood of its adoption.

### **6.3 Success of open source migration project**

Figure 12 provides a model that identifies the key factors that lead to the success of a migration project. The following six factors contribute to migration project success: (i) top management support, (ii) number of faculty who commit to use the open source LCMS, (iii) number of support staff who have credibility with developers of open source software, (iv) number of project team members with experience in open source migration projects, (v) complexity of migrating content, and (vi) complexity of developing new features, standards and interfaces to the open source LCMS and existing systems with which it needs to interoperate.



**Figure 12 Constructs that contribute to the success of open source migration projects**

The following propositions are offered when success is measured using an index of stakeholders' satisfaction with the migration project:

**Proposition 10:** Top management support increases migration project success.

**Proposition 11:** Number of faculty who commit to use the open source LCMS increases migration project success.

**Proposition 12:** Number of support staff with credibility with developers of open source LCMS increases migration project success.

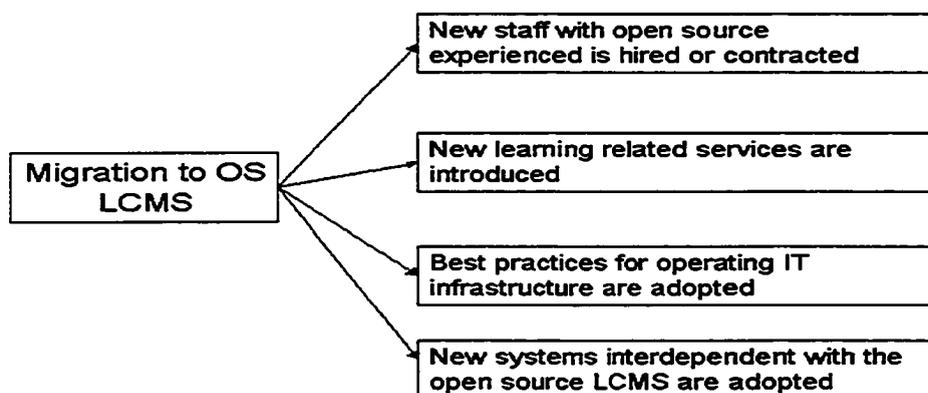
**Proposition 13:** Number of project team members with open source migration experience increases migration project success.

**Proposition 14:** Complexity of migrating content decreases migration project success.

**Proposition 15:** Complexity of developing new functions, standards and interfaces to the open source LCMS and existing systems decreases migration project success.

#### **6.4 Organizational consequences of open source migration**

Figure 13 provides a model that illustrates the organizational consequences of migrating from a proprietary to an open source LCMS. Four key changes are identified: (i) new staff with open source experience is hired or contracted, (ii) new learning-related support services are introduced, and (iii) best practices to manage the college's or university's IT infrastructure are introduced, and (iv) new systems interdependent with the LCMS are introduced.



**Figure 13 Organizational consequences of migrating from a proprietary to an open source LCMS**

The following propositions are offered.

**Proposition 16:** Migration to an open source LCMS results in the hiring or contracting of more staff with open source experience.

**Proposition 17:** Migration to an open source LCMS results in the introduction of new learning-related services.

**Proposition 18:** Migration to an open source LCMS results in the adoption of best practices for managing the IT infrastructure.

**Proposition 19:** Migration to an open source LCMS results in the adoption of new interdependent systems.

## **6.5 Propositions**

This is the list of the propositions identified from the results of this research:

**Proposition 1:** Savings expected from operating an open source LCMS distinguish the colleges and universities that make the decision to migrate from those that do not.

**Proposition 2: Need to modify the proprietary system's source code distinguish the colleges and universities that make the decision to migrate from those that do not.**

**Proposition 3: Delays when fixing bugs and adding functionality to the proprietary system distinguish the colleges and universities that make the decision to migrate from those that do not.**

**Proposition 4: Power of champions of open source within their institutions and strength of their relationships to open source communities distinguishes the colleges and universities that make the decision to migrate from those that do not.**

**Proposition 5: Number of features and standards of the open source LCMS valued by the users and IT staff increases the likelihood of its adoption.**

**Proposition 6: Size of the user base of the open source LCMS increases the likelihood of its adoption.**

**Proposition 7: Maturity of the open source LCMS increases the likelihood of its adoption.**

**Proposition 8: Number of successful migrations to the open source LCMS at other academic institutions increases the likelihood of its adoption.**

**Proposition 9: Extent of local and remote support for the open source LCMS increases the likelihood of its adoption.**

**Proposition 10: Top management support increases migration project success.**

**Proposition 11: Number of faculty who commit to use the open source LCMS increases migration project success.**

**Proposition 12: Number of support staff with credibility with developers of open source LCMS increases migration project success.**

**Proposition 13: Number of project team members with open source migration experience increases migration project success.**

**Proposition 14: Complexity of migrating content decreases migration project success.**

**Proposition 15: Complexity of developing new functions, standards and interfaces to the open source LCMS and existing systems decreases migration project success.**

**Proposition 16: Migration to an open source LCMS results in the hiring or contracting of more staff with open source experience.**

**Proposition 17: Migration to an open source LCMS results in the introduction of new learning-related services.**

**Proposition 18: Migration to an open source LCMS results in the adoption of best practices for managing the IT infrastructure.**

**Proposition 19: Migration to an open source LCMS results in the adoption of new interdependent systems.**

## **7 Conclusions, recommendations, limitations and suggestions for future research**

This chapter is organized into four sections. The first section provides a summary of the results of this research. The second section provides recommendations to CIOs and presidents of educational institutions considering the migration to an open source LCMS as well as recommendations to the top management teams of suppliers of proprietary LCMSs. The third section describes the limitations of this study. Finally, the fourth section provides suggestions for future research.

### **7.1 Summary of research**

Table 2 shows that Web searches resulted in the identification of 20 colleges and universities that have migrated from a proprietary to an open source LCMS. This is a very small number of instances of migrations from a proprietary to an open source LCMS. This research provides insights gained from nine of the 20 known LCMS migrations at colleges and universities.

Table 3 and Figure 3 suggest that the three most important reasons for migrating from a proprietary to an open source LCMS are: reducing expenses, ability to modify source code, and delays in removing deficiencies of proprietary LCMS.

Table 5 and Figure 6 suggest that the three major obstacles encountered during the migration from a proprietary to an open source LCMS are: missing functionalities, transfer of content, and resistance to implement change within the organization.

Table 6 and Figure 8 show that the three major factors that contribute to the success of migration project are: buy-in from faculty, help available from open source community, and qualification and experience of migration team members.

