Chapter 5  Analysis

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5.1 Introduction

This chapter stands for the analysis part of the study. Here, the investigator measures the maturity of DSpace software. The Woods and Guliani’s OSMM-2005 model (hereafter WG-OSMM) is the instrument to measure the maturity of DSpace. The WG-OSMM involves fifteen major elements to determine the status of maturity of OSS. These elements form the research questions in this thesis. The elements of maturity are listed below:

- Leadership and culture
- Vitality of community
- Quality of end-user support
- Extent and scope of documentation
• Quality of packaging
• Momentum
• Quality of code and design
• Quality of architecture
• Testing practices
• Integration with other products
• Support for standards
• Quality of project site
• License type
• Potential for commercial conflicts
• Corporate commitment

These fifteen elements of maturity are the functional specifications of requirements of an OSS. They are a combination of technical features as well as software environment. The leadership and culture, vitality of community, quality of end-user support, momentum, quality of project site, potential for commercial conflicts and corporate commitment are related to the environment of a software. The extent and scope of documentation, quality of packaging, quality of code and design, quality of architecture, testing practices, integration with other products, support for standards and license type are the technical aspects of a software. These specifications are matched against DSpace. The WGOSMM offers detailed descriptions for each element in order to understand the meaning of the element. The investigator has recognized sub elements under each major element to aid collection and presentation of data. These sub elements are not subjective to the investigator, but derived from the descriptions given for each element by the WGOSMM model. Data for the study were collected from multiples sources with official
websites of DSpace being the major one. The following are the analysis of the study

5.2 Leadership and Culture

The first major element of maturity is OSS leadership and culture. WG-OSMM distinguishes the quality of leadership as one of the most important factors of OSS maturity. The WG-OSMM considers open source a living thing that needs on-going nourishment, encouragement, and care. And without leadership of some kind, an open source program will wither and eventually die. WG-OSMM also expects a strong, professional, respectful culture for a mature OSS. The WG-OSMM seeks to understand the following sub research questions on leadership and culture; Identification of Leadership, Quality of Leadership, Previous Experience, Participation in Forums and Conferences, Significant Contributions, Response to Questions or Suggestions and the Project Culture. The investigator examines each element in detail

5.2.1 Identification of Leadership

WG-OSMM confirms whether the leadership of an OSS project is identifiable. This question is relevant when many projects are started by individuals and left unfinished, unrefined and unusable for any purpose. The identification of leadership behind the DSpace project is not difficult as several documents, both online and print, are available for verification. This element is related to the historical milestones of a project. For reliable data, the investigator relied on the official website of DSpace hosted in 2001 and 2002. The leadership of DSpace can be divided into two categories; Institutional and Individual. Institutional leadership denotes the organizations behind DSpace software.
The individual leadership implies the diversity of individuals from different field of knowledge who joined DSpace project from time to time

5.2.1.1 DSpace: Institutional Leadership

DSpace is a joint project of Massachusetts Institute of Technology (MIT) Libraries and Hewlett Packard (HP) Lab begun in 2002. MIT is a well-known world-class educational institution established in 1861 in the United States. MIT is a top ranking institution in the QS World University Rankings as well as the Times Higher Education World University Rankings for several years. MIT has numerous academic departments, divisions, and degree-granting programs, as well as interdisciplinary centers, laboratories, and programs. MIT Libraries are the important part of MIT sharing the values and qualities of the parent institution. The MIT Libraries create and sustain an evolving information environment that advances learning, research, and innovation at MIT. They are committed to excellence in services, strategies, and systems that promote discovery, preserve knowledge, and improve worldwide scholarly communication (MIT Library website, 2014). The HP Lab is the leading multinational company headquartered in California, United States. The company is associated with hardware, software and services segment. It has 45 years of experience in the field.

The reputation of MIT and HP indicates that DSpace had the patronage of strong institutional leadership. The data available on the official website of DSpace as of 2014 shows that the DSpace leadership was shifted to DSpace Federation in 2004 and DSpace Foundation in 2007 and DuraSpace Organization in 2009. DSpace Federation was formed by a group of institutions and the DSpace Foundation was a non-profit organization and DuraSpace is an independent and non-profit organization providing leadership
to open source technologies. Currently, Debra Hanken KurtzMichele is the Chief Executive Officer of DuraSpace who was formerly Assistant Director of Information Technology Services and Head of Digital Experience Services at Duke University libraries and director of the Texas Digital Library (TDL).

### 5.2.1.2 DSpace: Individual Leadership

The identification and listing of individual leadership is limited to those who were part of DSpace software during the 2000-2002. The DSpace project was started from 2000 onwards. The earliest archived official website of DSpace was found to be on 2\textsuperscript{nd} May, 2001 which shows the names of individuals who were the project team leaders and steering committee members of the project. The website was updated in 12\textsuperscript{th} December 2011 showing the names of more team members. Table 5.1 shows the name, title and association of the project team members.
Table 5.1 Project Team Leaders of DSpace (2001)

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Name</th>
<th>Title</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Michael Bass</td>
<td>Project Leader</td>
<td>HP</td>
</tr>
<tr>
<td>2</td>
<td>Margret Branschofsky</td>
<td>Faculty Liaison</td>
<td>MIT</td>
</tr>
<tr>
<td>3</td>
<td>Peter Breton</td>
<td>Consultant</td>
<td>White Rabbit</td>
</tr>
<tr>
<td>4</td>
<td>William Cattey</td>
<td>Senior Developer</td>
<td>MIT</td>
</tr>
<tr>
<td>5</td>
<td>Joyce Ng</td>
<td>Research Assistant</td>
<td>MIT</td>
</tr>
<tr>
<td>6</td>
<td>David Stuve</td>
<td>Senior Developer</td>
<td>HP</td>
</tr>
<tr>
<td>7</td>
<td>Robert Tansley</td>
<td>Developer</td>
<td>HP</td>
</tr>
<tr>
<td>8</td>
<td>Mary Barton</td>
<td>Senior Marketing Development Manager</td>
<td>Analysis Group/Economics</td>
</tr>
<tr>
<td>9</td>
<td>Peter Carmichael</td>
<td>Consultant</td>
<td>PC-Consulting</td>
</tr>
<tr>
<td>10</td>
<td>Daniel Chudnov</td>
<td>Systems Curator</td>
<td>MIT</td>
</tr>
<tr>
<td>11</td>
<td>Julie Harford</td>
<td>Marketing Development Manager</td>
<td>Adero</td>
</tr>
</tbody>
</table>

Table 5.1 shows the eleven project team members of DSpace. The project team was a combination of HP and MIT professionals with the support of members from consultant companies of software and business. Out of eleven, seven team members were from computer science and two each from business and library science respectively. Margret Branschofsky and Daniel Chudnov belonged to the library profession.

The steering committee of DSpace provided oversight of the overall project. There were six members in the steering committee. The Table 5.2 shows the names of steering committee members.

Measuring the maturity of OSS for digital libraries: a case study of DSpace
Table 5.2 shows the names of six steering committee members. Steve Brown and William Wickes were from the computer science field and Eric Celeste and Ann Wolpert were having library science background. Wolpert, (who died on 2nd October 2013) was the director of MIT’s libraries for seventeen years. She conceived the idea of a common, permanent repository platform for digital materials as a solution for preserving the intellectual heritage.

The presentation of data on the leadership leads to the inference that that DSpace had a support of two prestigious institutions and the individual leadership comprised of professionals from computer science, library science and business disciplines.

### 5.2.2 Quality of Leadership

The aspect of quality of leadership behind OSS is examined to verify whether they are serious developers with a strong understanding of technology. Data displayed on the Table 5.1 and 5.2 showed the names and association of project team members and steering committee members. It is disclosed that the leadership of DSpace came mainly from MIT and HP lab and on the basis of the reputation of both entities, the quality of the leadership can be confirmed.
The quality of the leadership can be further verified by examining their previous experience.

### 5.2.3 Previous Experience

The previous experiences and accomplishments of team leaders play an important role in the design of a new project and these attributes score for the maturity of software. The data regarding the previous experience of the team leaders of DSpace shows that all were having previous background in diverse fields and projects. Table 5.3 and 5.4 show the names of team leaders and steering group members arranged alphabetically with their previous experience.

