# Contents

Abstract

Table of Contents

List of Tables

List of figures

1 Introduction
   1.1 Cancer ......................................................... 2
   1.2 Global Situation About Cancer ............................... 3
      1.2.1 Breast Cancer ........................................... 3
      1.2.2 Cervix Cancer ........................................... 3
   1.3 Role of Information & Communication Technology in Oncology 4
   1.4 Clinical Decision Support System ............................ 5
   1.5 Need of Clinical Decision Support System in Cancer Care . . 5
   1.6 Motivation for the Study ..................................... 6
   1.7 Research Objectives .......................................... 6
   1.8 Significance of the Research ................................. 8
   1.9 Keywords ..................................................... 9

2 Literature Survey .............................................. 10
2.1 Introduction ...................................................... 10
2.2 Decision Support System ........................................ 11
2.3 Clinical Decision Support System .............................. 11
  2.3.1 Introduction ................................................... 11
  2.3.2 Historical Timeline in Clinical Decision Support System 12
  2.3.3 Phase model in architecture of Clinical Decision Support
        System .......................................................... 15
  2.3.4 Clinical Decision Support System Architecture ............ 16
  2.3.5 Methodology for Clinical Decision Support System ....... 17
    2.3.5.1 Bayesian Network ........................................ 17
    2.3.5.2 Neural Network ......................................... 17
    2.3.5.3 Genetic Algorithm ...................................... 18
    2.3.5.4 Rule-based system ...................................... 18
    2.3.5.5 Logical Condition ...................................... 18
    2.3.5.6 Casual Probability Network ............................. 19
  2.4 Selection and Implementation Guidelines for Clinical Decision
        Support System ................................................ 19
  2.5 Impact of Clinical Decision Support System .................. 20
  2.6 Related Work and Findings .................................... 21
    2.6.1 Oncocin [78] ................................................ 21
    2.6.2 Oncosifter [79] ............................................ 22
    2.6.3 Computer Aided Medical Diagnosis Tool [80] .......... 22
    2.6.4 OWCH [81] .................................................. 23
    2.6.5 KON3 [82,83] .............................................. 23
    2.6.6 OncoTheraper [84] ......................................... 24
    2.6.7 Clinical Decision and Economic Analysis Model of Cancer
           Pain Management [85] .................................... 24
2.6.8 LISA [86] .................................................. 24
2.6.9 OncoDoc [87–89] .............................. 25
2.6.10 Knowledge Based Approach for Diagnosis of Breast Cancer [90] ........................................ 25
2.6.11 Retrospect [91] .............................................. 26
2.6.12 A knowledge-based approach to assign breast cancer treatments in oncology units [92] ................ 26
2.6.13 Breast Cancer Decision Support System for Rural People [93] ........................................ 27
2.6.14 Decision Support System for Breast Cancer Chemotherapy [94] ........................................ 27
2.6.15 Computer Aided Medical Diagnostic (CAMD) System [95] 28
2.6.16 Decision Support System for Breast Cancer patient [96] 28
2.6.17 Clinical Practice Guidelines Based Ontology Driven Clinical Decision Support System for Breast Cancer [97] . . 29
2.6.18 Staging of Cervical Cancer with Soft Computing [98] . 29
2.6.19 Uterine Cervical Computer Aided Diagnosis [99] . . . 29
2.6.20 Limitation Observed with the existing system . . . . 30
2.7 Conclusion ..................................................... 32

3 Problem Definition .............................................. 33
3.1 Problem Definition ............................................. 34
3.2 Scope of Research ........................................... 36