Table 7 shows that the migration from proprietary to open source LCMS results in: the hiring or contracting of new staff with experience in open source software development, the introduction of new learning-related services, the adoption of best practices by IT staff, and the adoption of new systems that interoperate with the open source LCMS.

Table 8 suggests that open source LCMS are perceived to be better than proprietary LCMS because they are more: flexible (i.e., more responsive to needs), cheaper, and customizable.

Table 8 also suggests that some of the features of proprietary LCMS are missing in open source LCMS. Some of these features include: quizzes, grade

books, course cartridges and capability to generate reports. These features may provide proprietary LCMS with a competitive advantage over open source LCMS.

Table 9 and Figure 9 suggest that colleges and universities select an open source LCMS on the basis of extent of community support, greater number of features, system maturity, system design, and size of the user base.

Based on the results obtained, 19 propositions anchored around four models were developed.

## **7.2 Recommendations**

This section describes recommendations to CIOs and presidents of educational institutions and top management teams of supplier of proprietary systems.

### **7.2.1 Recommendations to CIOs and presidents of educational institutions considering migrating to an open source LCMS**

Based on the research results, at least eight recommendations may be made to presidents and/or CIOs of universities and colleges who are considering the migration from proprietary to open source LCMS.

The first recommendation is to allocate adequate resources (i) to the migration of content and (ii) to develop the functionalities in proprietary LCMS that are not available in the open source LCMS. In Table 5, cases 2, 5 and 6 report that functionalities were missing in open source LCMS and cases 4, 5, 6 and 7 report that the transfer of content was the major obstacles when migrating to an open source LCMS. Figure 6 also identifies these two issues as being among the three major obstacles to successful open source LCMS migration.

The results shown in Figure 6 suggest that users expect the new open source system to provide access to the content developed while they were using the proprietary LCMS and better system functionality than that provided by the proprietary LCMS. Serious migration problems may occur if the open source LCMS does not allow access to previously developed content and the functionality of the open source system is perceived to be inferior to that of the proprietary system.

The second recommendation to presidents and CIOs of colleges and universities pertains to change management. Figure 6 shows that organizational resistance to implement new technology is the third major obstacle encountered when migrating from proprietary to open source LCMS. To overcome resistance to the adoption of the open source LCMS and based on cases 4, 6 and 7 of Table 5<sup>1</sup> presidents and CIOs should: (i) provide evidence that the open source LCMS supports the institution's objectives; (ii) encourage faculty who are opinion leaders to experiment with the open source LCMS before it is widely deployed; (iii) provide hand-on training to students and faculty and teach the benefits of the new open source LCMS; (iv) fund projects that use the new open source LCMS and are based on interdepartmental or inter-institutional collaboration, and (v) appoint users as change leaders and hold them responsible for the deployment of the open source LCMS.

The third recommendation is to train the IT staff in the new open source LCMS before it is deployed widely and allow them to validate the functionality of the new software during the testing phase. The lessons learned from case 6 included in Table 10 emphasize training of staff for the purpose of successful migrations to open source.

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<sup>1</sup> Codes used in Table 5 are defined in Table 4.

Lessons learned from case 4 reported in Table 10 emphasize the need to be able to interact with the community that is developing the open source LCMS. The fourth recommendation to CIOs and presidents of colleges and universities is to hire people who can interact with the community that is evolving the open source LCMS as full-time staff or contractors. Alternatively, the educational organization can retain a company that specializes in the provision of open source services.

The fifth recommendation is that the universities and colleges implement best practices for load balancing and disaster recovery as well as an automated enrollment system during the migration to open source LCMS. Table 7 identifies the process changes implemented during migrations to open source LCMS. Respondents in case 4 identified the implementation of best practices for load balancing and disaster recovery while those in case 7 identified automating the enrollment process.

The sixth recommendation is to increase the level of services to students and faculty. Responses in cases 4, 6, 7 and 8 as indicated in Table 7 suggest increasing resources to help desks, establishing call centers, improving websites, and providing better online support, may improve services.

Figure 9 reveals that the two most important reasons for selecting a mature open source LCMS are: number of features and size of the user base. The seventh recommendation is to select a mature open source LCMS that has a large user base and more features than those of the proprietary system in use, as reported by cases 1 and 3, and cases 5, 7, 8 and 11 in Table 9 respectively.

The eighth recommendation to presidents and CIOs of colleges and universities is to ensure that the migration project team is comprised of qualified and experienced members capable of executing and managing open source migration projects and that the personnel committed to the migration project are not withdrawn. Cases 1 and 3 in Table 6 suggest that the success of the migration project requires the institution to invest in qualified resources and commit them during the duration of the project.

### **7.2.2 Recommendations for suppliers of proprietary LCMS**

As an outcome of this research, at least seven recommendations can be made to the management team of a supplier of proprietary LCMS.

The first recommendation for the suppliers is to add more functionalities and features in proprietary LCMS that users care about and are not available in

open source LCMS. Cases 2, 5 and 6 in Table 5 and Figure 6 reveal that the educational organizations that migrated to open source LCMS had to find workarounds for features that were missing in open source LCMS. Suppliers of proprietary LCMS can gain advantage by adding more features that would make it difficult for their customers to migrate to open source LCMS.

Cases 2, 4 and 8 in Table 3 and Figure 3 identify that one of the reasons the educational organizations migrated to open source LCMS was to access support from the open source community. The second recommendation for the suppliers of proprietary LCMS is to develop communities and partnerships similar to the ones that exist for open source systems, which would allow them to build better relationships with their customers.

Cases 2, 5, 6, 7, 8 and 9 in Table 3 and Figure 3 show that the educational organizations migrated from proprietary to open source LCMS to avoid delays in removal of deficiencies. The third recommendation for the suppliers of proprietary LCMS is that they should provide better support and service to their customers by reducing lead times between software releases, responding quickly to customer complaints and making changes requested in source code faster.

The fourth recommendation for the suppliers of proprietary LCMS is to encourage users to develop complementary products that fit with the

proprietary LCMS. Cases 4, 6 and 7 in Table 5 and Figure 6 show that there is resistance within the organization to implement new technology as the staff is not familiar with it. By adding complementary products that are not available in open source LCMS it would be possible for the suppliers of proprietary LCMS to build the resistance within organization to avert migration to open source LCMS.

The fifth recommendation to suppliers of proprietary LCMS is to increase the cost for customers to migrate to open source LCMS. Cases 1, 2, 3, 4, 5, 6, 7, 8 and 9 in Table 3 and Figure 3 indicate that the educational organizations migrated to open source LCMS to reduce expenses. The suppliers of proprietary LCMS can reduce the expenses incurred by educational organizations towards system maintenance, license fee, technical support, and source code modifications in a way that they are not excessive for the educational organizations to start thinking of migration to open source LCMS.