Table 5.3 Previous Experiences of DSpace Team Leaders

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Daniel Chudnov</td>
<td>Systems Architect, Cushing/Whitney Medical Library, Yale School of Medicine.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Haven, CT Programmer / Systems administrator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University of Michigan Medical Center</td>
</tr>
<tr>
<td>2</td>
<td>David Stuve</td>
<td>Software engineer for HP. Team leader for a HP's ink jet printer division.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ran a consulting company that specialized in graphics tools and firmware</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for networked devices.</td>
</tr>
<tr>
<td>3</td>
<td>Joyce Ng</td>
<td>Experience with HP (knowledge management, Architecture Technology Group,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mountain View), ArsDigita, and Lotus.</td>
</tr>
<tr>
<td>4</td>
<td>Julie Harford</td>
<td>Strong background in product management and business planning. Senior Product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manager at Adero, an Internet content distribution service.</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Background and Experience</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Margret Branschofsky</td>
<td>Professional librarian in academic science and engineering libraries at University of Cincinnati and MIT. Previous experience in library automation and computer programming.</td>
</tr>
<tr>
<td>6</td>
<td>Mary Barton</td>
<td>Senior Marketing Development Manager in the MIT Libraries Digital Library Research Group. Holds MBA from the MIT Sloan School of Management and has a background in finance and microeconomics.</td>
</tr>
<tr>
<td>7</td>
<td>Michael Bass</td>
<td>11 years of hardware and software design, and program management experience with Hewlett-Packard Company. Designed hardware and software contributing to HP's Precision Architecture microprocessors.</td>
</tr>
<tr>
<td>8</td>
<td>Peter Breton</td>
<td>A software developer since 1994 with White Rabbit Software company. Specialized in Web development in Java and XML. Worked with Swiss ISP, and with the Department of Education.</td>
</tr>
<tr>
<td>9</td>
<td>Peter Carmichael</td>
<td>A software developer since 1983. Specializing in Java, OOMD, Graphical User Interfaces, and Evolutionary Prototyping. Developed a Palm application for wireless order entry, and GUI and middleware design and development in Java &amp; C++ for commercial and government projects.</td>
</tr>
<tr>
<td>10</td>
<td>Robert Tansley</td>
<td>PhD in the application of semiotics to multimedia information at the University of Southampton in 2000. Designed and implemented the Eprints software. Involved in the specification and alpha-testing of the OAI-PMH</td>
</tr>
<tr>
<td>11</td>
<td>William Cattey</td>
<td>Senior Analyst Programmer for Information Systems at MIT. Part of Athena project at MIT</td>
</tr>
</tbody>
</table>
Table 5.4 Previous Experiences of DSpace Steering Group Members

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Previous Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ann Wolpert</td>
<td>Director of MIT Libraries since 1996 and a pioneer in digital libraries, open access, open courseware. Background in applied technology in libraries. Postgraduate in library science from University of Chicago.</td>
</tr>
<tr>
<td>2</td>
<td>Eric Celeste</td>
<td>Had combination of library and technology experience. Developed Uthink blog and Minnesota University Digital Conservancy. Technical leader of SHARE project.</td>
</tr>
<tr>
<td>3</td>
<td>Nick Wainwright</td>
<td>Research department manager at HP. Researcher in information infrastructure for future Internet services.</td>
</tr>
<tr>
<td>4</td>
<td>Robin Gallimore</td>
<td>Director of the Publishing Systems and Solutions Laboratory to create HP Labs’ digital media solutions research program.</td>
</tr>
<tr>
<td>5</td>
<td>Steve Brown</td>
<td>Marketing manager at HP Labs.</td>
</tr>
<tr>
<td>6</td>
<td>William Wickes</td>
<td>Asst. Professor of Physics at Princeton University and University of Maryland. Development of advanced scientific calculators, portable computers and operating systems.</td>
</tr>
</tbody>
</table>

Table 5.3 and 5.4 show that DSpace had an experienced leadership and majority of them were having strong background in computer technologies. The library and information professionals and business experts were also having several years of experience in their field. This data also satisfies the sub element of quality of leadership discussed in section 5.2.2
5.2.4 Participation in Forums and Conferences

WG-OSMM looks for the degree to which a project leader or other team members participate in the many forums and mailing lists and their presence at important conferences to make significant contribution to the public knowledge base for the product. Team leaders of a mature product work for the promotion of the software. To examine this sub- research element, it is necessary to find out the mailing list maintained by the DSpace project. Both the official website of DSpace and the sourceforge.net website give the details of DSpace mailing list which are given in Table 5.5

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Name</th>
<th>Purpose</th>
<th>Active Since</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DSpace-tech</td>
<td>Technology discussion list. Deals with technical support, installation, configuration, and customization</td>
<td>November 2002</td>
<td>Live</td>
</tr>
<tr>
<td>2</td>
<td>DSpace-general</td>
<td>General discussions, announcements about non-technical aspects like services, policies, legal issues, features and functions, etc.</td>
<td>August 2003</td>
<td>Live</td>
</tr>
<tr>
<td>3</td>
<td>DSpace-devel</td>
<td>For developers-discussions about the DSpace core code</td>
<td>April 2006</td>
<td>Live</td>
</tr>
<tr>
<td>4</td>
<td>DSpace-changelog</td>
<td>For developers-notifications of every commit to the codebase</td>
<td>August 2006</td>
<td>Live</td>
</tr>
<tr>
<td>5</td>
<td>DSpace-release</td>
<td>For developers/Others and discussion of the next release of the DSpace</td>
<td>May 2012</td>
<td>Live</td>
</tr>
<tr>
<td>6</td>
<td>DSpace-tickets</td>
<td>For Developers notification of any ticket activity from issue tracker</td>
<td>July 2014</td>
<td>Live</td>
</tr>
</tbody>
</table>

Table 5.5 Status of DSpace Mailing list
Table 5.5 shows that there are six mailing lists for DSpace. The archives of the list are available online with sourceforge.net website. DSpace-tech is the oldest mailing list started from November 2002 onwards followed by DSpace-general (2003), DSpace-devel and Dspace-changelog (2006), DSpace-release (2012) and DSpace-tickets (2014).

The examination of the participation of the team members in various mailing lists was achieved with the help of a simple computer programming to extract data from all mails archive. The presentation of data is limited to dspace-general and dspace-tech mailing lists since they exist for users and more mails are exchanged through these two forums. The Figure 5.1 and 5.2 show the names of team leaders and the number of mails posted by them in DSpace-tech and DSpace-general mailing list respectively.

Figure 5.1 Presence of Leaders in DSpace-tech Mailing List

Figure 5.1 shows the names of 15 team members of DSpace who handled more mails. The names of team members mentioned in Table 5.1 and 5.2 are those who were leaders at the initial stage of DSpace. The names shown in
Figure 5.1 include leaders in different capacities from 2002 to 2014. Ivan Masar is top with 2805 mails followed by Tim Donohue, Mark Diggory, Hilton Gibson, Mark H.Wood, u’Claudia and Tansley. Ivan Masar is a DSpace committer’s team member who joined the project in 2012. Tim Donohue is the technical lead for the DSpace project at DuraSpace from 2009 onwards. Mark Diggory was a member of development team since 2008. Tansley was a team member in the beginning of DSpace. All others mentioned in the figure 5.1 are associated with DSpace in various positions. There are a total of 35784 mails communicated through DSpace-tech mailing list during November 2002 to December 2014. Figure 5.2 shows the presence of ten DSpace leaders in the DSpace-general mailing list with the number of mails.

Figure 5.2 Presence of Leaders in DSpace-general Mailing List

There are 5862 mails communicated through DSpace-general mailing list during August 2003 to December 2014. Figure 5.2 displays the presence of ten DSpace team leaders in the mailing list. Leaders were very active in DSpace-general mailing list. Tim Donohue is top with 2614 mails followed by
Ivan Masar (1463), Mark Diggory (1370), Mark H. Wood (1284), Lewis (662), Taylor (654), Bollini (592), Tansley (517), Luyten (443) and Shepherd (342).

The examination of two DSpace mailing list showed that DSpace leaders belonging to different periods of the project were active in exchanging mails. Viewing from the maturity aspects of an OSS, it is very important that leaders of an OSS project are visible on its mailing list.

5.2.5 Significant Contributions of Team Leaders

The effort to make the project known to the public is important because lack of awareness inhibits the adoption and use of a product. There are several channels of communication to disseminate knowledge of an OSS. Conferences, workshops and publications are the three important ways of publicizing a project. DSpace leaders have extensively used these ways to popularize the software from 2002 onwards. The first paper on DSpace was presented in the 1st Joint Conference on Digital Libraries (JCDL) held at Roanoke, USA by Michael J. Bass and Margret Branschofsky. Daniel Chudnov published an article on DSpace in *serials* journal of November 2001 issue. These papers are still available online. Danile Chudnov along with Margret Branschofsky presented a paper on DSpace in the 2nd Joint Conference on Digital Libraries (JCDL) held at Portland, USA during July 14-18, 2002. MacKenzie Smith, Mary Barton, Mick Bass, Margret Branschofsky, Greg McClellan, Dave Stuve, Robert Tansley, and Julie Harford Walker presented a paper on DSpace at the 3rd ACM/IEEE-CS joint conference on Digital libraries held at Houston, Texas in 2003. A list of papers published by the leaders of DSpace has been given as Appendix A.
The approach of DSpace team leaders in attending conferences and presenting papers and the publishing of articles in journals is significant. Moreover, these resources are still available online on multiple locations.

