

Content

| | | |
|----------|--|-----------|
| 1 | Introduction | 3 |
| 1.1 | Usability evaluation in Web development | 3 |
| 1.2 | Usability evaluation methods | 4 |
| 1.3 | Problem statement..... | 6 |
| 1.4 | Research goals | 8 |
| 1.5 | Research environment | 9 |
| 1.6 | Research design..... | 10 |
| 1.6.1 | Systematic research methods | 10 |
| 1.6.2 | Laboratory experiments..... | 14 |
| 1.7 | Thesis outline | 17 |
| 2 | Literature review on Usability Evaluation Methods for the Web | 23 |
| 2.1 | Need for a systematic mapping study..... | 23 |
| 2.2 | Research method | 26 |
| 2.2.1 | Planning stage | 27 |
| 2.2.2 | Conducting stage | 35 |
| 2.3 | Results | 35 |
| 2.3.1 | Origin of the UEMs employed..... | 36 |
| 2.3.2 | Underlying usability definition of the UEMs | 37 |
| 2.3.3 | Types of UEMs employed | 39 |
| 2.3.4 | Type of evaluation performed by the UEMs | 41 |
| 2.3.5 | Phase(s) and Web artifacts in which the UEMs are applied | 42 |
| 2.3.6 | Feedback provided by the UEMs | 44 |
| 2.3.7 | Empirical validation of the UEMs..... | 45 |

| | | |
|----------|---|-----------|
| 2.3.8 | Mapping results | 46 |
| 2.3.9 | Interest of the topic | 48 |
| 2.4 | Discussion | 50 |
| 2.4.1 | Principal findings..... | 50 |
| 2.4.2 | Limitations of the systematic mapping study..... | 51 |
| 2.4.3 | Implications for research and practice..... | 52 |
| 2.5 | Conclusions..... | 56 |
| 2.6 | Extension: a systematic review on the effectiveness of Web usability evaluation methods | 56 |
| 2.6.1 | Research method..... | 57 |
| 2.6.2 | Results..... | 60 |
| 2.6.3 | Limitations of the systematic review..... | 64 |
| 2.6.4 | Conclusions..... | 64 |
| 3 | Standards for Usability Evaluation..... | 67 |
| 3.1 | Existing standards for usability evaluation | 67 |
| 3.1.1 | Process-oriented standards: ISO/IEC 9241 and 13407..... | 68 |
| 3.1.2 | Product-oriented standards: ISO/IEC 9126 and 14598 | 70 |
| 3.1.3 | ISO/IEC 25000 SQuaRE standard series..... | 73 |
| 3.2 | Web usability evaluation approaches based on standards..... | 78 |
| 3.3 | Conclusions..... | 82 |
| 4 | Usability Evaluation in Model-Driven Web Development..... | 85 |
| 4.1 | Model-driven Web development methods..... | 85 |
| 4.1.1 | Object-Oriented Hypermedia Design Method (OOHDM) | 88 |
| 4.1.2 | Web Site Design Method (WSDM)..... | 89 |
| 4.1.3 | Scenario-Based Object-Oriented Hypermedia Design Methodology (SOHDM)..... | 89 |
| 4.1.4 | Web Modeling Language (WebML) | 90 |
| 4.1.5 | UML based Web Engineering (UWE)..... | 91 |

| | | |
|----------|--|------------|
| 4.1.6 | W2000 | 91 |
| 4.1.7 | Object-Oriented Hypermedia Method (OO-H)..... | 92 |
| 4.1.8 | Object-Oriented Web Solutions (OOWS) | 93 |
| 4.1.9 | Navigational Development Techniques (NDT) | 93 |
| 4.2 | Usability evaluation approaches for Model-driven Web development processes | 94 |
| 4.3 | Conclusions | 96 |
| 5 | WUEP: A Web Usability Evaluation Process for Model-Driven Web Development | 101 |
| 5.1 | Integrating usability evaluations into Model-driven Web development processes | 102 |
| 5.2 | Web Usability Model..... | 104 |
| 5.2.1 | Web Usability Model from the Quality Product perspective... | 105 |
| 5.2.2 | Web Usability Model from the Quality in Use perspective | 113 |
| 5.2.3 | Generic Web measures..... | 116 |
| 5.3 | Definition of the Web Usability Evaluation Process | 119 |
| 5.3.1 | Introduction to SPEM2 for defining software processes..... | 119 |
| 5.3.2 | Web Usability Evaluation Process defined using SPEM 2.0 ... | 122 |
| 5.4 | Conclusions | 131 |
| 6 | Instantiation of the Web Usability Evaluation Process | 135 |
| 6.1 | Instantiation of WUEP in the OO-H method..... | 135 |
| 6.1.1 | Introduction to OO-H and its modeling primitives | 136 |
| 6.1.2 | Operationalization of measures for OO-H..... | 140 |
| 6.1.3 | Case study: Task Manager..... | 150 |
| 6.1.4 | Evaluating the usability of Web applications developed with OO-H..... | 166 |
| 6.2 | Instantiation of WUEP in the WebML method..... | 188 |
| 6.2.1 | Introduction to WebML and its modeling primitives..... | 188 |

