ESTABLISHING EFFECTIVE WORKFLOW INTEROPERABILITY FRAMEWORK IN THE CASE OF DOMINO WORKFLOW AND MICROSOFT EXCHANGE 2000 SERVER

A Thesis submitted to the Graduate School in full fulfilment of the requirements for the degree Master of Science (Information Technology), Universiti Utara Malaysia

by
Juliana Binti Wahid

(c) Juliana Binti Wahid, 2002. All rights reserved
PERMISSION TO USE

In presenting this thesis in full fulfilment of the requirements for a post graduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor(s) or, in their absence, by the Dean of the Graduate School. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Graduate School
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman
ABSTRAK

Kewujudan produk Pengurusan Aliran Kerja (WFMS) yang banyak di dalam pasaran membolehkan pengguna menggunakan produk tertentu untuk memenuhi keperluan aplikasi yang khusus. Walabagaimanapun, ciri-ciri sedia ada WFMS tidak dapat menyokong kebolehoperasian antara produk WFMS. Kegagalan untuk kebolehoperasian ini boleh menyebabkan berlakunya pulau-pulau otomasi proses yang tidak serasi di dalam organisasi atau pun di antara organisasi.


ABSTRACT

The availability of a wide range of workflow management system (WFMS) products within the market has allowed users to adopt particular products to meet specific application needs. However, states of the art WFMSs do not have adequate features of interoperability among WFMSs. Failure of interoperability between WFMS products can cause incompatible "islands" of process automation within an organization or between organizations.

The research introduces method of realizing workflow interoperability between Domino® Workflow from Lotus® Corporation and Microsoft® Exchange 2000 Server from Microsoft Corporation. Towards the end of this research, the method used has alleviated the strategy, level and model of interoperability between different products that exist between organizations and departments.

To realize the workflow interoperability, this research adopted a System Development approach that consists of five stages. The first was to construct a conceptual framework of workflow interoperability between both products. The second was to develop a system architecture. In this stage, the tools of interoperability were analysed. Only two tools were chosen, i.e. Microsoft Exchange Connector for Lotus Notes and Extensible Markup Language (XML) of Document Object Model (DOM) standard. These tools then were modelled together with Domino Workflow and Microsoft Exchange 2000 Server in the system architecture. The third was to analyse and design the system. In this stage, a specific business process, i.e. leave application was selected to be developed as the prototype. The fourth was to build the prototype to demonstrate the practicality of the method used. Finally, the system was observed and evaluated to validate the effectiveness of the tools used.

From the developed prototype, it was concluded that the use of Microsoft Exchange Connector for Lotus Notes and XML of DOM standard realized the workflow interoperability between Domino Workflow and Microsoft Exchange 2000 Server. Two models of workflow interoperability were realised from the developed prototype, i.e. Nested Sub-process model and Parallel Synchronised model. Documents (tasks) from both environments were exchanged by the XML of DOM standard that complied with the Limited Common Application Programming Interface (API) Subset level. The documents were then transferred to each other by the Microsoft Exchange Connector for Lotus Notes that corresponded with the Message Passing strategy.
ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful.

I would like to thank:

The Ministry of Science and Technology for the financial support,

The University of Northern Malaysia for the facilities and resources provided,

The Dean, that also acts as my supervisor, Associate Professor Dr. Zulkhairi Md Dahalin, for his advices, support and time spent on discussions,

The ex-Dean, Professor Abu Talib Othman for his thoughtful ideas that inspired this research,

The academic and administration staff who participated in the usability testing,

Finally my family and friends for all the support and encouragement they have given me over the years.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERMISSION TO USE</td>
<td>i</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xiii</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 Background ........................................... 1
1.2 Problem Statement ................................... 2
1.3 Objectives ............................................ 5
1.4 Outline of the Research Method .................... 6
1.5 Summary of Contributions ........................... 6
1.6 Thesis Outline ....................................... 6