5.2.6 Responses to Questions or Suggestions

The response of team leaders towards questions or suggestions from users for changes and new features is very important. Most open source developers communicate through mailing lists and they are a rich source of information which researchers can use to understand software processes and improve development practices (Shihab et al, 2010). The examination of the archive of six mailing list of DSpace shows that there are more than seventy five thousand mails that include questions, announcements, clarifications etc. The examination of a sample of answers provided by the DSpace leaders’ showed that they were positive to questions and suggestions from users. The positive attitude of DSpace leaders can also be verified by the inspection of added features to DSpace from time to time based on the suggestions from user community.

5.2.7 Project Culture

Another crucial measure of an OSS project is its culture. This sub research question demands to examine the attitude of the project, its response to questions or suggestions for changes or new features and the degree of defensiveness.

The verification of data from mailing lists, DSpace documentation and from historical documents shows that DSpace software maintained a professional culture throughout its various stages of development. The DSpace project was materialized out of a commitment and strategy maintained at MIT. The
commitment was to manage the exponential growth of digital materials as they posed access and archiving problems. DSpace was developed out of the obligation that institutions could and should accept stewardship responsibility for wide-spread and long-term access to their intellectual output. On the strategic part it was decided to build a simple digital archiving solution that any academic institution could use with minimal configuration and customization. The MIT’s commitment of openness of educational technology was extended to DSpace and it became an open source project.

When the DSpace 1.0 was released in November 2002, innovations in digital archiving were at the initial stage. Hodge (2000) observed that while there were traditions of stewardship and best practices that have become institutionalized in the print environment, many of these traditions were inadequate, inappropriate or not well known among the stakeholders in the digital environment. The project responded positively to suggestions for new features.

5.3 Vitality of Community

The vitality of community is the second major element of OSS maturity. Since OSS is a community driven project, it is essential to understand the vitality of community. Under this, WG-OSSM requires examining the following sub research questions; division of labour between developers and users, the size of the community, the liveliness of forums and the number and frequency of downloads. The investigator has attempted to examine each sub-element in detail.
5.3 Vitality of Community

5.3.1 Division of Labour

This element of maturity seeks to understand the relationship between project’s developers and users. A mature product, as per WG-OSMM, keeps separate mailing list for users and developers and the releases of easy to use installation packages/documentation for the users.

The Table 5.5 showed that DSpace maintains a total number of six mailing lists namely DSpace-tech, DSpace-general, DSpace-devel, DSpace-changelog, DSpace-release and DSpace-tickets. The Figure 5.3 displays the two types of DSpace mailing list.

Figure 5.3 DSpace Mailing List for Users and Developers

Figure 5.3 shows six mailing lists of DSpace. Out of six, the two- DSpace-general and DSpace-tech – are devoted to users of DSpace. The remaining four mailing lists exist for the developers. While the DSpace-general is intended for general discussions and announcements about non-technical aspects like services, policies, legal issues, features and functions DSpace-tech provides
technical support and it is a platform for question and answers regarding installation, configuration and customization.

The availability of easy to use installation packages/ documentation for the users of the software is an essential part of OSS. Lack of good documentation affects the success and sustainability of any OSS. The absence of proper documentation has been regarded as a risk of an OSS project (Bell, Ng & Lambros, 2003). The official website of DSpace keeps documentation for all versions of the software in online and downloadable format. The practice of creation of easy-to-use installation packages or user documentation is very active in DSpace. Table 5.6 shows the availability of documentation associated with all stable versions of DSpace from 2002 onwards.

Table 5.6 DSpace Documentation Status

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSpace 1.0.x</td>
<td>04-11-2002</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.1.x</td>
<td>08-05-2003</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.2.x</td>
<td>05-05-2005</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.3.x</td>
<td>09-10-2005</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.4.x</td>
<td>10-05-2007</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.5.x</td>
<td>14-04-2009</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.6.x</td>
<td>15-06-2010</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.7.x</td>
<td>25-07-2013</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.8.x</td>
<td>25-07-2013</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 3.x</td>
<td>24-07-2013</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 4.x</td>
<td>03-03-2014</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 5.x</td>
<td>16-01-2015</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.6 shows that releasing easy-to-use installation packages is core to DSpace project. It keeps documentation for all versions. The length of
documentation varies. The documentation for the first version of DSpace was around 10 pages whereas the latest versions contain user manuals having around 700-800 pages.

The two aspects examined under division of labour satisfy the requirement of a mature project. DSpace maintains separate list for users and developers and it has easy-to-use installation packages for all stable versions.

5.3.2 The Size of the Community

The size of the OSS community is an important factor for its success and sustainability. The examination of official data revealed that the DSpace community is a large entity comprising of several components. The Figure 5.4 shows the different group that form the size of DSpace community.

Figure 5.4 Size of DSpace Community

The Figure 5.4 shows that DSpace has a strong base of community structure with Steering Group at the apex. There are DSpace Steering Group,
Leadership Group, and Project Members at the core of the community. The other components include Committers, Emeritus Committers, Contributors, Community Advisory Team, Ambassador Programme Members, Sponsors and Users. The following part attempts to understand each component of DSpace community.

5.3.2.1 **DSpace Steering Group**

The DSpace Steering Group provides support for leadership and sets strategic direction for DSpace software. They oversee project operations and recommend annual budget allocations. Steering Group is nominated and elected by the DSpace Leadership Group. Currently there are 8 members in the group.

5.3.2.2 **DSpace Leadership Group**

The DSpace Leadership Group approves the overall priorities and strategic direction of the project presented by the Steering Group. It is a subset of the overall DSpace Members, selected based on their level of contribution to DSpace.

5.3.2.3 **DSpace Project Members**

DSpace Project Members are not directly involved with decisions regarding the DSpace platform. However, they may provide their feedback via member-directed surveys or similar.
5.3.2.4   Committers

The DSpace Committers are members authorized to commit change to the code repository. They are having the final responsibility for the form, architecture and design of DSpace going forward. They are applying code changes contributed by the larger DSpace development community. As of 31st December 2014 there are 23 members in the DSpace Committer Group who belong to diverse institutions. Eight members belong to different universities in the world and the five out of them are from library field. Twelve members belong to different firms that support DSpace.

5.3.2.5   Emeritus Committers

Emeritus Committers are those who, for one reason or another, are no longer able to contribute code to DSpace on a regular basis. As of 31st December 2014 there are 12 emeritus committers in DSpace who are providing advice and guidance for the software development.

5.3.2.6   Contributors

Contributors are the largest component of DSpace Community who report and fix a bug, provide a new feature, help with documentation, or otherwise contribute to the software product. As of 31st December 2014 there are 162 contributors to DSpace software who are comprised of individuals as well as institutions and have contributed to at least one version of DSpace.

5.3.2.7   Community Advisory Team (DCAT)

The DCAT stands for the service of repository managers and administrators at the global level. They are also representing the interest of DSpace end users.
indirectly. It is a permanent Working Group that advises other DSpace project governance and leadership groups. DCAT solicits feedback through community-wide discussions, surveys, etc. to help ensure future software releases.

5.3.2.8 DSpace Product Planning Group

The Product Planning Group develops and maintains the DSpace Product Plan in conjunction with the DCAT and the Technology Advisory Group.

5.3.2.9 DSpace Technology Advisory Group

The DSpace Technology Advisory Group advises all groups on DSpace technology and architectural decisions. They help to research and/or prototype various implementation options, and recommend the "best of class" for implementation.

5.3.2.10 DSpace Ambassadors

The DSpace Ambassador is a volunteer in every country or region to be a point of contact for organizations just getting started with DSpace. They help new or potential users interested in adopting DSpace. Ambassadors are also encouraged to help build the DSpace user network within their country. Individuals with DSpace knowledge and experience may become an Ambassador. There are 48 Ambassadors for DSpace across the world.

5.3.2.11 DSpace Sponsors/Members

DSpace Members are leaders from university, research, library organizations, and others, who have made a financial commitment to DSpace project. There
are Platinum, Gold, Silver and Bronze members who contribute $20,000, $10000 and $5000 and $2500 respectively. There are currently three Platinum members, five gold members, six silver members and nine bronze members for DSpace.

5.3.2.12 DSpace Software Users

Data from the official website of DSpace shows that DSpace has a large community of users. As of October 2014, the official website lists a total number of 1781 DSpace installations spread across 117 countries in the world. Figure 5.5 shows the top nine countries having more than 50 DSpace installations in the world.

![Bar chart showing the top nine countries with more than 50 DSpace installations](chart.png)

Figure 5.5 Countries Having More DSpace Installations

Figure 5.5 shows the ten countries that have more DSpace installations. United States is the major country having more DSpace installations followed by India, Japan, Brazil, Spain, United Kingdom, Taiwan, Turkey and Norway.
5.3.3 The Liveliness of Forums

The examination of mailing lists shown in Table 5.5 revealed that there are total six mailing lists for DSpace and the Figure 5.3 showed the existence of separate mailing list for users and developers. The number of emails exchanged through these mailing lists indicates the liveliness of forums. The Figure 5.6 shows the number of mails communicated through the six mailing lists from the beginning to December 2014.