4 Methodology .................................................... 37
4.1 Overview ..................................................... 37
4.2 Research Design ........................................... 38
4.3 Methodology as per Objectives: ................................ 39
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.1</td>
<td>Methodology for Objective 1:</td>
<td>39</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Methodology for Objectives 2, 3, 4 &amp; 5</td>
<td>39</td>
</tr>
<tr>
<td>4.3.2.1</td>
<td>Study Design</td>
<td>40</td>
</tr>
<tr>
<td>4.3.2.2</td>
<td>Study Setting</td>
<td>40</td>
</tr>
<tr>
<td>4.3.2.3</td>
<td>Sample Size</td>
<td>40</td>
</tr>
<tr>
<td>4.3.2.4</td>
<td>Inclusion Criteria</td>
<td>40</td>
</tr>
<tr>
<td>4.3.2.5</td>
<td>Data Collection Tool</td>
<td>41</td>
</tr>
<tr>
<td>4.3.2.6</td>
<td>Methods of Data Collection</td>
<td>42</td>
</tr>
<tr>
<td>4.3.2.7</td>
<td>Statistical Analysis</td>
<td>43</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Methodology for Objective 6:</td>
<td>43</td>
</tr>
<tr>
<td>4.3.3.1</td>
<td>Patient database module</td>
<td>43</td>
</tr>
<tr>
<td>4.3.3.2</td>
<td>Search engine module</td>
<td>47</td>
</tr>
<tr>
<td>4.3.3.3</td>
<td>Knowledge Base Module</td>
<td>47</td>
</tr>
<tr>
<td>4.3.3.4</td>
<td>Case Base Module</td>
<td>50</td>
</tr>
<tr>
<td>4.3.3.5</td>
<td>Statistical Module</td>
<td>51</td>
</tr>
<tr>
<td>4.4</td>
<td>Security Issues built in OncoSys</td>
<td>52</td>
</tr>
<tr>
<td>4.5</td>
<td>Architecture</td>
<td>53</td>
</tr>
<tr>
<td>4.5.1</td>
<td>User Interface</td>
<td>53</td>
</tr>
<tr>
<td>4.5.2</td>
<td>Hardware Interface</td>
<td>53</td>
</tr>
<tr>
<td>4.5.3</td>
<td>Software Interface</td>
<td>54</td>
</tr>
<tr>
<td>4.5.4</td>
<td>Communication Interface</td>
<td>54</td>
</tr>
<tr>
<td>4.6</td>
<td>User Acceptance Test</td>
<td>54</td>
</tr>
<tr>
<td>4.7</td>
<td>Ethical Consideration</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Results of Survey of Oncologist</td>
<td>56</td>
</tr>
<tr>
<td>5.1</td>
<td>Introduction</td>
<td>56</td>
</tr>
<tr>
<td>5.2</td>
<td>Results and Discussion</td>
<td>57</td>
</tr>
<tr>
<td>5.2.1</td>
<td>Characteristics of the respondents</td>
<td>57</td>
</tr>
</tbody>
</table>
5.2.1.1 Gender Wise Distribution ........................................ 57
5.2.1.2 Age-wise Distribution ........................................... 57
5.2.1.3 Designation-Wise Distribution .................................... 58
5.2.1.4 Department-wise Distribution ..................................... 59
5.2.1.5 Years of Experience .............................................. 59

5.2.2 Knowledge of respondents about Information System ........ 61
5.2.2.1 Knowledge of Information System ................................ 61
5.2.2.2 Mean Score of the response ....................................... 62

5.2.3 Utilization Pattern of Existing Information System ........... 64
5.2.3.1 Usefulness of the system in medical documentation ........... 65
5.2.3.2 Usefulness of the system in decision making in patient care ............................................. 66
5.2.3.3 Usefulness of the system in patient care ..................... 68
5.2.3.4 Usefulness of the system in research & education ........... 70
5.2.3.5 Utilization with respect to reporting of patients health information ........................................... 71

5.2.4 Opinion on Clinical Decision Support System: ............... 73
5.2.4.1 Opinion on Clinical Decision Support System ................ 73
5.2.4.2 Opinion on Decision Support System .......................... 73
5.2.4.3 Opinion on CDSS by different sections of oncologists depending on their years of experience ....................... 76

5.2.5 Expectations from Clinical Decision Support System .......... 77
5.2.5.1 Expectation with regard to Clinical Decision Making ............ 77
5.2.5.2 Expectation with regard to Documentation & Statistics of Patient Information ........................ 80
5.2.5.3 Expectation with regard to Patient Care  
5.2.6 Overall opinion on Clinical Decision Support System  
5.2.7 Recommendation and Suggestions Provided by the Oncologists  
   5.2.7.1 The knowledge base should have the provision to have access to the following text materials:  
   5.2.7.2 The respondents also suggested that the knowledge base should have the linking to the PubMed and other research database for the access of recent knowledge related to Cancer.  
   5.2.7.3 When the respondents were asked to list the kind of patient information to be added to the patient module, they listed the followings:  
   5.2.7.4 The respondents also provided the following suggestion:  
5.3 Time motion study and workflow Pattern  
5.4 Conclusion  