## CHAPTER 2 WORKFLOW

2.1 Groupware Industry .................................... 9
2.2 Introduction to the Workflow Management System (WFMS) .... 10
2.3 Existing WFMS Products ............................... 11
   2.3.1 Domino® Workflow .................................. 12
   2.3.2 Microsoft® Exchange 2000 Server ................. 12
   2.3.3 Ultimus® .......................................... 12
   2.3.4 Flowware® ......................................... 13
   2.3.5 TIBCO InConcert™ .................................. 13
   2.3.6 MQSeries Workflow ................................ 13
2.4 Definition ............................................. 14
   2.4.1 Workflow .......................................... 14
   2.4.2 Workflow Management System (WFMS) .............. 14
2.5 Existing Applications ................................ 17
   2.5.1 Leave Application ................................ 17
   2.5.2 Document Control ................................. 18
   2.5.3 Ministerial Correspondence ....................... 19
   2.5.4 Product Service Information Architecture/Workbench 19
2.6 Workflow Benefits .................................... 20
2.7 Similar Research Projects ........................... 21
   2.7.1 VORTEL - Teleservice for Workflow Management ...... 21
   2.7.2 Interworkflow System ............................. 22
   2.7.3 The Mentor Project ................................ 23
2.8 Workflow Interoperability ............................ 25
   2.8.1 Workflow Interoperability Strategies ............. 25
     2.8.1.1 Direct Interaction ............................. 25
     2.8.1.2 Message Passing .............................. 25
     2.8.1.3 Bridging ..................................... 26
     2.8.1.4 Use of Shared Database ....................... 26
   2.8.2 Workflow Interoperability Models ................. 27
2.8.2.1 Chained Model ................................................. 27
2.8.2.2 Nested Sub-process Model ................................. 28
2.8.2.3 Parallel Synchronised Model ............................... 28
2.8.3 Workflow Interoperability Levels ......................... 29
  2.8.3.1 Level 1 – No interoperability ............................... 29
  2.8.3.2 Level 2 – Coexistence .................................... 29
  2.8.3.3 Level 3 – Unique Gateways ............................... 30
  2.8.3.4 Level 3a – Common Gateway API ......................... 30
  2.8.3.5 Level 4 – Limited Common API Subset ...................... 31
  2.8.3.6 Level 5 – Complete Workflow API ......................... 31
  2.8.3.7 Level 6 – Shared Definition Formats ...................... 31
  2.8.3.8 Level 7 – Protocol Compatibility ......................... 31
  2.8.3.9 Level 8 – Common Look and Feel Utilities ............... 32
2.9 Workflow Management Coalition .................................. 32
2.10 Workflow Products used in this Study ....................... 33
  2.10.1 Domino Workflow ........................................... 33
     2.10.1.1 Installation ........................................... 34
     2.10.1.2 Features .............................................. 39
  2.10.2 Microsoft Exchange 2000 Server .......................... 44
     2.10.2.1 Installation ........................................... 44
     2.10.2.2 Features .............................................. 50
2.11 Summary .......................................................... 55

CHAPTER 3 RESEARCH METHODS .................................. 56
3.1 Reviews on Research Methods .................................... 56
3.2 Research Methods used in this Study ......................... 57
  3.2.1 Construct a Conceptual Framework ......................... 59
  3.2.2 Develop a System Architecture ............................ 61
  3.2.3 Analyze and Design the System ............................ 62
  3.2.4 Build the System (Prototype) .............................. 63
  3.2.5 Observe and Evaluate the System ......................... 63
3.3 Summary .......................................................... 64

CHAPTER 4 ANALYSIS OF TASKS .................................. 65
4.1 Determining the Interoperability Tools ....................... 65
  4.1.1 Microsoft Exchange Connector for Lotus Notes .................. 65
  4.1.2 Microsoft Exchange Application Converter for Lotus Notes .......... 67
  4.1.3 eKnowledge® 7.0 ........................................... 69
  4.1.4 Extensible Markup Language (XML) .......................... 72
4.2 Workflow Interoperability Framework Modelling ............... 76
4.3 Workflow Interoperability Design ................................ 79
  4.3.1 Selecting of the Business Process .......................... 79
  4.3.2 Identifying of the Basic Activities .......................... 80
  4.3.3 Designing Business Process ................................ 80
     4.3.3.1 Respective Environment ................................ 81
     4.3.3.2 Interoperability Environment .......................... 81
4.4 Summary .......................................................... 83
CHAPTER 5 WORKFLOW INTEROPERABILITY DEVELOPMENT