![Figure 5.6 Liveliness of Forums](image)

The Figure 5.6 shows that DSpace mailing list was very active in exchanging communication among leaders and users. The DSpace-tech mailing list contains more number of mails (35784), followed by DSpace-devel (23841), DSpace-changelog (6870), DSpace-general (5862), DSpace-tickets (2445) and DSpace-release (626). From the data obtained, it can be concluded that the DSpace mailing lists were very active. The involvement of DSpace team leaders in the two forums shown in Figure 5.1 and 5.2 adds more value to the liveliness of mailing lists.
5.3.4 The Frequency of Downloads

The number and frequency of downloads provide information on the status and popularity of a software product. The information on the download status of open source projects is available in the sourceforge.net website. The data for DSpace downloads were collected for the period of 2002 to 2014. Figure 5.7 shows the number of downloads of DSpace from November 2002 to December 2014.

Figure 5.7 Download Statistics of DSpace

Figure 5.7 shows that DSpace received more than 3.5 lakhs downloads during 2002-2014. The statistics indicate a balanced growth of downloads for the project except in 2009. These download statistics correspond to various versions of DSpace. More downloads were registered in 2014 the years in which DSpace 4.x was released. Many factors influence the process of OSS
downloads. While every download would not result in an adoption of the software, the download statistics provide inference on the interest of users towards the software.

From the data obtained, it is possible to generate the frequency of downloads. The Figure 5.8 shows the frequency of DSpace downloads.

![Figure 5.8 Frequency of Downloads](image)

The Figure 5.8 show that DSpace is receiving an average 75 downloads per day, 2253 downloads per month and 27046 download per year. The download statistics of DSpace was compared with other OSS in the same category for the years 2014. The Figure 5.9 shows the download statistics of three OSS for DLs; DSpace, Greenstone and Fedora Commons.
5.4 Quality of End-User Support

Figure 5.9 shows that Greenstone and DSpace received more downloads during 2014 compared to Fedora Commons software.

5.4 Quality of End-User Support

The third major element of maturity, as per WG-OSMM, is the quality of end-user support. It is a key element for the understanding and installation of any OSS. The quality of end user support can be verified by examining the existence of active forums, well-maintained FAQs (Frequently Asked Questions), and online documentation that are available through a search engine. The investigator attempts to examine the extent of end user support applicable to DSpace.

5.4.1 Active Forums

WG-OSMM envisages the very public and free-ranging discussions among the lead developers, far-flung contributors and end users as one of the most compelling aspects of open source projects. The data on the availability of six
mailing list of DSpace was shown in Table 5.5. The Figures 5.1 and 5.2 provided data on the presence of DSpace leaders in DSpace-tech and DSpace-general mailing list. The Figure 5.6 displayed the liveliness of DSpace forums with a description of the total number of mails exchanged through these forums from the beginning to December 2014. A further exploration of the mailing forums is attempted here.

Figure 5.10 shows the six mailing lists and the number of mails exchanged from their beginning to December 2014.

![Figure 5.10 DSpace-Mailing List and Number of Mails](image)

Figure 5.10 displays that among the six mailing list maintained by DSpace, DSpace-tech is the most active forum that deals with technical questions answered by the DSpace community. DSpace-devel stands for developers writing code for the DSpace. It also contains release information for DSpace committers. The DSpace-changelog is also for developers that handles notifications of every commit to the codebase of DSpace. DSpace-general deals with questions, announcements, and discussions about non-technical
5.4 Quality of End-User Support

aspects of DSpace including services, policies, legal issues, features and functions, etc. DSpace-tickets is a notification-only mailing list. Members of this mailing list receive an email notification whenever any ticket in the DSpace Issue Tracker (JIRA) is created/updated/closed. This was started in 2014 only and these issues were accomplished through DSpace-devel mailing list before. DSpace- release is meant for developers for planning and discussing issues on the future release of DSpace. Figure 5.11 shows the number of mails exchanged through DSpace-tech mailing list from 2002 to 2014.

![Figure 5.11 DSpace-tech Mailing List](image)

Figure 5.11 shows that DSpace-tech mailing list contained less number of mails during 2002-2014. The number of mails increased to 1187 in 2003 to 1715 in 2004.

The movement of mails depends on many factors including the release of a new version, integration of a new service or applications to the new version etc. There were a total number of 35784 mails during 2002-2014 with a yearly average of 2752. mails. The examination of sample of mails revealed that the
discussions were more intensive on technical aspects of DSpace. There were around 2000 members who participated in the discussion at the level of lead developers, far-flung contributors and end users. The investigator could identify many users from India who participated in the discussions.

5.4.2 Archives of Questions and Answers

The examination of the details of DSpace mailing list on sourceforge.net website revealed the following facts regarding the availability of archives of questions and answers on DSpace. The Table 5.7 shows the names of the mailing list and the total number of mails being archived on the website as of December 2014 with the status of availability of online archive.

Table 5.7 Archives of Questions and Answers

<table>
<thead>
<tr>
<th>DSpace Mailing List</th>
<th>No. of Questions and Answers</th>
<th>Online Archive</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSpace-tech</td>
<td>35784</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace-devel</td>
<td>23841</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace-changelog</td>
<td>6870</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace-general</td>
<td>5862</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace-tickets.</td>
<td>2445</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace-release</td>
<td>626</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.7 shows that there are a total number of 74678 mails being archived from six mailing forums of DSpace from 2002 to 2014. The data collected from the sourceforge.net website reveals that all mails exchanged through the six mailing lists from the beginning to December 2014 are archived.
5.4.3 Availability of FAQs

Frequently Asked Questions (FAQs) is a common feature of websites of products and services. They are enquiries and answers supposed to be performed regularly in some context on a particular topic. FAQs help to save the time of readers as well as providers. The examination of the official website of DSpace revealed that FAQ is an essential component of the website. DSpace maintains two FAQs; EndUser FAQ and Technical FAQ. End User FAQ deals with questions on the working of DSpace, OSS development model and the ways to contribute to DSpace. Technical FAQ deals with technical questions on customization and code contribution.

5.4.4 Online Documentation

The availability of online documentation is an essential component of any OSS package since the development and growth of OSS are depending on the Internet. DSpace website provides links to various online documentations for the end users. The resources include online user manuals for various versions of DSpace, training materials, publications, results of community surveys, brochures and blogs. All the online documentations are available through search engines. The search for “documentation for DSpace software” was performed on Google, Bing, Yahoo, Ask.com, Aol.com, Wow.com, and it was found that all the six search engines bring the official webpage of DSpace on the first page displaying links to DSpace online manual. Hence it can be concluded that DSpace maintains online documentation and it is easily retrievable through search engines.
5.5 Extent and Scope of Documentation

The fourth major element of WG-OSMM requires examining the quality of a project’s documentation. As per WG-OSMM the quality of documentation gives ideas about a project's work process and code quality. The extent and scope of documentation is determined by examining the following sub elements; Clarity in language, Historical milestones of code’s development, Organization of documentation, Documentation archives, Contents of documentation and User manual.

5.5.1 Clarity in Language

A mature software’s documentation contains instructions for installing, running, and fine-tuning the software written in reasonably clear English. The wiki.duraspace.org website provides documentation for installing DSpace on various platforms. The investigator examined the user manual for five versions of DSpace and found that they contain instructions for installing, running, and fine-tuning the software. It is written in simple and clear English language. The language used for DSpace documentation satisfies the qualities of simplicity and clarity.

5.5.2 Historical Milestones of Code’s Development

WG-OSMM wants to check whether the historical milestones in the code’s development are available for verification. All original code of DSpace is in the Java programming language. The examination of GitHub web site, the world’s largest code repository, revealed that source codes of DSpace are available for downloading. Table 5.8 shows the DSpace version and availability of code in the GitHub.
5.5 Extent and Scope of Documentation

Table 5.8 Availability of DSpace Code in GitHub

<table>
<thead>
<tr>
<th>Version</th>
<th>Code in GitHub</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSpace 1.0.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.1.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.2.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.3.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 1.4.x</td>
<td>Yes</td>
</tr>
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<td>DSpace 1.7.x</td>
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</tr>
<tr>
<td>DSpace 1.8.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 3.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 4.x</td>
<td>Yes</td>
</tr>
<tr>
<td>DSpace 5.x</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.8 displays the DSpace versions 1.0.x to 5.x and the availability of source code for all versions. The codes can be viewed and downloaded by anyone. The codes are available in zip and tar.gz format to be used on Windows as well as on Linux based systems. The source codes are also available with the wiki.duraspace.org website where it is kept as binary form as well as full source release. These facts reveal the transparency of DSpace project which is a quality of a mature software.

5.5.3 Organization of Documentation

The WG-OSMM requires checking the way OSS project documentation is being organized. The recommended approach is organization of documentation by major version release, the latest being first and so forth. Moreover, the project needs to keep documentation for each release available because many users may still use older releases of the program. The
examination of the official website of DSpace revealed that all DSpace documentation is arranged in descending order. The documentation is available in online format as well in PDF format. The organization of documentation for DSpace satisfies the requirement for a mature OSS.