| | | |
|-------|--|-----|
| 6.2.2 | Operationalization of measures for WebML..... | 191 |
| 6.2.3 | Case study: ACME store..... | 194 |
| 6.2.4 | Evaluating the usability of Web applications developed with WebML..... | 196 |
| 6.3 | Lessons learned from cases studies | 203 |
| 6.4 | Conclusions..... | 204 |

7 Empirical validation of the Web Usability Evaluation Process... 209

| | | |
|-------|---|-----|
| 7.1 | Empirical validations of usability inspection methods | 210 |
| 7.1.1 | Empirical Studies for Traditional Web Development..... | 210 |
| 7.1.2 | Empirical Studies for Model-driven Web Development | 213 |
| 7.1.3 | Discussion | 214 |
| 7.2 | Methods involved in our empirical validation..... | 215 |
| 7.3 | Assessing the actual and perceived performance of WUEP in practice: a family of experiments with OO-H | 218 |
| 7.3.1 | The family of experiments..... | 218 |
| 7.3.2 | Design of individual experiments | 229 |
| 7.3.3 | Results..... | 233 |
| 7.3.4 | Family data analysis..... | 239 |
| 7.4 | Assessing the usefulness of WUEP: a controlled experiment with WebML..... | 244 |
| 7.4.1 | Experiment Planning..... | 244 |
| 7.4.2 | Experiment Operation | 249 |
| 7.4.3 | Result Analysis..... | 251 |
| 7.5 | Threats to validity..... | 256 |
| 7.5.1 | Internal Validity..... | 256 |
| 7.5.2 | External validity..... | 257 |
| 7.5.3 | Construct validity | 259 |
| 7.5.4 | Conclusion validity..... | 260 |
| 7.6 | Conclusions..... | 260 |

| | | |
|----------|---|------------|
| 8 | Conclusions | 265 |
| 8.1 | Conclusions | 265 |
| 8.1.1 | Goal 1: Analysis of Web usability evaluation methods..... | 266 |
| 8.1.2 | Goal 2: Study of standards for software product quality evaluation..... | 268 |
| 8.1.3 | Goal 3: Analysis of usability evaluation approaches based on model-driven Web development..... | 269 |
| 8.1.4 | Goal 4: Definition of a Web Usability Model..... | 270 |
| 8.1.5 | Goal 5: Definition of a generic Web Usability Evaluation Process | 271 |
| 8.1.6 | Goal 6: Instantiation of the Web Usability Evaluation Process | 272 |
| 8.1.7 | Goal 7: Empirical validation of the Web Usability Evaluation Process | 273 |
| 8.2 | Related publications | 274 |
| 8.2.1 | Refereed International Indexed Journals (JCR):..... | 274 |
| 8.2.2 | Book Chapters | 274 |
| 8.2.3 | Refereed International Conferences | 275 |
| 8.2.4 | Refereed International Workshops..... | 276 |
| 8.2.5 | Refereed National Conferences | 276 |
| 8.2.6 | Refereed Ibero-american Conferences..... | 276 |
| 8.2.7 | Ongoing papers | 276 |
| 8.2.8 | Summary and quality of the publications:..... | 277 |
| 8.3 | Research stays..... | 277 |
| 8.4 | Grants awarded..... | 277 |
| 8.5 | Future research directions | 278 |
| | Figure Index..... | 279 |
| | Table Index | 281 |
| | Acronym List | 283 |

| | |
|--|------------|
| Appendix A. Systematic research methods sources | 287 |
| Appendix B. Web Usability Model | 311 |
| Appendix C. Experiment Material..... | 324 |
| Bibliography..... | 335 |