5.1 Directory Synchronization Configuration .................................................. 85
  5.1.1 Preparation of the Lotus Notes Environment .................................. 86
  5.1.2 Preparation of the Exchange Environment ..................................... 88
  5.1.3 Configuration of the Connector ...................................................... 89

5.2 Leave Application Workflow Process Development ................................. 91
  5.2.1 Domino Workflow Leave Application Development .......................... 92
    5.2.1.1 Creating Workgroup Definition at the Organization Database .... 92
    5.2.1.2 Adding Domino Workflow API into the Application Database .... 92
    5.2.1.3 Creating LotusScript Agents that use the API Functionality ....... 93
    5.2.1.4 Creating Forms and Views in the Application Database ............ 94
    5.2.1.5 Creating Process at the Domino Workflow Architect ................ 110
  5.2.2 Microsoft Exchange 2000 Server Leave Application Development ....... 112
    5.2.2.1 Creating Public Folders ....................................................... 113
    5.2.2.2 Setting Permission for the Public Folders ............................... 114
    5.2.2.3 Creating Forms and Views ..................................................... 115
    5.2.2.4 Creating Agents ................................................................. 123
    5.2.2.5 Creating Process ............................................................... 125

5.3 Usability Testing ...................................................................................... 130
  5.3.1 Usability Test Design ...................................................................... 131
    5.3.1.1 Identification of User ............................................................. 131
    5.3.1.2 Tasks Development ................................................................ 131
    5.3.1.3 Specification of the Test Apparatus ....................................... 132
  5.3.2 Running the Test ............................................................................ 132
  5.3.3 Data Analysis .................................................................................. 133

5.4 Summary ............................................................................................... 134

CHAPTER 6 DISCUSSION AND CONCLUSION

6.1 Discussion .............................................................................................. 135
  6.1.1 Findings .......................................................................................... 136
    6.1.1.1 Determining the Interoperability Tools .................................. 137
    6.1.1.2 Workflow Interoperability Framework Modelling ................... 138
    6.1.1.3 Workflow Interoperability Design ......................................... 138
    6.1.1.4 Workflow Interoperability Development ................................ 139
    6.1.1.5 Usability Testing ................................................................. 141
  6.1.2 Research Contributions .................................................................... 142
    6.1.2.1 Offers an Alternative Technique in Achieving Workflow Interoperability .................................................. 142
    6.1.2.2 Provides an Applicable Framework of Interoperability .......... 143
  6.1.3 Future Work ..................................................................................... 143
    6.1.3.1 Minimizing the Turnaround Time ......................................... 143
    6.1.3.2 Processing the XML Document Using SAX .......................... 144
    6.1.3.3 Designing Different Workflow Interoperability Framework .... 144