5.5.4 Documentation Archives

DSpace documentation is available with wiki.duraspace.org webpage which provides facility to browse online as well as to download the full document in PDF format. The sourceforge.net website is working as the archive for DSpace documentation. For DSpace codes, GitHub is the archive. Information about documentations can easily be located through various search engines.

5.5.5 User Manual

The WG-OSMM seeks to examine the presence of comprehensive user manual or reference guide as part of documentation which shall provide complete instructions for installing and configuring software. The official DSpace documentation published along with every stable version of the software is a comprehensive user manual. The investigator examined the contents of DSpace documentation for the last five versions. All are comprehensive and lengthy. Table 5.9 provides details about DSpace user manual.
Table 5.9 shows the five user manuals of DSpace belonging to different versions. All manuals were authored by DSpace Developer Team. All manuals are lengthy documents with an average page length of 674. The second and fourth modules of user manual for DSpace 5.x and DSpace 4.x deal with complete instructions for installation and configuration of the software. The manuals for DSpace 1.7 to 3.x (3 versions) include instruction for installation in the 4th module and that for configuration in the 6th to 8th modules. The presence of comprehensive user manual is an essential part of DSpace documentation.

### 5.6 Quality of Installation Packaging

The fifth major element of maturity is the quality of installation packaging. WG-OSMM inquires the way an open source program is packaged. Some software are available only as source code. Users need to undertake the task of compiling source code into binary, executable form, which is a difficult task. Some projects provide both source and binaries, ready to be used for specific operating systems. A mature OSS is one that is having an installation package and that can be installed easily on many different platforms and
configurations. These elements are examined under the following sub elements; form of packaging and multiplatform compatibility.

5.6.1 Form of Packaging

The examination of the official website of DSpace revealed that DSpace is available both in binary and source code. It can be downloaded as binary release (no Java source code included) or as full source release from the file area in sourceforge.net website. The binary release of DSpace 5.x is having a file size of 580 MB and full source release is 8MB. DSpace source code is also available from GitHub repository.

5.6.2 Multiplatform compatibility

As per WG-OSMM, mature OSS products conform compatibility to multiple operating systems. DSpace is a multiplatform compatible software. It can be installed both on UNIX-like operating systems (Linux, HP-UX, Mac OSX, etc.) and on Windows platform. For this, installation files are kept in zip format for Windows, tar.gz format for UNIX-like systems. The user manuals for different versions of DSpace provide instructions for installation and customization of the software on Windows as well as UNIX-like operating systems. Data available on the official website of DSpace (DSpace user’s registry) shows that there are DSpace installations in multiple platforms. Figure 5.12 shows the distribution of DSpace installations among various operating systems.
5.7 Momentum (Frequency of Releases)

Figure 5.12 shows that DSpace is installed on Linux, Windows, Unix, Solaris and HP-UX platforms by institutions across the globe. As of December 2014, out of 792 live DSpace installations across the globe (who provided information on the use of operating system), majority (489) are installed on Linux (62%) followed 227 Windows (29%), 50 Unix (6%), 22 Solaris (3%) and 4 HP-UX.

5.7 Momentum (Frequency of Releases)

The sixth major element of maturity is the frequency of software release. According to WG-OSMM the right release schedule depends largely on how stable and mature a project is. Lack of updates can be an indication of abandonment project. A well-managed release cycle indicates the presence of experienced technologists at work. The information on the frequency of release of DSpace software is available on the official website of DSpace, sourceforge.net, and GitHub. As of January 2015, 12 stable versions were released for DSpace. Figure 5.13 displays the stable DSpace versions and time of release.
5.7.1 Changes in new Release

WG-OSMM seeks to check out the release history of an OSS and examine if the new releases are mainly significant or more trivial. Ideally, new releases should be put forth only when substantial additions and changes have been made to a program, and not simply with every sprinkling of not-so-important changes.
To study the important changes made in each new release of DSpace, the investigator examined the user manual for the last four versions of DSpace. All documents contain a list of new features, bug fixes and improvements in the release note section. The following are the ten major new features added to the DSpace 5.x version released in January 2015.

1. Option to upgrade to 5.x from any previous version
2. Perform Batch Imports from user interfaces
3. Linked (Open) Data support via a new RDF interface
4. OAI-PMH improvements, including OpenAIRE v3 compliance
5. Enhanced Image and PDF Thumbnails using ImageMagick / Ghostscript
6. File downloads tracking using Google Analytics
7. All DSpace Objects having underlying metadata support
8. ORCID integration
9. Enhanced thumbnail quality
10. Batch import from various bibliographic formats

From the examination of additions to DSpace 5.x, it can be concluded that a DSpace version is updated incorporating several additional features.

5.8 Quality of Code and Design

The seventh major element of maturity is the quality of code and design. WG-OSMM asks to examine the organization of the code, the aspects of modularization, the grouping of modules, the naming convention and the facility to examine the high level structure and the labels being used. These aspects are separately examined under the following sub element;
5.8.1 Organization of DSpace code

Modularity in programming is a software design approach that subdivides a system into independent, interchangeable modules or skids. It is opposed to monolithic approach where the smallest component is the whole. In modular design, numerous small modules are written separately and these become an executable application programme when compiled together. Modularity is advocated for the sake of changeability, independent development, and comprehensibility. Source code repositories are useful to developers as they help to consolidate systems’ source code into a common place. This facilitates them to investigate the program structure and high level relationships exist between the source code components. Since its inception, DSpace software is consolidated in well-known open source repositories like GitHub and sourceforge.net.

The structural view of DSpace code is split mainly into three directory trees viz. DSpace source directory ([dspace-src]), install directory ([dspace]) and web deployment directory ([tomcat/webapps/dspace]). [dspace-src] contain all the source code to build various modules, license files and build property files. Upon installation, [dspace] directory is populated with configuration files, command line tools, libraries, and archive information. The web deployment directory [tomcat/webapps/dspace] contains the XML, JSP, Java classes and libraries necessary to run DSpace application. The aspect of modularity was examined by verifying data from the sourceforge.net and GitHub repository. The following are the conclusions drawn.

The DSpace source code is organized to cohere very strictly to the three-layer architecture. It consists of Application layer, Business logic, and Storage layer. DSpace follows a modular approach for code design. The codes are
independently designed and contributed by several contributors across the
globe as branches. These are accepted according to a quality checklist and the
DSpace Committers review the branches. Both GitHub and sourceforge.net
keeps the codes of all versions of DSpace for examination and verification.
The DuraSpace organization follows several checklists to ensure the DSpace
code high manageable. The following are the checklist for code contribution;

1. Any changes must be Java 1.6 compliant
2. Contribution should be a "Pull Request" sent to GitHub repository
3. Ensure the code is commented and correctly formatted by IDE’s format
   functions or using tools like Jacobe.
4. Code contribution must adhere to licensing requirements to be included.
5. User interface patches must be internationalized.
6. User interface patches must be XHTML-compliant and have a W3C
   WAI Conformance Level of "Double-A"
7. User Interface features are encouraged, not necessary, to support both
   XMLUI and JSPUI interfaces.
8. The patch must come with Documentation.
9. Examples or Use Cases should be submitted to help Committers
   understand and adequately test the patch prior to applying it to the core
   code
10. Any new features should be configurable
11. When adding new configuration parameters, name them appropriately.
12. Add appropriate WARN, INFO and DEBUG-level logging.
13. Retain backwards compatibility where possible.
14. No Database schema changes unless absolutely necessary
5.9 Quality of Architecture

The eighth major element of maturity is quality of architecture. WG-OSMM considers the quality of an open source program’s architecture as an important measure of the code’s maturity. By architecture, WG-OSMM means system components (such as classes in J2EE, PHP systems, modules in Perl), use of design patterns, and naming conventions.

The examination of the user manual for all versions provides data for understanding the architecture of DSpace. J2EE (Java 2 Platform Enterprise Edition) is not required for DSpace. Instead, DSpace uses the Java SE JDK (Standard Edition Java Development Kit) which is a platform to perform Java applications on desktops and servers and embedded environments. Java offers a rich user interface, performance, versatility, portability, and security that a digital library requires. Further, DSpace uses many Java classes and software libraries. The DSpace Web User Interface is the largest and most-used component in the application layer. It is built on Java Servlet and JavaServer Page technology which allow end-users to access DSpace systems over the web via web browsers. The other system components include Apache Maven, Apache Ant, PostgreSQL, Apache Tomcat and Perl. Apache Maven is used to manage a project's build, reporting and documentation from a central piece of information. Apache Ant is a Java build tool. PostgreSQL is the relational database (can be substituted by Oracle), Apache Tomcat is the servlet engine (can be substituted by Jetty, Caucho Resin or equivalent) and Perl, the web programming language.
5.9 Quality of Architecture

5.9.1 DSpace Architecture

The DSpace system is organized into three layers, each of which consists of a number of components. The Figure 5.14 shows the system architecture of DSpace.