Cases 4, 5, 6 and 7 in Table 5 and Figure 6 reveal that migrating content from proprietary to open source LCMS was one of the major obstacles in migration. The sixth recommendation for the supplier of proprietary LCMS is to render it difficult for users to migrate content from proprietary to open source LCMS.

The seventh recommendation for the suppliers of proprietary to open source LCMS is to identify problems in open source LCMS. In comparison with large

numbers of educational organizations that have deployed proprietary systems, only small numbers of migration cases exist. The Table 5 shows the different obstacles encountered by educational organizations as they migrated to open source LCMS, and can be used by suppliers of proprietary LCMS to gain benefit.

### **7.3 Research limitations**

The first limitation of this study is the small size of the sample used to reach conclusions. It is always difficult to make strong statements based on a sample size that is small.

A database on migrations to open source LCMS does not exist. It is difficult to know the size of the population of open source migration projects. Thus, the second limitation of this study is that it is not known the extent to which the nine projects sample is representative of the LCMS project migration population.

The third limitation of this study is that the synthesis of the results was not validated with the 11 respondents.

#### **7.4 Suggestions for future research work**

The questionnaire developed in this research work and the method used for analyzing data can be used in a similar study of open source migrations.

The propositions developed in chapter 6 can be tested for LCMS and can be modified to examine the migration of other open source systems.

This research suggests the need to further examine content migration, the development of features in open source LCMS and the integration of LCMS with other organizational systems.

A guide can be developed for open source migration projects that can be used to reduce fear, uncertainty and doubt in educational institutions that are planning to migrate from proprietary to open source LCMS.

## 8 References

Blackboard. ([WWW.blackboard.com](http://WWW.blackboard.com), last visited September 25, 2005).

Brennan, M., Funke, S., & Anderson, C. 2001. The learning content management system: A new eLearning market segment emerges. IDC white paper.

(<http://www.internetttime.com/Learning/lcms/IDCLCMSWhitePaper.pdf>, last visited September 25, 2005).

Christensen, C. M., Anthony, S. D., & Roth, E. A. 2004. Seeing what's next: Using the theories of innovation to predict industry change. Boston: Harvard Business School Press.

Commonwealth of Learning. 2003. COL LMS open source.

(<http://www.col.org/Consultancies/03LMSOpenSource.pdf>, last visited September 25, 2005).

Creswell, J. W. 1998. Quality inquiry and research design choosing among five traditions. London: Sage Publications.

DePietro, R., Edith, W., & Mitchell, F. 1990. The context for change: Organization, technology and environment, in Tomatzky, L. G., & Mitchell, F., The processes of technological innovation. Lexington Mass: Lexington Books.

DotLRN. Case study: University of Heidelberg. (<http://dotlm.org/case-study/universitaet-heidelberg/>, last visited September, 2005).

Drozdik, S., Kovács, G. L., & Kochis, P. Z. 2005. Risk assessment of an open source migration project. Proceedings of First International Conference on Open Source Systems, Geneva, 246-249.

Fitzgerald, B., & Kenny, T. 2003. Open source software in the trenches: Lessons from a large-scale OSS implementation. Twenty-Fourth International Conference on Information Systems. Seattle, Washington, USA.

Iacovou, C. L., Benbasat, I., & Dexter, A. S. 1995. Electronic data interchange and small organizations: Adoption and impact of technology. MIS Quarterly, 19(4): 465-485.

- Internet Time Group. eGlossary. (<http://www.internetttime.com/Learning/Eglossary.htm>, last visited September 25, 2005).
- Jacobsen, P. 2002. LMS vs. LCMS. (<http://www.ltimagazine.com/ltimagazine/article/articleDetail.jsp?id=21264>, last visited September 25, 2005).
- KBSt. 2003. Migration guide—A guide to migrating the basic software components on servers and workstation computers, 57. ([http://www.kbst.bund.de/Anlage303777/pdf\\_datei.pdf](http://www.kbst.bund.de/Anlage303777/pdf_datei.pdf), last visited September 25, 2005).
- Kirby, D., & Turner, M. 1993. IT and the small retail business. *International Journal of Retail and Distribution Management*, 21(7): 20-27.
- Krishnan, V., & Ulrich, K. T. 2001. Product development decisions - A review of the literature. *Management Science*, 47(1): 1-21.
- Lineweaver, R. 2003. Cost savings of open source software in the server room. ([www.netproject.com/docs/migoss/v1.0/](http://www.netproject.com/docs/migoss/v1.0/) under case studies, and at <http://staff.harrisonburg.k12.va.us/~rlineweaver>, last visited September 25, 2005).
- McMullin, B., & Munro, M. 2004. Moodle at DCU. (<http://odtl.dcu.ie/wp/2004/odtl-2004-01.html>, last visited September 25, 2005).
- Ranganathan, C., Manheim, M. B. W., & Keeler, J. 2004. Bringing professionals on board: Lessons on executing IT-enabled organizational transformation. *MIS Quarterly Executive*, 3(3): 151-160.
- Robins, S. R. The evolution of learning content management system. (<http://www.learningcircuits.org/NR/exeres/483F426A-BEA4-4E32-8080-01FC7AA26DED.htm>, last visited September 25, 2005).
- Rogers, E. M. 1995. *Diffusion of innovations*. 4<sup>th</sup> Ed., New York: Free Press.
- Skidmore, D. 2005. The future of software as a business artifact. *Proceedings of First International Conference on Open Source Systems, Geneva*, 231-236.

- Tessmer, M. 1991. Back to the future: The environment analysis stage of the front end analysis. *Performance and Instruction*, 30(1): 9-12.
- Thong, J.Y.L., & Yap, C.S. 1995. CEO characteristics, organizational characteristics and information technology adoption in small business. *Omega International Journal of Management Science*, 23(4): 429-442.
- Van Heck, E., & Ribbers P. M. 1997. Value-creation by reshaping customer and supplier relationships with EDI. *Proceeding of the 5<sup>th</sup> European Conference of Information Systems*, Cork, Ireland, 3.
- WebCT ([www.webct.com](http://www.webct.com), last visited September 25, 2005).
- Weber, S. 2004. *The success of open source*. Cambridge, Mass: Harvard University Press.
- Weissman, G. 2003. Opportunities for open source software among non-profit organizations ([http://www.uwsepa.org/team4tech/files/osswp\\_t4t.pdf](http://www.uwsepa.org/team4tech/files/osswp_t4t.pdf), last visited September 25, 2005).
- Wheeler, D. A. 2003. How to evaluate open source software/free software (OSS/FS) programs. ([http://www.dwheeler.com/oss\\_fs\\_eval.html](http://www.dwheeler.com/oss_fs_eval.html), last visited September 25, 2005).
- Wheeler, D. 2005. Why open source software / free software (OSS/FS, FLOSS, or FOSS)? Look at the numbers! ([http://www.dwheeler.com/oss\\_fs\\_why.html](http://www.dwheeler.com/oss_fs_why.html), last visited September 25, 2005).