6.2 Conclusions ......................................................................................... 145

REFERENCES ............................................................................................. 147

APPENDIX A: STEPS OF THE CONNECTOR CONFIGURATION ......................... 154
APPENDIX B: THE PROCESS OF CREATING “ALL” WORKGROUP ..................... 159
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.1</td>
<td>Sub-components and Features in Domino Workflow and Microsoft Exchange 2000 Server</td>
<td>54</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Tools Summary</td>
<td>75</td>
</tr>
<tr>
<td>Table 5.1</td>
<td>List of Elements used in the “Leave Form”</td>
<td>96</td>
</tr>
<tr>
<td>Table 5.2a</td>
<td>List of LotusScript used in the “Leave Form”</td>
<td>97</td>
</tr>
<tr>
<td>Table 5.2b</td>
<td>List of Formula used in the “Leave Form”</td>
<td>97</td>
</tr>
<tr>
<td>Table 5.2c</td>
<td>List of Simple Action used in the “Leave Form”</td>
<td>97</td>
</tr>
<tr>
<td>Table 5.3</td>
<td>List of Views and Columns Properties</td>
<td>104</td>
</tr>
<tr>
<td>Table 5.4</td>
<td>List of Views Used by Each Agent</td>
<td>106</td>
</tr>
<tr>
<td>Table 5.5</td>
<td>List of “leave form” Elements</td>
<td>118</td>
</tr>
<tr>
<td>Table 5.6</td>
<td>List of Scripting in “leave form”</td>
<td>119</td>
</tr>
<tr>
<td>Table 5.7</td>
<td>List of “form approval” Elements</td>
<td>122</td>
</tr>
<tr>
<td>Table 5.8</td>
<td>List of Views and Its Properties</td>
<td>123</td>
</tr>
<tr>
<td>Table 5.9</td>
<td>List of Agents in Microsoft Outlook 2000</td>
<td>124</td>
</tr>
<tr>
<td>Table 5.10</td>
<td>Result of Questionnaire</td>
<td>133</td>
</tr>
<tr>
<td>Table F.1</td>
<td>List of Elements in “Personal Data” Form</td>
<td>167</td>
</tr>
<tr>
<td>Table F.2</td>
<td>LotusScript and Formula used in “Personal Data” Form</td>
<td>168</td>
</tr>
<tr>
<td>Table P.1</td>
<td>List of “profile” Form Elements</td>
<td>181</td>
</tr>
</tbody>
</table>