![Figure 5.14 System Architecture of DSpace (Courtesy DSpace.org)](image)

The Figure 5.14 shows the basic architecture of DSpace. It consists of application layer, logic layer and storage layer. Each layer performs fundamental functions. The application layer has components that communicate with the world outside of the individual DSpace installation, like the web user interface, Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) service and Google analytics. The components of business logic layer deals with managing the content of the system, users of the archive (e-people), authorization, and workflow. The storage layer is responsible for physical storage of metadata and content.
5.9.2 Naming Convention in DSpace

In computer programming, naming convention denotes a set of rules to make programs more understandable and easier to read. Naming convention provides information about function of an identifier used in the program which helps better understanding of the code. Moreover, it reduces the effort required to read and understand the source code of software. DSpace follows the Java programming naming convention. The main identifiers used in Java are Packages, Classes, Interfaces, Methods and Variables. All these identifiers have predefined rules for naming and are strictly followed by DSpace committers. The checklist provided by DuraSpace (as detailed in section 5.8.1) ensures this point.

5.10 Testing Practices

The ninth major element of maturity is the testing practice of OSS. WG-OSMM observes that some open source code comes with automated, built-in testing facilities as standard features. The presence of unit tests is a key indicator of good design. The purpose of testing is to detect software failures and fix them possibly during early stages of development. Many OSS follow a test driven development framework in which tests are developed along with the code. Testing approaches are classified as follows:

- Unit tests: To test each method of an object for expected output in various situations.
- Functional tests: To test use-cases originated from the end user
- Integration tests: To test the interaction among the components within the system

Measuring the maturity of OSS for digital libraries: a case study of DSpace
Regression tests: To test the software after a major code change
Performance tests: To test the software behaviour under heavy load

To address this research element, the investigator depends the various test performed on DSpace by the Texas Digital Library (www.tdl.org) in 2010. They observed that;

1) DSpace is highly integrated and nearly impossible to separate from the database and file systems,

2) Creating unit test for all of DSpace is very time consuming. It is simpler to write a few functional tests that cover a wide set of features over the whole application. To address this problem the Texas Digital Library created a simple framework for adding both integration tests and functional tests. The main concept was to script the install of a test DSpace, with a full configuration and setup. Then they started DSpace in an embedded web server and then run through several scenarios just as a normal user would. The test was performed successfully for two DSpace-based projects.

The TDL test details were posted to DSpace-devel mailing list in April 2010 and there are several responses from the DSpace community leaders. A careful examination of the responses of the DSpace leaders indicate that the concept of testing facility of DSpace was an innovative idea and a good starting point for more automated testing (Unit Tests, Functional Tests, etc.) in general. Data for this element was collected from Tim Donohue who is a technical lead for the DSpace project at DuraSpace from 2009, by email communication. Donohue offered the following information. “Currently, DSpace has unit testing capability built in. They are included in the codebase under the "/src/test/java" subdirectories. They can be executed from the command line via: mvn package -Dmaven.test.skip=false. DSpace also uses a Continuous
Integration (CI) system which automatically runs all Unit Tests on any change in the codebase (this helps to ensure no changes break our tests). DSpace uses Travis CI for those purposes. The details are given at https://travis-ci.org/DSpace/DSpace/

Based on the knowledge provided by one of the DSpace technical experts, it can be concluded that DSpace has unit test facility inbuilt.

5.11 Integration with Other Products

The tenth major element of maturity is the software’s integration with other products. WG-OSMM looks for the ability of an OSS to integrate with other products. A set of interdependencies cause programs to work on each other. Altering or ignoring certain dependencies between the previous set of applications and subsystems shall affect the ecological balance of different programmes. A mature software pays attention to the aspect of compatibility. The examination of documentation for various versions of DSpace brings information about the integration of DSpace with other products. DSpace is developed as a generic platform. Hence, its integration with other applications is very essential to make the platform fit for the intended use. The aspects of integration is discussed under the following sub elements; hardware integration, software integration.

5.11.1 Hardware Integration

DSpace can be installed on a modern personal computer, laptop or server class machine. The building of DSpace system for an institution having large number of users requires a server hardware having minimum 3 GB RAM and 20 GB Hard disc storage space to entertain searches, accesses, and downloads.
5.11 Integration with Other Products

A high end production system that accommodates more than five lakhs documents requires 8 GB RAM and 1TB storage space.

5.11.2 Software Integration

WG-OSMM looks software integration as an important element of mature software. The changing of software dependencies over different versions of the project shall affect the process of upgrades. It is expected that when a new release of software or dependencies comes out, it will be tested with the other. To examine this element, the investigator depended on the contents of user manual of DSpace. DSpace is written in Java, a general purpose, concurrent and object oriented programming language from the Oracle Corporation. DSpace can therefore be installed on any operating system (UNIX-Linux, HP-UX, Windows, Mac OSX etc.). To examine the integration of DSpace with other products, the investigator examined the prerequisite software of DSpace for last five versions. Table 5.10 shows the list of five DSpace versions and the dependencies associated with them.
Table 5.10 DSpace Dependencies Across Various Versions

<table>
<thead>
<tr>
<th>DSpace</th>
<th>OS</th>
<th>Development Platform</th>
<th>Build Tool</th>
<th>Java Library</th>
<th>Relational Database</th>
<th>Servlet Engine</th>
<th>Language Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.1</td>
<td>Multiple</td>
<td>Oracle Java JDK6</td>
<td>Apache Maven 2.2.x</td>
<td>Apache Ant 1.7 or later</td>
<td>PostgreSQL/Oracle</td>
<td>Tomcat 5.5/6 or Jetty or Cauchoo Resin or similar</td>
<td>Perl</td>
</tr>
<tr>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.x</td>
<td></td>
<td>JDK6 or 7</td>
<td>Apache Maven 2.2.x or higher</td>
<td>Apache Ant 1.8 or later</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.x</td>
<td></td>
<td>JDK 7</td>
<td>Apache Maven 3.x</td>
<td></td>
<td></td>
<td>Tomcat 7 or Jetty or Cauchoo Resin or similar</td>
<td></td>
</tr>
<tr>
<td>5.x</td>
<td></td>
<td>JDK 7 or open JDK7</td>
<td>Apache Maven 3.0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.10 shows that DSpace uses the Apache Web server, the Tomcat Servlet engine, and the PostgreSQL relational database. All these tools are coming under open source license. DSpace used the same kind of prerequisite software over the years across various versions. There is no change for the operating system compatibility of DSpace. There are only changes in the editions of development platform, Java build tool, Java library and Servlet engine. Moreover, when every new version of DSpace releases, there is provision for upgrading from any previous version.
5.12 Supports for Standards

The eleventh major element of maturity is the support for standards. WG-OSMM stresses the need for programs to use standard-based APIs (Application Programme Interface) along with dependencies. API is a set of routines, protocols, and tools for building software applications. Both commercial and OSS use various APIs supplied by a number of different projects or authors. WG-OSMM wants to check if all the APIs work together correctly.

The standards compatibility of DSpace has been documented in the official website, scholarly articles and book chapters produced by the DSpace leaders. The user manuals also provide information on APIs. The API and standards to which DSpace is compatible are listed in 5.12.1-5.12.7.

5.12.1 Open Archives Initiative (OAI)

Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is a protocol developed by the Open Archives Initiative. It is used to harvest (or collect) the metadata descriptions of the records in a digital repository so that interoperability can be achieved among many archives. It provides an application-independent interoperability framework based on metadata harvesting. A harvester or collector is a client application that issues OAI-PMH requests. A harvester is operated by a service provider as a means of collecting metadata from repositories. DSpace has implemented OAI-PMH by using the OCLC OAICat and is exposing Dublin Core metadata for every item in the system.
5.12.2 Open Archives Initiative Object Reuse and Exchange (OAI-ORE)

OAI-ORE is a standard for the description and exchange of aggregations of Web resources. These aggregations, sometimes called compound digital objects, may combine distributed resources with multiple media types including text, images, data, and video. The goal of these standards is to expose the rich content in these aggregations to applications that support authoring, deposit, exchange, visualization, reuse, and preservation. This standard can be used to harvest content (bit streams and metadata) into DSpace from an external OAI-PMH or OAI-ORE server.

5.12.3 Simple Web-service Offering Repository Deposit (SWORD)

SWORD is a repository-standard ingest service using Atom Publishing Protocol. The embedded SWORD Client allows a user to copy an item to a SWORD server. This allows the DSpace installation to deposit items into another SWORD-compliant repository (including another DSpace install). The SWORD interface is configured within the main dspace.cfg file.

5.12.4 Web Distributed Authoring and Versioning (WebDAV)

It is an extension of the Hypertext Transfer Protocol (HTTP) that allows clients to perform remote Web content authoring operations. WebDAV is a proven and robust protocol that was designed for accessing and modifying resources and their metadata over a network.
5.12 Supports for Standards

5.12.5 OpenSearch

OpenSearch is a small set of conventions and documents for describing and using search engines, meaning any service that returns a set of results for a query. It allows publishing of search results in a format suitable for syndication and aggregation. It is commonly visible in modern web sites with search capability. It is used by Wikipedia, Facebook, CNN, etc. DSpace appears as a 'search-engine' to OpenSearch-aware software.