## Appendix A Lists of open source and proprietary LCMS

List of open source learning management systems with ratings	<a href="http://www.unesco.org/cgi-bin/webworld/portal_freesoftware/cgi/page.cgi?q=Software/Courseware_Tools/index.shtml&amp;d=1">http://www.unesco.org/cgi-bin/webworld/portal_freesoftware/cgi/page.cgi?q=Software/Courseware_Tools/index.shtml&amp;d=1</a>
List of course management systems	<a href="http://elc.unitar.edu.my/modules.php?name=Web_Links&amp;op=viewlink&amp;cid=16">http://elc.unitar.edu.my/modules.php?name=Web_Links&amp;op=viewlink&amp;cid=16</a>
List of open source LCMS	<a href="http://vcclearns.vcc.ca/html/body_os-lcms.html">http://vcclearns.vcc.ca/html/body_os-lcms.html</a>
List of learning software	<a href="http://www.campussource.de/org/">http://www.campussource.de/org/</a>
List of open source platforms	<a href="http://www.fn1.ch/LOBs/LOs_Public/OpenSourcePlatf.html">http://www.fn1.ch/LOBs/LOs_Public/OpenSourcePlatf.html</a>
Popular proprietary LCMS	WebCT <a href="http://www.webct.com/">http://www.webct.com/</a>  Blackboard <a href="http://www.blackboard.com/">http://www.blackboard.com/</a>

Note: links listed above were last visited on September 22, 2005.

## Appendix B Web resources on LCMS

Resources name	Links
e-Learning Centre	<a href="http://www.e-learningcentre.co.uk/eclipse/vendors/contentmgt.htm">http://www.e-learningcentre.co.uk/eclipse/vendors/contentmgt.htm</a>
EuroNuke	<a href="http://www.euronuke.com/poplinks-10-num.html">http://www.euronuke.com/poplinks-10-num.html</a>
Internet time	<a href="http://www.internettime.com/Learning/lcms/#news">http://www.internettime.com/Learning/lcms/#news</a>
E-Learning Platforms	<a href="http://www.shambles.net/pages/staff/OLLE/">http://www.shambles.net/pages/staff/OLLE/</a>
Knowledge Mechanics	<a href="http://www.traineeasy.com/products/lcms.htm">http://www.traineeasy.com/products/lcms.htm</a>
e-Learning Centre	<a href="http://www.e-learningcentre.co.uk/eclipse/Resources/choosing-lms.htm">http://www.e-learningcentre.co.uk/eclipse/Resources/choosing-lms.htm</a>  <a href="http://www.e-learningcentre.co.uk/eclipse/Resources/choosing-cms.htm">http://www.e-learningcentre.co.uk/eclipse/Resources/choosing-cms.htm</a>
e-Learningpost	<a href="http://www.elearningpost.com/features/archives/001022.asp">http://www.elearningpost.com/features/archives/001022.asp</a>
LMS and LCMS demystified	<a href="http://www.brandonhall.com/public/resources/lms_lcms/">http://www.brandonhall.com/public/resources/lms_lcms/</a>

Note: links listed above were last visited on September 22, 2005.

## Appendix C Open source LCMS

Open source LCMS	Links	Type of Learning Systems	Open source	Free Software	Migration from proprietary to open source LCMS?	Type of Organization
.LRN	<a href="http://dotlrn.org/">http://dotlrn.org/</a>	LCMS	Yes	Yes	Yes	Managed by Group of Universities. Originally developed at MIT's Sloan School of Management
ATutor	<a href="http://www.atutor.ca/index.php">http://www.atutor.ca/index.php</a>	LCMS	Yes	Yes	Yes	Company
Claroline	<a href="http://www.claroline.net/index.php">http://www.claroline.net/index.php</a>	LCMS	Yes	Yes	No	Managed by University of Louvain
Dokeos	<a href="http://www.dokeos.com/">http://www.dokeos.com/</a>	LCMS	Yes	Yes	Yes	Company
Fie3	<a href="http://fie3.uiah.fi/index.html">http://fie3.uiah.fi/index.html</a>	LCMS	Yes	Yes	No	Managed by University of Helsinki
Ilias	<a href="http://www.iliaskoeln.de/ios/index.html">http://www.iliaskoeln.de/ios/index.html</a>	LCMS	Yes	Yes	No	Managed by group of Universities and Organizations. Project coordination is done by University of Cologne.

LON-CAPA	<a href="http://www.lon-capa.org/">http://www.l on- capa.org/</a>	LCMS	Yes	Yes	No	Managed by Michigan University
Manhattan Virtual Class Room	<a href="http://manhattan.sourceforge.net/index.php?menu=1">http://manh attan.sourc eforge.net/i ndex.php? menu=1</a>	LCMS	Yes	Yes	No	Managed by Western New England College
Moodle	<a href="http://moodle.org/">http://moodl e.org/</a>	LCMS	Yes	Yes	Yes	Community based
OLAT	<a href="http://www.olat.org/index.php">http://www. olat.org/ind ex.php</a>	LCMS	Yes	Yes	Yes	Managed by University of Zuerich
Mambo	<a href="http://mambo.sourceforge.net/">http://mamb oserver.co m/</a>	LCMS	Yes	Yes	No	Community based

## **Appendix D Questionnaire**

**This questionnaire has three parts. Please answer all questions. Provide answer after each question.**

### **1. DECISIONS TO SET UP MIGRATION PROJECT**

**Question 1: What were the main reasons for your institution's migration to an open source learning content management system and what was their relative importance? Please describe each reason to migrate and identify its relative importance.**

**Question 2: Who championed the migration to an open source learning content management system? Please identify the individual(s) and group(s) who advocated, promoted and supported the migration to open source.**

**Question 3: Did the migration enable your institution to collaborate with other institutions that operate the same open source learning content management system?**

**Question 4: Who led the team responsible for the migration? Please identify the individual who was responsible for the day-to-day execution of the open source migration project.**