6 Software Requirement Specification  
   6.1 Introduction  
   6.2 Product Features  
      6.2.1 General Description  
         6.2.1.1 Purpose  
         6.2.1.2 Scope  
         6.2.1.3 Abbreviation  
         6.2.1.4 Overview  
      6.2.2 Overall Description  
      6.2.2.1 Product Perspective
| 6.2.2.2 | Product Functions | 95 |
| 6.2.2.3 | User Characteristics | 99 |
| 6.2.2.4 | General Constraints | 99 |
| 6.2.2.5 | Assumptions and Dependencies | 99 |
| 6.2.3 | Specific Requirements | 100 |
| 6.2.3.1 | External Interface Requirements | 100 |
| 6.2.3.2 | Performance Requirements | 100 |
| 6.2.3.3 | Design Constraints | 101 |
| 6.2.3.4 | Attributes | 101 |
| 6.2.3.5 | Security Requirements | 101 |
| 6.2.3.6 | Other Requirements | 101 |
| 6.3 | Process Model | 101 |
| 6.4 | Development Approach | 103 |
| 6.5 | Duration | 104 |

## 7 System Design

7.1 System Design | 105
7.1.1 Modular Description | 106

7.2 Preliminary Design | 115
7.2.1 Entity Relationship Diagram | 115
7.2.2 System Architecture | 120

7.3 Detailed Design | 122
7.3.1 Schema Diagram | 122
7.3.2 Table Structure | 127
7.3.3 Data Flow Diagram | 132
7.3.3.1 Process Description | 136
7.3.4 Search Engine Classes | 139
7.3.5 Search Engine Methodology | 142
Contents

7.3.5.1 Robots Exclusion . . . . . . . . . . . . . . . . 142
7.3.5.2 Web Crawler . . . . . . . . . . . . . . . . . . 143
7.3.5.3 String Splitting . . . . . . . . . . . . . . . . . 145
7.3.5.4 Index . . . . . . . . . . . . . . . . . . . . . . 145
7.3.5.5 Ranking . . . . . . . . . . . . . . . . . . . . . 145
7.3.5.6 Search Method . . . . . . . . . . . . . . . . . 146
7.3.6 Functional Dependencies . . . . . . . . . . . . . . . . 147
7.3.7 Data Dictionary . . . . . . . . . . . . . . . . . . . . . . 148

8 System Development 154

8.1 System Development . . . . . . . . . . . . . . . . . . . . . . 154
8.1.1 Software Development and Construction . . . . . . . 155
8.1.2 Integration . . . . . . . . . . . . . . . . . . . . . . . . 156

9 Testing 157

9.1 Testing Methods . . . . . . . . . . . . . . . . . . . . . . . . 157
9.1.1 White Box Testing . . . . . . . . . . . . . . . . . . . . 157
9.1.1.1 Code Coverage . . . . . . . . . . . . . . . . . 157
9.1.1.2 Fault Injection . . . . . . . . . . . . . . . . . 158
9.1.2 Unit Testing . . . . . . . . . . . . . . . . . . . . . . . . 159
9.1.3 Integration Testing . . . . . . . . . . . . . . . . . . . . 159
9.1.4 System Testing . . . . . . . . . . . . . . . . . . . . . . 160
9.1.5 Functional Testing . . . . . . . . . . . . . . . . . . . . 160
9.1.6 Usability Testing: . . . . . . . . . . . . . . . . . . . . . 161
9.1.7 Interface Testing . . . . . . . . . . . . . . . . . . . . . 161
9.1.8 Compatibility Testing . . . . . . . . . . . . . . . . . . . 162
9.1.9 Security Testing: . . . . . . . . . . . . . . . . . . . . . 163
10 Implementational Details 164

10.1 SQL .......................... 164

10.1.1 Tables .......................... 164

10.1.2 Stored Procedures ................. 168

10.1.3 Triggers ......................... 170

11 User Acceptance Test 171

11.1 Introduction ....................... 171

11.2 Purpose .......................... 172

11.3 Phases of User acceptance Test ........ 172

11.4 User Acceptance Test for OncoSys: .......... 173

11.4.1 Installation of the OncoSys on Intranet ......... 173

11.4.2 Demonstration of OncoSys to the Oncologist .... 173

11.4.3 Collection of feedback to determine the acceptance level

of OncoSys .......................... 174

11.4.3.1 User Acceptance related to the User Interface 174

11.5 Conclusion ......................... 179

12 Conclusions and Future Work 180

12.1 Conclusion ......................... 180

12.2 Future Work ......................... 183

13 Contributions ....................... 185

14 Screenshots ......................... 187

References ......................... 198

Appendices ......................... 222