5.12.6 OpenURL

DSpace supports the OpenURL protocol in a rather simple fashion. If an institution has an SFX server, DSpace will display an OpenURL link on every item page, automatically using the Dublin Core metadata. Additionally, DSpace can respond to incoming OpenURLs. Presently it simply passes the information in the OpenURL to the search subsystem. A list of results is then displayed, which usually gives the relevant item (if it is in DSpace) at the top of the list.

5.12.7 Rich Site Summary (RSS)

RSS is a family of standard web feed formats to publish frequently updated information like blog entries, news headlines, audio, video. RSS removes the need for the user to manually check the website for new content. All RSS feed options are available in dspace.cfg. DSpace RSS feeds were designed to offer feeds for recent submissions for the entire repository, communities and collections. RSS feeds enable publishers to syndicate data automatically. A standard XML file format ensures compatibility with many different machines/programs. RSS feeds also help users to receive timely updates from favourite websites or to aggregate data from many sites.
5.12.8 Google Scholar Metadata Mappings

Google Scholar offers search for scholarly literature. The contents archived in DSpace systems are indexed by Google Scholar through automatic crawling by search robots. This helps the DSpace items retrievable easily to large audience. DSpace supports the standards for indexing by Google Scholar since version 1.7 onwards. The DSpace 4.0 contains several enhancements to these standards which were requested by the Google Scholar team. These included providing users (and web indexers) a way to browse content by the date it was added to DSpace ensuring the "dc.date.issued" field is set more accurately.

5.13 Quality of Project Site

The twelfth major element of maturity is the quality of OSS website. Since the success of OSS is very much based on Internet based communications and interactions, an excellent website is essential for any mature project. Different types of websites vary in their organization and display of contents. For a mature OSS, the website shall be educative, simple and easy to navigate. The result of the examination of the official website of DSpace is given below.

5.13.1 DSpace Website

DSpace maintains an official website (www.dspace.org) to communicate information regarding the software. As per Web Archive website, the history of DSpace website goes to 2nd May 2001. However, the purpose of the website at that time was to introduce DSpace as a service of MIT. The first version of DSpace was released on 4th November 2002. The option for downloading DSpace was visible on the website hosted on 14th November 2002. The information and links were organized under six headings that
included “What is DSpace”, “Technology platform”, “MIT Implementation”, “News”, “People” and “Contact Us”. As of January 2015, the official website of DSpace still functions as the central point of access for a variety of information and services. The site is highly informative and all-embracing. It has organized information mainly under 5 headings. The Figure 5.15 shows the links that are provided under the five major headings of DSpace website.

Figure 5.15 Contents of DSpace Official Website

Figure 5.15 shows that there are 34 links to search information on various aspects of DSpace software. The website also provides links to take a tour, download current release, who’s using DSpace, Hosted DSpace and DSpace news. Apart from this, the website provides site map, facility to search the site content and link to contact the DuraSpace, the non-profit organizing that provides leadership to DSpace project. The site contents are licensed under Creative Commons.
5.13.2 Site Design

The examination of the contents and links available on the official website of DSpace revealed that it conforms to the degree of brevity and clarity expected of a mature OSS project by the WG-OSMM. The site is organized in a simple way to facilitate easy navigation by any visitor.

5.13.3 Educative

As per WG-OSMM a great site can make it easy for everyone to educate himself and find what he needs. The study has examined the details provided in the 34 links that appear on the home page of DSpace website. The examination revealed that the DSpace website is intended for educating the user on all aspects of the software. It provides knowledge covering basics to highly technical aspects of the software. A user of the software is able to view, read and download text and videos containing essential information on the software.

The link to training materials leads to a webpage that provides a variety of materials and resources developed by the DSpace user community which can be used as self-guided tutorials. This section gives information about DSpace Course that is intended for DSpace administrators or developers and includes 20 different modules on various topics. The contents were created by experts in the field who work as committers, developers and trainers of DSpace. This page also provides links to DSpace Resources wiki which contains latest technical information about DSpace platform. The wiki page holds documentation in downloadable format for all the versions of the DSpace.
5.14 License Type

The thirteenth major element of maturity is the type of OSS license. WG-OSMM considers direct access to the programmes’ source code as the great attractions of open source. This is a vital form of insurance. Open source software employ a variety of licenses. In some cases, there might be no restriction on the use of the software for developing a new system that is based on certain software. But when it comes to distribute those applications and the underlying program in a commercial application, or to make the applications available through a public web site, users must pay a fee perhaps determined by how many servers are executing the software. Some licenses give the user freedom not only to work with the program to develop new applications, but also to distribute it at no charge. Still another level of license permits users to modify the software themselves, perhaps requiring that they contribute their improvements back to the open source project. The WG-OSMM requires checking the type of license.

Open source licenses are licenses that comply with the Open Source Definition of the Open Source Initiative (OSI). They allow software to be freely used, modified, and shared. DSpace is shared and distributed under Berkeley Software Distribution (BSD) license. DSpace attaches other open source tools to package with the DSpace applications and all these are freely available under an open-source license. However they don’t carry the same license. The BSD license is permissive license which allows the source code to be copied or used without requesting the authors’ permission and without cost. The distribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
• Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution. Neither the name DuraSpace nor the name of the DSpace Foundation nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission. The following are the acceptable licensing models of DSpace.

• Apache License 2.0
• BSD
• Common Development and Distribution License (CDDL)
• Common Public License (CPL)
• GNU Library or "Lesser" General Public License (LGPL)
• MIT / X11 License
• Mozilla Public License

The following are the unacceptable licensing models of DSpace

• GNU General Public License (GPL)
• GNU Affero General Public License (AGPL)
• European Union Public Licence (EUPL)
• Any license which strictly forbids "sublicensing" as detailed at http://choosealicense.com/licenses/
• Any license which limits commercial use/redistribution of binary code

The DSpace license is aimed at commercial entities and service providers to be able to customize the entire codebase and redistribute/repackage/sell it in a binary form. GPL licenses is preventing this option and DSpace has included it under unacceptable license category
5.15 Potential for Commercial Conflicts

The fourteenth major element of maturity is the potential for commercial conflicts. WG-OSMM cautions the possibility of dubious legal status of software of all types in which code might infringe or simply appear to infringe on the intellectual property of a commercial company. This puts developers as well as users at risk of potential legal action by those commercial suppliers. Though this sort of conflict is a rare occurrence, it is desirable that open source projects focus mostly on integration with other open source projects.

The DSpace uses standard software as prerequisites from Java to Perl. The list below describes the third-party components and tools needed to run a DSpace server.

- Unix-Like Operating System or Microsoft Windows. Many distributions of Linux/Unix come with some of the dependencies pre-installed or easily installed via updates.
- Oracle Java JDK 7 or OpenJDK 7- OpenJDK (Open Java Development Kit) is a free and open source implementation of the Java programming language licensed under the GNU General Public License (GNU GPL) with a linking exception.
- Apache Maven- it is an open source project.
- PostgreSQL- a relational database. It is also an open source project
- Apache and Tomcat- both from the Apache Foundation and belong to open source category.
- Jena (an RDF toolkit from HP Labs
- OAICat from OCLC
It is found that all leveraged components and libraries attached to DSpace are also OSS and there is no possibility of commercial conflict with any software within DSpace.

5.16 Corporate Commitment

The fifteenth major element of maturity is the corporate commitment. Several open source projects, such as the Linux operating system and Apache Web Server, have enjoyed tremendous support from large, established computer companies, including IBM, Sun, HP, and Dell. IBM, in particular, has helped the Apache server effort with people and valuable source code. The support for a project from reputed corporations adds values to maturity. The supports received by DSpace from various corporate sectors are listed below.

5.16.1 Support for DSpace

DSpace is a joint project of Massachusetts Institute of Technology (MIT) Libraries and Hewlett Packard (HP) Lab begun in 2002. MIT is a well-known world-class university in the United States. The HP Lab is the leading multinational company headquartered in California, United States. The company is associated with hardware, software and services segment. It has 45 years of experience in the field. Moreover DSpace has received funding from Andrew Mellon Foundation, USA. Currently the DuraSpace looks after the project under the leadership of highly qualified professionals from across the globe. Over two-thirds of DSpace revenue are coming from sponsorship and hosted solutions. DSpace has several kinds of membership that include universities, university libraries and digital libraries. The corporate support for DSpace is sufficient to achieve the status of a mature OSS.
5.16.2 Third Party Support for DSpace

DSpace has many registered service providers across the globe who work with DuraSpace organisation. The official website of DSpace has given a list of nine firms who provide third party support for DSpace. They include Agronet from S.Korea, Arvo consulters from Spain, @mire from Belgium and USA, Cineca-from Italy, DSquare from India, Ibai from Spain, LongSight from USA, ProviderIT from Brazil and Open Repository from United Kingdom.

5.17 WG-OSMM – Maturity Scoring

The last part of the WG-OSMM attempts to quantify the maturity of an OSS in product criteria, use criteria and integration criteria. The details of these criteria are given below.