**Question 5: How many people were dedicated full-time to the migration project? How many were part-time? What was the composition of the team responsible for the migration project? How was the team staffed? What was the breakdown between internal staff and external consultants?**

**Question 6: What was your role in the migration project? How many years experience in learning content management system do you have?**

**Question 7: What were the planned outcomes of the migration project and their relative priorities? Please describe each project outcome and its priority.**

**Question 8: What were the actual outcomes of the migration project? How different were the actual outcomes from planned outcomes?**

**Question 9: What benefits did students, teachers, technical staff, institution and local community derive from the migration to an open source learning content management system? Please describe benefits for each group.**

**Question 10: What was the project duration (Month/ year of project start and project end)?**

**Question 11: What were the planned stages of the migration project? Please provide the scheduled duration for each stage (e.g., the planning stage was scheduled from start of Dec 2004 to mid March 2005, testing stage was scheduled from mid July to end of July 2005, and so on).**

**Question 12: What were the major milestones of the migration project?**

**Question 13: What were the main obstacles encountered during the open source migration and what initiatives were undertaken to overcome them? For each obstacle, please identify the initiative undertaken to overcome it.**

**Question 14: What means were used to control and monitor the migration project?**

**Question 15: What lessons have been learned from the migration to open source?**

## **2. DECISIONS WITHIN MIGRATION PROJECT**

**Question 16: What were the main reasons for selecting the open source learning content management system deployed over other open source systems?**

**Question 17: What makes the open source learning content management system better than the proprietary system it replaced?**

**Question 18: What makes the replaced proprietary system better than the open source system that has been deployed?**

**Question 19: What types of content outputs does the open source learning content management system support (e.g., Web output, XML output, CD-ROM, offline courses, print-based, formatted lesson plan, Word output, PowerPoint output, Pocket PC, formatted student guide, and PALM output)**

**Question 20: What external resources (e.g., individual consultants, companies) were used during the migration project? What did they do? How effective were they?**

**Question 21: What type of interactions did the team responsible for the migration project have with the core designers of the open source system (e-mails, phone calls, meetings, joint development, etc.)? What were the reasons for these interactions? What were the outcomes of these interactions? How effective were these interactions?**

**Question 22: How was the open source learning content management system tested?**

Question 23: How was the effectiveness of the open source system validated with students and faculty?

Question 24: What was the migration path followed (e.g., by academic programs, by location, by professor, etc.) What was the approach used to cut-off the old proprietary learning content management system (e.g., operated two systems concurrently, big-bang conversion from one system to another, etc.)?

Question 25: What problems were encountered when migrating the content available with the proprietary system into the open source system? For each problem encountered, please explain how it was solved.

Question 26: What type of support was made available to students and professors to facilitate the migration to the open source system?

Question 27: How did professors, students and staff learn about the progress and outcomes of the migration project?

Question 28: Was the project completed on time and within the budget?

Question 29: What were the three factors that most contributed to the success of the migration project?

### **3. CHANGES IN RESOURCES, PROCESSES AND VALUES**

Question 30: What were the main changes in resources that resulted from the migration to an open source learning content management system? By resources we mean the things and assets that your organization has such as students, teachers, technical staff, technology, products, equipment, information, cash, brand and distribution channels.

Question 31: What were the main changes in processes that resulted from the migration to an open source learning content management system? By processes we mean the ways your organization does its work such as resource allocation, planning, recruiting, teaching, and support.

Question 32: What were the main changes in values that resulted from the migration to an open source learning content management system? By values we mean the criteria used to set priorities such as cost, student demand, educational excellence, and ethics.

Please add any comments you believe will add value to this research.

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**Table 1 Codes used to organize responses to questionnaire**

<b>Element</b> DePietro, Wiarda and Fleischer (1990)	<b>Factor</b>	<b>Characteristics</b> Rogers (1995)	<b>Codes</b>
<b>1. Technology</b>	Security	Relative Advantage	1A
	Performance / Efficiency	Relative Advantage	1B
	Reliability	Relative Advantage	1C
	Scalability	Relative Advantage	1D
	Flexibility	Relative Advantage	1E
	Ease of Usability	Relative Advantage	1F
	Increase number of potential applications	Relative Advantage	1G
	Reduce hardware complexity / integration issues	Complexity	1H
	Attain conformity with industry standards	Compatibility	1I
	Better technical support / maintenance	Relative Advantage	1J
	Open and/or modifiable source code / Customizable	Relative Advantage	1K
	Unique features	Relative Advantage	1L

	Translations in different languages	Relative Advantage	1M
	Deficiencies in existing system	Relative Advantage	1N
	Software complexity	Complexity	1O
	Scope Management	Complexity	1P
	Relieve load on system	Complexity	1Q
<b>2. Organization</b>	Business growth	Values	2A
	Reducing expenses	Values	2B
	Organizational growth	Values	2C
	Reduce administrative difficulties	Processes	2D
	Pedagogical improvement	Resources	2E
	Convenience and time savings	Values	2F
	Avoid legal and license fees	Values	2G
	Engage resources	Resources	2H
<b>3. Environment</b>	Community support	Support environment	3A
	Vendor independence (avoid vendor lock in)	External environment	3B
	Provide better services to users	Instructional environment	3C

	Community access and recognition	External environment	3D
	Faster and better learning approach	Instructional environment	3E
	External pressure: Users' demand	External environment	3F
	External pressure: Partner's imposition	External environment	3G
	External pressure: Competition with other organizations	External environment	3H
	Organizational readiness	Support environment	3I
	Level of expertise	Support environment	3J
	Perceived benefits of new technology	Instructional environment	3K
	Provide research and development platform	Instructional environment	3L
	Financial stability of Vendor	External Environment	3M
	Vendor Performance	External Environment	3N