*If not otherwise indicated, the author is the source of the tables.*
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1</td>
<td>Generic WFMS Product Structure (Source: Workflow Management Coalition, 1995)</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>Employee Hiring Process (Source: Lotus Corporation, 2000a)</td>
<td>14</td>
</tr>
<tr>
<td>Figure 2.3</td>
<td>WFMS Characteristics (Source: Workflow Management Coalition, 1995)</td>
<td>15</td>
</tr>
<tr>
<td>Figure 2.4</td>
<td>Textual Form of Process Definition in Domino Workflow</td>
<td>16</td>
</tr>
<tr>
<td>Figure 2.5</td>
<td>Language Notation of Process Definition in Microsoft Exchange 2000 Server</td>
<td>16</td>
</tr>
<tr>
<td>Figure 2.6</td>
<td>The VORTEL Architecture (Source: Haake, 2001)</td>
<td>22</td>
</tr>
<tr>
<td>Figure 2.7</td>
<td>Interworkflow System Design (Source: Hiramatsu et al., 1998)</td>
<td>23</td>
</tr>
<tr>
<td>Figure 2.8</td>
<td>The Client/Server Architecture of Mentor (Source: Weissenfels et al., 2000)</td>
<td>24</td>
</tr>
<tr>
<td>Figure 2.9</td>
<td>Direct Interaction between the WFMS Products (Source: Workflow Management Coalition, 1996)</td>
<td>25</td>
</tr>
<tr>
<td>Figure 2.10</td>
<td>WFMS Products Interacting by Message Passing (Source: Workflow Management Coalition, 1996)</td>
<td>26</td>
</tr>
<tr>
<td>Figure 2.11</td>
<td>WFMS Products Interacting via Gateway (Source: Workflow Management Coalition, 1996)</td>
<td>26</td>
</tr>
<tr>
<td>Figure 2.12</td>
<td>WFMS Products Integrated via use of a Shared Database (Source: Workflow Management Coalition, 1996)</td>
<td>26</td>
</tr>
<tr>
<td>Figure 2.13</td>
<td>Chained Model (Source: Workflow Management Coalition, 1996)</td>
<td>27</td>
</tr>
<tr>
<td>Figure 2.14</td>
<td>Nested Sub-process Model (Source: Workflow Management Coalition, 1996)</td>
<td>28</td>
</tr>
<tr>
<td>Figure 2.15</td>
<td>Parallel Synchronised Model (Source: Workflow Management Coalition, 1996)</td>
<td>29</td>
</tr>
<tr>
<td>Figure 2.16</td>
<td>Domino Workflow Architecture (Source: Lotus Corporation, 2000a)</td>
<td>35</td>
</tr>
<tr>
<td>Figure 2.17</td>
<td>Notification Property</td>
<td>39</td>
</tr>
<tr>
<td>Figure 2.18</td>
<td>List of Tasks for an Activity</td>
<td>40</td>
</tr>
<tr>
<td>Figure 2.19</td>
<td>Decision Specification</td>
<td>41</td>
</tr>
<tr>
<td>Figure 2.20</td>
<td>Assigning Conditions</td>
<td>41</td>
</tr>
<tr>
<td>Figure 2.21</td>
<td>Timing Settings</td>
<td>41</td>
</tr>
<tr>
<td>Figure 2.22</td>
<td>Automated Actions</td>
<td>42</td>
</tr>
<tr>
<td>Figure 2.23</td>
<td>No Errors in Process Syntax</td>
<td>43</td>
</tr>
<tr>
<td>Figure 2.24</td>
<td>Errors and Warnings in Process Syntax</td>
<td>43</td>
</tr>
<tr>
<td>Figure 2.25</td>
<td>Activating a Process</td>
<td>44</td>
</tr>
<tr>
<td>Figure 2.26</td>
<td>Microsoft Exchange 2000 Server Services</td>
<td>46</td>
</tr>
<tr>
<td>Figure 2.27</td>
<td>Workflow Designer for Microsoft Exchange 2000 Server</td>
<td>47</td>
</tr>
<tr>
<td>Figure 2.28</td>
<td>Microsoft Outlook 2000</td>
<td>49</td>
</tr>
<tr>
<td>Figure 2.29</td>
<td>State Expires Feature</td>
<td>50</td>
</tr>
<tr>
<td>Figure 2.30</td>
<td>Condition and Action Verification Features</td>
<td>51</td>
</tr>
<tr>
<td>Figure 2.31</td>
<td>Script Verification Feature</td>
<td>52</td>
</tr>
<tr>
<td>Figure 2.32</td>
<td>Action Types</td>
<td>53</td>
</tr>
<tr>
<td>Figure 2.33</td>
<td>Activating a Workflow Process in a Folder</td>
<td>53</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>System Development Research Process (Source: Adapted from</td>
<td>53</td>
</tr>
</tbody>
</table>
If not otherwise indicated, the author is the source of the figures.
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL</td>
<td>Access Control List</td>
</tr>
<tr>
<td>AD</td>
<td>Active Directory</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>BASIC</td>
<td>Beginner's All Purpose Symbolic Instruction Code</td>
</tr>
<tr>
<td>CDO</td>
<td>Collaboration Data Object</td>
</tr>
<tr>
<td>CEC</td>
<td>Digital's Applied Research Center</td>
</tr>
<tr>
<td>CORBA</td>
<td>Common Object Request Broker Agent</td>
</tr>
<tr>
<td>DLLs</td>
<td>Dynamic Link Libraries</td>
</tr>
<tr>
<td>DMA</td>
<td>Document Management Alliance</td>
</tr>
<tr>
<td>DOM</td>
<td>Document Object Model</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision Support System</td>
</tr>
<tr>
<td>E-Business</td>
<td>Electronic Business</td>
</tr>
<tr>
<td>E-Commerce</td>
<td>Electronic Commerce</td>
</tr>
<tr>
<td>EAI</td>
<td>Enterprise Application Integration</td>
</tr>
<tr>
<td>ENC</td>
<td>European Networking Center</td>
</tr>
<tr>
<td>FSO</td>
<td>File System Object</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>ID</td>
<td>Identification Data</td>
</tr>
<tr>
<td>IE</td>
<td>Information Engineering</td>
</tr>
<tr>
<td>IPSD</td>
<td>Interactive, Process-Oriented System Development</td>
</tr>
<tr>
<td>IPSI</td>
<td>Integrated Publication and Information Systems Institute</td>
</tr>
<tr>
<td>ISST</td>
<td>Institute for Software Engineering and Systems Engineering</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>Mentor</td>
<td>Middleware for Enterprise-Wide Workflow Management</td>
</tr>
<tr>
<td>MIS</td>
<td>Management Information System</td>
</tr>
<tr>
<td>MoU</td>
<td>Memorandum of Understanding</td>
</tr>
<tr>
<td>OpenGL</td>
<td>Open Graphic Library</td>
</tr>
<tr>
<td>PDF</td>
<td>Portable Data Format</td>
</tr>
<tr>
<td>R5</td>
<td>Release 5</td>
</tr>
<tr>
<td>RDBMS</td>
<td>Relational Database Management Systems</td>
</tr>
<tr>
<td>RTF</td>
<td>Rich Text File</td>
</tr>
<tr>
<td>SAX</td>
<td>Simple API XML</td>
</tr>
<tr>
<td>SD</td>
<td>System Development</td>
</tr>
<tr>
<td>SMTP</td>
<td>Simple Mail Transfer Protocol</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>TP</td>
<td>Transaction Processing</td>
</tr>
<tr>
<td>URLs</td>
<td>Unified Resource Locators</td>
</tr>
<tr>
<td>UUM</td>
<td>Universiti Utara Malaysia</td>
</tr>
<tr>
<td>VBScript</td>
<td>Microsoft Visual Basic Scripts Edition</td>
</tr>
<tr>
<td>WFMCO</td>
<td>Workflow Management Coalition</td>
</tr>
<tr>
<td>WFMS</td>
<td>Workflow Management System</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
</tbody>
</table>
CHAPTER 1 INTRODUCTION