Product Criteria - Product criteria are specifics about the product itself. Since OSS products are often under rapid development, with major advances made in a few weeks to a few months, the model lists momentum as a criterion to offset the age criterion. Product criteria help to spot products that aren't mature enough today but are worthy of keeping an eye on.

Use Criteria - Use criteria are specifics about what it takes to use the product from day to day, from the effort of initial installation and configuration to the work required for daily upkeep and support mechanisms available to help in tailoring the product to an institution’s needs and fixing defects encountered.

Integration Criteria - Integration criteria are specifics about what it takes to make the product work in the institution’s environment. For each criterion the Model assigns a score of 1, 2, or 3: Table 5.11 shows the score and description of the score.
Table 5.11 WGOSMM Scoring Description

<table>
<thead>
<tr>
<th>Score</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Immature product</td>
<td>The product is lacking in several critical areas. It is not fit for adoption for a production use.</td>
</tr>
<tr>
<td>2</td>
<td>Reasonably mature</td>
<td>The product has sufficient quantity of features with a bright future. But it is weak on some areas.</td>
</tr>
<tr>
<td>3</td>
<td>Very mature</td>
<td>The product has a long and stable history, a broad and vibrant user community.</td>
</tr>
</tbody>
</table>

Table 5.12, 5.13 and 5.14 show the WGOSMM scoring chart under product criteria, use criteria and integration criteria.

Table 5.12 WG-OSMM Score Chart for Product Criteria

**Woods and Guliani’s Open Source Maturity Model-2005**

<table>
<thead>
<tr>
<th>Maturity Criteria</th>
<th>Score=1</th>
<th>Score=2</th>
<th>Score=3</th>
<th>Criteria Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>6 months</td>
<td>6-months -2 years</td>
<td>2 years</td>
<td>OSS that are just getting underway are risky</td>
</tr>
<tr>
<td>Multiple Supported Platforms</td>
<td>One Platform</td>
<td>Many related platforms</td>
<td>Multiple heterogeneous platforms</td>
<td></td>
</tr>
<tr>
<td>Momentum</td>
<td>No release in last 6 months</td>
<td>two releases in past year</td>
<td>Regular releases</td>
<td>This is key to helping separate vital products from ones that are withering.</td>
</tr>
<tr>
<td>Popularity</td>
<td>Unknown product</td>
<td>Viable alternative</td>
<td>Category leader</td>
<td>Popular OSS products are well tested and therefore more mature.</td>
</tr>
<tr>
<td>Design quality</td>
<td>Monolithic application</td>
<td>Multiple components</td>
<td>Well-defined API</td>
<td>This is key in determining the effort required to extend and adapt the product for use.</td>
</tr>
</tbody>
</table>
Measuring the maturity of OSS for digital libraries: a case study of DSpace

<table>
<thead>
<tr>
<th>Woods and Guliani’s Open Source Maturity Model-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maturity Criteria</strong></td>
</tr>
<tr>
<td>Use Criteria</td>
</tr>
<tr>
<td>Setup cost</td>
</tr>
<tr>
<td>Usage cost</td>
</tr>
<tr>
<td>End-user support</td>
</tr>
</tbody>
</table>
5.18 Measuring Maturity of DSpace

The last part of analysis attempts to measure the maturity of DSpace software against the quantitate values set by WG-OSMM. The scoring is based on the examination of fifteen major elements of maturity and various sub-elements coming under them. Table 5.15, 5.16. and 5.17 show the WG-OSMM maturity chart organized under product criteria, use criteria and integration criteria respectively. The first column contains criteria, the second, third and
fourth columns cover the status of a product, the fifth column provides explanation corresponding to DSpace against the criteria. The sixth column shows the score obtained by DSpace against each criterion. The value of score and status of software is described below.

I = Immature (Score 1),
RM = Reasonably Mature (Score 2), and
VM = Very Mature (Score 3).

Table 5.15 WG-OSMM Score for DSpace Under Product Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>I</th>
<th>RM</th>
<th>VM</th>
<th>DSpace</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>6 months</td>
<td>6-months -2 years</td>
<td>2 years</td>
<td>More than 2 years</td>
<td>3</td>
</tr>
<tr>
<td>Multiple Supported Platforms</td>
<td>One Platform</td>
<td>Many related platforms</td>
<td>Multiple heterogeneous platforms</td>
<td>Run on Unix-like and Windows based platforms</td>
<td>3</td>
</tr>
<tr>
<td>Momentum</td>
<td>No release in last 6 months</td>
<td>two releases in past year</td>
<td>Regular releases</td>
<td>12 stable release in 14 years</td>
<td>3</td>
</tr>
<tr>
<td>Popularity</td>
<td>Unknown product</td>
<td>Viable alternative</td>
<td>Category leader</td>
<td>Category leader</td>
<td>3</td>
</tr>
<tr>
<td>Design quality</td>
<td>Monolithic</td>
<td>Multiple components</td>
<td>Well-defined API</td>
<td>Well defined API</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5.15 contains the score obtained by DSpace for the criteria of Age, Multiple Supported Platforms, Momentum, Popularity and design quality. DSpace was developed in 2002. As of November 2014, it has crossed twelve years. The multiple supported platforms compatibility of DSpace has been discussed in section 5.6.2. The momentum of DSpace was explained in section 5.7. The popularity criterion has been given in section 4.6. DSpace is the category leader of OSS for DLs. Design quality criterion of DSpace was
given in section 5.8.1. DSpace received the highest score for all the product criteria of WG-OSMM. Table 5.16 shows the score for Use Criteria.

Table 5.16 WG-OSMM Score for DSpace Under Use criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>I</th>
<th>RM</th>
<th>VM</th>
<th>DSpace</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup cost</td>
<td>Poorly documented</td>
<td>Well-documented install process; reasonable documentation; help from developers; help from forums</td>
<td>Well-documented, Support from forums, support from third party</td>
<td>Well-documented, Support from forums, support from third party</td>
<td>3</td>
</tr>
<tr>
<td>Usage cost</td>
<td>Poor or documentation; only direct contact with developers</td>
<td>User manuals available; help available in support forums</td>
<td>Third-party training services available</td>
<td>User manuals available; support forums</td>
<td>3</td>
</tr>
<tr>
<td>End-user support</td>
<td>No forums or mailing lists</td>
<td>Some forums or mailing lists</td>
<td>Well-run forums and mailing lists, with archives and search; third-party support options</td>
<td>Six mailing lists, mail archive, support from DuraSpace</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5.16 contains the score obtained by DSpace for the criteria of Setup cost, Usage cost and End-user support. The aspects of documentation and third party support of DSpace were discussed in section 5.5 and 5.16.2 respectively.
DSpace has received the highest score for all criteria under the use criteria score of WG-OSMM.

Table 5.17 shows the score for DSpace under Integration Criteria.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>I</th>
<th>RM</th>
<th>VM</th>
<th>DSpace</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modularity</td>
<td>Monolithic structure; possible but hard to extend</td>
<td>Multiple modules; possible to extend</td>
<td>Multiple modules, well-defined API; possible and easy to extend</td>
<td>Modular design, multiple modules, well defined API, easy to extend</td>
<td>3</td>
</tr>
<tr>
<td>Collaboration with other products</td>
<td>Unknown</td>
<td>Known cases of integration</td>
<td>Lots of integration documented</td>
<td>Integration with Standard products</td>
<td>3</td>
</tr>
<tr>
<td>Standard Compliance</td>
<td>Unknown or proprietary</td>
<td>Outdated</td>
<td>Current industry standard</td>
<td>Latest industry standard</td>
<td>3</td>
</tr>
<tr>
<td>Developer support</td>
<td>No forums or mailing lists</td>
<td>Some forums or mailing lists</td>
<td>Well-run forums and mailing lists with archives and search; third-party support options</td>
<td>Very active forums with archive to search. Support from DuraSpace and others</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5.17 contains the score obtained by DSpace for the criteria of Modularity, Collaboration with other products, Standard Compliance, Developer support. The modularity of DSpace has been given in 5.8.1. The ability of DSpace to integrate with other products and the Standard Compliance of DSpace were
discussed in section 5.11 and 5.12 respectively. The details of DSpace mailing forum have been given in 5.4 and 5.5. DSpace received the highest score for all criteria under the use criteria score of WG-OSMM.

The measuring of the maturity of DSpace open source software using the WG-OSMM is presented in Table 5.15, 5.16 and 5.17. The descriptive section examined fifteen elements of maturity and the sub-elements under it. The scoring chart of WG-OSMM contains twelve criteria of maturity under product criteria, use criteria, and integration criteria. DSpace has achieved the highest score for each criterion under product criteria, use criteria and integration criteria. Based on the examination of the descriptive elements and the scoring criteria, the investigator has found that DSpace is a mature OSS. The feasibility of DSpace for a DL has been examined by studies attempted previously. This study adds extensions to the previous studies. The outcome of the study is that while DSpace is a suitable OSS for DL, it is a mature software also. The findings of the study are summarized in the next chapter.
References