**Table 2 Colleges and universities that migrated from proprietary to open source LCMS**

College / University	From	To	First source of information on migration	Number of people approached	Number of completed questionnaires	Part of sample
Dublin City University (Ireland)	WebCT	Moodle	<a href="http://www.dcu.ie/index.shtml">http://www.dcu.ie/index.shtml</a>	1	1	Yes
University of Zuerich (Switzerland)	VAM	OLAT	<a href="http://www.unizh.ch/">http://www.unizh.ch/</a>	1	1	Yes
MIT Sloan School of Management (USA)	Proprietary System	.LRN	<a href="http://mitsloan.mit.edu/indexflash.php">http://mitsloan.mit.edu/indexflash.php</a>	2	1	Yes
Open Polytechnic (New Zealand)	Blackboard	Moodle	<a href="http://www.openpolytechnic.ac.nz/">http://www.openpolytechnic.ac.nz/</a>	2	1*	Yes
Tampere Polytechnic (Finland)	WebCT	Moodle	<a href="https://moodle.tpu.fi/">https://moodle.tpu.fi/</a>	1	1	Yes
Central Piedmont Community College (USA)	Blackboard	Moodle	<a href="http://www.cpcc.cc.nc.us/">http://www.cpcc.cc.nc.us/</a>	2	2	Yes
America's Sports University (USA)	e-College	Moodle	<a href="http://www.ussa.edu">www.ussa.edu</a>	1	1	Yes
San-Francisco State University (USA)	Blackboard	Moodle	<a href="http://www.sfsu.edu/">http://www.sfsu.edu/</a>	2	1	Yes
University of Heidelberg (Germany)	Proprietary System	.LRN	<a href="http://dotlrn.org/case-study/universitaet-heidelberg/">http://dotlrn.org/case-study/universitaet-heidelberg/</a>	1		No
Eastern Kentucky University (USA)	Blackboard	Moodle	<a href="http://www.kentuckyclassroom.com/teacher/">http://www.kentuckyclassroom.com/teacher/</a>	1	1	Yes
Harvard Medical School (USA)			<a href="http://hms.harvard.edu/hms/home.asp">http://hms.harvard.edu/hms/home.asp</a>	1		No
Aerolearn Inc. (USA)	Proprietary System	Dokeos	<a href="http://www.dokeos.com/migration.php">http://www.dokeos.com/migration.php</a>	1		No

Borwa Community Junior Secondary (Botswana)			<a href="mailto:borwaciss@BOTSNET.BW">borwaciss@BOTSNET.BW</a>	1		No
Heritage Education (USA)			<a href="http://www.heritage-educationonline.com/moodle/">http://www.heritage-educationonline.com/moodle/</a>	1		No
Humboldt State University (USA)	Blackboard	Moodle	<a href="http://www.humboldt.edu/">http://www.humboldt.edu/</a>	1		No
Heidelberg Medical School (Germany)	Proprietary System	.LRN	<a href="http://med.uni-hd.de/index_eng.html">http://med.uni-hd.de/index_eng.html</a>	1		No
Luther College (USA)			<a href="http://www.luther.edu/">http://www.luther.edu/</a>	1		No
Universiteit Brussel (Nederland)			<a href="http://www.vub.ac.be/OSC">http://www.vub.ac.be/OSC</a>	2		No
University of Memphis (USA)			<a href="http://itd.memphis.edu/webdev/news/newsitems/news6">http://itd.memphis.edu/webdev/news/newsitems/news6</a>	1		No
North Dakota University System (USA)			<a href="http://www.ndus.nodak.edu/uploads%5Cdocument-library%5C197%5C03-20&amp;21-03_board_minutes.pdf">www.ndus.nodak.edu/uploads%5Cdocument-library%5C197%5C03-20&amp;21-03_board_minutes.pdf</a> <a href="https://www.educationcause.edu/apps/eq/eqm05/eqm05210.asp">https://www.educationcause.edu/apps/eq/eqm05/eqm05210.asp</a>	1		No
<b>Total number of migrations identified = 20</b>				<b>Number of people approached = 25</b>	<b>Number of completed questionnaires = 10*</b>	<b>Number of projects in sample = 9</b>

\* 2 individuals completed one questionnaire. Thus, 11 respondents completed the 10 questionnaires used as data.

**Table 3 Reasons colleges and universities migrate from proprietary to open source LCMS**

<b>Reasons for migration:</b>	<b>Technology</b>									
<b>Cases</b>	Type of Organization :- U: University – S: School - P: Polytechnic – C: College – CL: Class									
<b>Case # 1</b>	U									
<b>Case # 2</b>	U			1E				1K	1N	
<b>Case # 3</b>	S	1A		1C				1K		
<b>Case # 4</b>	P					1G		1K		
<b>Case # 5</b>	P						1H		1N	
<b>Case # 6a</b>	C									1Q
<b>Case # 6b</b>	C		1B		1E			1K	1N	
<b>Case # 7</b>	U							1K	1N	
<b>Case # 8</b>	U				1F			1K	1N	
<b>Case # 9</b>	CL									



<b>Case # 2</b>	<b>U</b>	<b>2B</b>	<b>2C</b>	<b>2G</b>	<b>3A</b>					
<b>Case # 3</b>	<b>S</b>	<b>2B</b>								
<b>Case # 4</b>	<b>P</b>	<b>2B</b>			<b>3A</b>					
<b>Case # 5</b>	<b>P</b>	<b>2B</b>								
<b>Case # 6a</b>	<b>C</b>	<b>2B</b>								
<b>Case # 6b</b>	<b>C</b>	<b>2B</b>								
<b>Case # 7</b>	<b>U</b>	<b>2B</b>							<b>3M</b>	<b>3N</b>
<b>Case # 8</b>	<b>U</b>				<b>3A</b>					<b>3N</b>
<b>Case # 9</b>	<b>CL (NA)</b>	■								
<b>Total</b>		<b>8</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>
		<b>Values</b>	<b>Values</b>	<b>Values</b>	<b>Support Environment</b>	<b>Instructional Environment</b>	<b>Instructional Environment</b>	<b>Instructional Environment</b>	<b>External Environment</b>	<b>External Environment</b>

<b>Results</b>			
<p><b>Major Characteristics based on studies done by Rogers (1995), Tessmer (1991), and Iacovou et al. (1995).</b></p>	<p><b>Criteria: Variables above mean : 6.6</b></p> <p><b>Relative Advantage - 18</b>  <b>Values - 11</b>                      External Environment – 3                      Instructional Environment - 3                      Support Environment - 3                      Complexity - 2</p> <p><b>Relative Advantage and Values are the only variable factors above the mean value.</b></p>		
<p><b>Major Reasons – Variables above mean : 2.1</b></p>	<p>1K – Open / modifiable source code – 6 occurrences in total of 40 occurrences.                      1N – Deficiencies in existing system - 5 occurrences in total of 40 occurrences.</p>	<p>2B – Reducing expenses – 8 occurrences in a total of 40 occurrences.</p> <p>Note: Case 6a and 6b correspond to same project.</p>	<p>3A – Community support – 3 occurrences in a total of 40 occurrences.</p>
<p><b>Data broken up into elements identified by DePietro, Wiarda and Fleischer (1990)</b></p>	<p>In all 20 technology related reasons for migration out of 40 occurrences - 50%</p> <p>■ Case # 9 was not included in the overall calculations as it was a migration of class and not an educational institute.</p>	<p>In all 11 organizational related reasons for migration out of 40 occurrences – 27.5%</p>	<p>In all 9 environmental related reasons for migration out of 40 occurrences – 22.5%</p>