1.1 Background

Recent years have seen the focus of a number of issues for workflow. These include support for ensuring correctness of execution of workflows (Kamath and Ramamritham, 1996), ability to work with heterogeneous systems and at the same time provides high availability (Kamath et al., 1996), and integrating simulation modeling and analysis capabilities in workflow (Miller et al., 1995). These studies have addressed some of the limitations of workflow management system (WFMS) described by Georgakopoulos et al. (1995) and Alonso and Schek (1996) such as lack of interoperability among workflow management systems, lack of support for correctness and reliability, and weak tool support for analysis, modeling, testing and debugging workflows.

Apart from the efforts by individual or groups of individuals, an organization, known as the Workflow Management Coalition (WFMC), was established to address some of the issues in workflow. As stated in Workflow Management Coalition (1998a), the WFMC was founded in August 1993. It is a non-profit, international organization of workflow vendors, users and analysts. Some of the objectives of this organization are to develop workflow standard terminology and to enable interoperability between different workflow systems.

The WFMC has released several standards such as Process Definition Tools Interface (Workflow Management Coalition, 1999a), Workflow Client Application Interface (Workflow Management Coalition, 1997 and 1998c), Invoked Application Interface (Workflow Management Coalition, 1998c), and Workflow Interoperability Interface (Workflow Management Coalition, 1996 and 2000c). As stated in
The contents of the thesis is for internal user only
REFERENCES


http://www.redbooks.ibm.com

http://www.computer.org/concurrency/pd1998/p2toc.htm


http://www-ccs.cs.umass.edu/~kamath/publications.html


148


2001 from the World Wide Web:
http://www.microsoft.com/exchange


Vol. 7, No. 3. 89-106.

Wide Web: http://www.cnilive.com

Automated One-to-Many e-Commerce Negotiation. Proceedings of the Twenty-

221, 223-224, 227-228, 230, 232.

Rubin, J. (1994). Handbook of usability testing: How to plan, design, and conduct

Coordination for Supply Chain Integration. Business Process Management

November, 2001 from the World Wide Web:
us/dnmag00/html/xml0500.asp

http://www.staffware.com

Sun Microsystems, Inc. (2001). Developing XML Solutions with Java Pages™