**Table 4 List of codes used to organize obstacles encountered during the migration from proprietary to open source LCMS**

<b>DePietro et al. (1990) - Elements</b>	<b>Obstacles</b>	<b>Codes</b>
Technology	Missing functionalities	1A
	Adapting to new functionalities	1B
	Poor documentation of original system	1C
	Transfer of contents	1D
	Integration with other system	1E
	Hardware requirements	1F
Organization	Hiring / engaging staff	2A
	Managing scope	2B
	Resistance to implementing change within organization	2C
Environment	Resistance from the owner of original system	3A

**Table 5 Obstacles encountered during the migration from proprietary to open source LCMS**

Migration Projects	Sources of Data	Project Status : IP: In progress - C: Complete - NA: Not Applicable	Type of Organization : U: University - S: School - P: Private - C: College - Cl: Class	Based on technology adoption elements identified by DePietro, Wiarda and Fleischer (1990)		
				Technology related	Organization related	Environment related
Case # 1	Interview			2A		
	Case Study					
	Questionnaire	C	U			
Case # 2	Interview			1A - 1B - 1B		
	Case Study					
	Questionnaire	C	U			
Case # 3	Interview			2B		
	Case Study					
	Questionnaire	C	S			
Case # 4	Interview			1C - 1D - 1D	2C - 2C	
	Case Study					
	Questionnaire	C	P			
Case # 5	Interview			1A - 1D		
	Case Study					
	Questionnaire	IP	P			
Case # 6a	Interview			1A - 1A - 1D	2C	
	Case Study					
	Questionnaire	IP	C			
Case # 6b	Interview			1D	2C	
	Case Study					
	Questionnaire	IP	C			

Case # 7	Interview			1D	2C	
	Case Study					
	Questionnaire	C	U			
Case # 8	Interview			1E – 1F		
	Case Study					
	Questionnaire	IP	U			
<b>Observations:</b> <b>1D - Transfer of contents</b> - 4 occurrences in a total of 17 occurrences <b>2C - Resistance to implementing change within organization</b> – 3 occurrences in a total of 17 occurrences <b>1A - Missing functionalities</b> – 3 occurrences in a total of 17 occurrences				Total number of obstacles falling under "Technology" - 11	Total number of obstacles falling under "Organization" - 5	Total number of obstacles falling under "Environment" - 1
<b>Major obstacles - Variables above mean: 1.7</b> <b>Result:</b> On the basis of data analyzed it is observed that 1D, 2C and 1A are the major obstacles in migration from proprietary to open source LCMS. From the data it is observed that most of the obstacles are technology related (64.7%).				11 out of total 17 obstacles – 64.7 % Note: Cases 6a and 6b correspond to same project	5 out of total 17 obstacles – 29.4% Note: Cases 6a and 6b correspond to same project	1 out of total 17 obstacles – 5.9 %

**Table 6 Factors that contribute to the success of migration projects involving LCMS**

Case #	Type of Organization :- U: University – S: School - P: Polytechnic – C: College – CL: Class	Contributors :- PO – Project Officer - TL: Team Leader - A- Advisor – D: Director – PM: Project Manager - TE : Technology Expert – ID: Instructional Developer/Designer – P: Professor – SA: System Administrator – PC: Program Chair – I: Instructor- NA: Not Applicable	Project Status :- IP: In progress - C: Complete – NA: Not Applicable	Years of experience	Support from Administration	Qualified and experienced team members	Buy in from Faculty	Performance of team	Educational/personal advice of content developers	Project Management	Development support from external team	Help of open source community	Ease of use of new system	Reliability of new system	Methodological Approach	Putting teaching and learning first
Case # 1	U	PO TL	C	7		x	x	x								
Case # 2	U	TL	C	3				x	x							
Case # 3	S	A	C	6		x										
Case # 4	P	D PM	C	6						x						
Case # 5	P	TE		.												
Case # 6a	C	ID		5												
Case # 6b	C	PC I		4.5												
Case # 7	U	TL ID	C	3			x					x	x			
Case # 8	U	SA		6												
Total						2	2	2	1	1	1	1	1	1	2	1
Result -	Qualified and experienced team members – 2 occurrences (above the mean value)															
Major success factors – Variables above mean: 1.375	Help of open source community – 2 occurrences (above the mean value)															
	Buy in from faculty – 2 occurrences (above the mean value)															
	Note: Only those cases were considered that were successfully completed. These are highlighted in yellow.															

**Table 7 Organizational changes that result from migrating to an open source learning content management system**

Migration Projects	Data Source	Project Status	Based on theory of resources, processes and values by Christensen et al. (2004)		
			Changes in Resources	Changes in Processes	Changes in Values
Case # 2	Questionnaire	Complete	<ul style="list-style-type: none"> <li>- Cost reduction (1A)</li> <li>- No license fees (1B)</li> </ul>		
Case # 3	Questionnaire	Complete	<ul style="list-style-type: none"> <li>- Cost savings two times in commercial tools (1A)</li> <li>- Cost savings four times in custom development (1A)</li> </ul>		
Case # 4	Questionnaire	Complete	<ul style="list-style-type: none"> <li>- Outsourcing has resulted in slack resources (1C)</li> <li>- Recruitment of additional development professionals (1F)</li> <li>- Support for e-learning infrastructure outsourced (1G)</li> </ul>	<ul style="list-style-type: none"> <li>- Implemented best practices for load balancing and disaster recovery (2A)</li> </ul>	<ul style="list-style-type: none"> <li>- Increased organizational capabilities in e-learning (3A)</li> <li>- Community playing vital role in the adoption/customization of applications (3B)</li> <li>- Increased use of online campus (3C)</li> </ul>
Case # 5	Questionnaire	In progress	<ul style="list-style-type: none"> <li>- Resources are spend better in more productive tasks (1D)</li> <li>- Integration of other systems with LCMS (1H)</li> </ul>		
Case #6a	Questionnaire	In progress	<ul style="list-style-type: none"> <li>- Redistribution of work load among existing IT personnel (1D)</li> <li>- Expansion of services include (1I):               <ul style="list-style-type: none"> <li>o Diversification of training</li> <li>o Online support documents</li> <li>o Call Center</li> </ul> </li> <li>- Changes to the website (1J)</li> </ul>		<ul style="list-style-type: none"> <li>- Open source brings more control and responsibility into IT department (3D)</li> </ul>

Case #6b	Questionnaire	In progress			- Enormous improvement in on-line teaching (3A)
Case # 7	Questionnaire	Complete	- Substantial savings each year (1A) - Providing help desk service (1I)	- Automating enrollment process (2B)	- More customized learning experience for students (3E) - Offering better support to faculty (3F)
Case # 8	Questionnaire	In progress	- Slight increase in budget offset by the fact that the product is free (1E) - Additional staff required to maintain servers and to offer help desk (1F) + (1I) -		- More emphasis on the importance of teaching and learning over technology (3G) - Faculty members being encouraged to enhance their teaching environment (3A) - Using Rubric for online instruction as teaching methodology (Refer to website: CSU Chico - <a href="http://www.csu.chico.edu/celt/roi/">http://www.csu.chico.edu/celt/roi/</a> ) - Changing from reactive (respond to help) to proactive (open labs) support system (3H)

LIST OF CODES								
Resources			Processes			Values		
Code	Description	Occurrences	Code	Description	Occurrences	Code	Description	Occurrences
1A	Cost Reduction	3	2A	Implemented best practices for load balancing / disaster recovery	1	3A	Improvement in on-line teaching	3
1B	No License fee	1	2B	Automating enrollment process	1	3B	Community involvement in customization / adoption of applications	1
1C	Slack resources	1				3C	Increased use of on-line campus	1
1D	Redistribution of resources	2				3D	More responsibility and control in IT department	1
1E	Increase in budget	1				3E	More customized learning experience for students	1
1F	Recruitment of staff	2				3F	Better support to Faculty	1
1G	Support outsourced	1				3G	More emphasis on learning over technology	1
1H	Integration with other systems	1				3H	Changing from reactive to proactive support system	1
1I	Expansion of services	3						
1J	Changes to website	1						
Changes in resources, processes and values as an outcome of migration.  Results based on measurement of mean: 1.4 Sample size 28			Following factors have number of occurrences above the mean value: 1A - Cost Reduction: 3 1D - Redistribution of resources: 2 1F - Recruitment of staff: 2 1I - Expansion of services: 3 3A - Improvement in on-line teaching: 3					

**Table 8 Comparison of proprietary and open source LCMS**

Comparison of proprietary and open source LCMS:	Type of Organization :- U: University – S: School - P: Polytechnic – C: College – CL: Class SD: School District	Why open source LCMS is better than proprietary system?	What can be done to improve open source LCMS (why proprietary system is better than open source LCMS)?		
Case # 1	U			x	More flexible / More Responsive to needs
Case # 2	U			x	Cheaper / Cost effective
Case # 3	S			x	Development and customization possible / Code transparency
Case # 4	P			x	Better Security
					Documentation
					More functions / More features
					Community Support
					Better usability
					More Stable
					Better interface
					Quizzes (Essay questions)
					Add Course Cartridges
			Grade Book		
			Reporting Features		
			More options within tools		
			More colorful buttons		
			Better discussion forums functionality		

Case # 5	P	x		x					x											
Case # 6a	C									x										
Case # 6b	C	x		x				x		x										
Case # 7	U	x	x																	
Case # 8	U	x						x	x			x								
Case # 9	CL		x																	
Total occurrences in 10 cases		7	5	5	1	2	3	2	2	1	1	2	1	2	1	1	1	1	1	1
Result	Mean: 2.9	Advantages of open source LCMS over proprietary LCMS										More Flexible – 7 occurrences (above the mean value) Cheaper - 5 occurrences (above the mean value) Customization possible – 5 occurrences (above the mean value) More functions – 3 occurrences (above the mean value)								
Result	Mean: 1.28	Advantages of proprietary LCMS over open source LCMS										Quizzes – 2 occurrences (above the mean value) Grade Book – 2 occurrences (above the mean value)								

**Table 9 Reasons for selecting the open source LCMS deployed over other open source LCMS**

Selecting open source LCMS	Type of Organization :- U: University - S: School - P: Polytechnic - C: College - CL: Class SD: School District	Reasons for selecting the open source LCMS in comparison with other open ones.										
		Number of tools/features	Community support	Fully Developed System / Maturity	Easy to setup	Easy to use	Past experience / Trained staff	Social constructive design	Flexibility	Large user base	Met technical requirements	Superior Architecture (Scalability/portability/maintainability)
Case # 3	S			x						x		
Case # 4	P											x
Case # 5	P	x	x							x	x	
Case # 7	U	x	x				x	x				
Case # 8	U	x	x	x	x	x		x				
Case # 9	U			x					x			
Total		3	3	3	1	1	1	2	1	2	1	1
Results	Mean: 1.7	Number of features - 3 occurrences out of a total of 19 occurrences Community Support - 3 occurrences out of a total of 19 occurrences System Maturity - 3 occurrences out of a total of 19 occurrences Social Constructive Design - 2 occurrences out of a total of 19 occurrences Large user base - 2 occurrences out of a total of 19 occurrences										

Table 10 Lessons learned during the course of migration projects

Cases	IP: Project in progress - C: Project completed - NA: Not Applicable - NR: No Response	Type of Organization :- U: University - S: School - P: Polytechnic - C: College - CL: Class	Lessons Learned: Extracts from responses received by research participants.
Case # 2	C	U	Planning is very important. There should be enough time to test new contents on the new LMS before they are published.
Case # 3	C	S	Content and user administration is 3x the challenge of technology
Case # 4	C	P	The open source paradigm of community development is not commonly understood. There is the need to proactively provide educational services, models, and communication about what is, and how the organisation can benefit from its use.
Case # 5	IP	P	One can not make accurate, detailed prediction on the development of open sources systems in a time-frame that would make sense to an educational institution. (This may well be true of all IT systems.) Using open source systems will pay of with a higher ability to adept to situations you can not predict.
Case # 6a	IP	C	Implementing an OS project requires significant commitment of institutional resources. Advisable to have programmers and developers knowledgeable of application environment/languages.
Case # 6b	IP	C	Users perceive additional flexibility with unease, suspecting it to be too complicated. Need lots and lots of quality training- lack of quality in training sessions hurt project. Need to really walk thru and map all processes - migration from semester to semester, hybrids and masters, section shells, what to do with logs, handling auditing, etc.
Case # 7	C	U	We learned that attempting to make significant upgrades to course content at the same time as migrating is difficult. Given our limited time and staff, we decided it was better to get the content up on the new system before making the upgrades.
Case # 8	IP	U	We have learned that large organizations do not change quickly. The impediments to academic technology changes are more political than technical. Since I am in the Faculty Development Center, it is important for me to emphasize that the teaching and learning needs drive the technology changes, not the other way around. Some people prefer to look only at the technological aspects of the project.