

The Quality of an Ontology:

The development and demonstration of an instrument for ontology quality assessment.

ROSETTA ROMANO

A thesis submitted in fulfilment of the requirements for award of the degree

Master of Information Sciences (Research)
University of Canberra
Canberra, Australia

February 2012



Abstract - In the Information Sciences *ontology* specifies the conceptual structure of a real-world domain through its vocabulary and its meaning, or semantics. The conceptual structure comprises definitions of concepts and the rules for the relationships between those concepts. Examples of traditional ontologies include database schemas, taxonomies and library classification schemes. Modern ontologies are designed for the computer and, as well as specifying a common understanding of a domain for its different human users, allow automated information processes such as interpretation, aggregation and manipulation. As an ontology is fundamental to systems in an organisation its quality is critical for the sound operation of those systems.

The problem is that there seems no systematic basis or method for identifying the criteria for undertaking an assessment of ontology quality. An abundance of literature proposes ideas about what constitutes a 'good' ontology, but it is diverse, scattered and incoherent. This means that, in practice, it is difficult to conduct a holistic quality evaluation.

The aim of this research is to review the literature and produce and demonstrate an instrument for assessing the quality of an ontology. The production of the instrument places this research in the design-science paradigm, that is, it contributes a new and innovative artefact for practitioner use in addition to scholarly contribution.

The Ontology Quality Assessment Instrument was demonstrated using two case studies. The first study concerned assessing whether the Australian Government's Standard Business Reporting (SBR) ontology has the quality required to replace the Standard Chart of Accounts used by the Queensland University of Technology when reporting its grants funding to government. The instrument demonstrated some of the difficulties associated with assessing quality, particularly the difficulty of grounding the criteria in the actuality of the case because the criteria evolved from the literature and this required further explanation or a glossary. It also demonstrated the difficulty interpreting the results of an assessment as criteria are met or not met. Operationalizing the criteria became necessary and this was useful in making sense of the findings in the case studies. The second case study applied the instrument to a proposed taxonomy for defining the term 'information' in the Information Systems literature. The use of the instrument identified risk areas in the taxonomy. In future, the research and practitioner communities could refine the criteria and add to the examples within the instrument for use by ontology.

The contribution of this research is in the assembly and organisation of quality attributes into a qualitative assessment instrument that provides the criteria for assessing '*The Quality of an Ontology*'.

Acknowledgments

I would like to thank my supervisory panel Professors Craig McDonald and John Campbell for their encouragement.

I would also like to thank the Canberra University for providing the scholarship for me to undertake this work.

Within a week of being offered the placement my mother suffered a severe stroke. I was rethinking the commitment and was encouraged by mum to accept it. I dedicate this work to the memory of Veneranda Romano.

I often doubted that I could complete this work but have been supported along the way by people who I love, who I work with and for.

To my husband Dominic Schimizzi and our children Vanessa and Christopher who always encouraged me to finish what I had begun. My father Bruno who always said I could do and be whatever I wanted to be.

To my friends who provided me with encouragement throughout the long process: Joyce Rajasekaram, Bronwyn Shepherd, Grazia Garrard, Lorraine Bird and Nadia Frankham. To Mike Zissler, Michael Vanderheide, John Robertson and David Bird who gave hope to the early attempts of the work. My managers David Wardle, Paul Madden and Greg Divall who approved my study leave and later long-service leave to care for my mother and to write the thesis. To Warwick Foster who provided the information for the SBR case study, to Jennifer Bradley for editing the work and to Violeta Row and Jane Andrews for approving time for me to complete the thesis.

Importantly, I was privileged to be guided through the process by a supervisor who was able to challenge my thinking and plant new ideas for exploration. A personal trainer of sorts, with an uncanny knack for suggesting improvements without criticizing – how is that even done? When I thought it would never end, giving me a date for completion was just the thing that would build confidence. Thanks Craig - excellent job!

Contents

Chapter 1 Introduction	1
1.1 Motivation for the Project	1
1.2 Thesis Introduction	3
1.3 Aim	4
1.4 Thesis Approach	5
1.5 Thesis Outline.....	7
Chapter 2 Research Methodology	9
2.1 Research Project Development.....	9
2.2 Design-science research guidelines	10
2.3 Other research methodology.....	14
Chapter 3 Literature Review	17
3.1 The origins of the term Ontology.....	17
3.2 International Standards addressing the Quality of Ontology	17
3.3 Ontology Development Life Cycle.....	18
3.4 The Stakeholders identified at each Ontology Development Life Cycle Stage	22
3.5 Processes identified at each Ontology Development Life Cycle Stage	27
3.6 Quality Interests of Stakeholders – At Life Cycle Stages.....	41
3.7 Data Quality	43
3.8 Ontology Quality in the Literature	45
3.9 Deriving a new ontology quality framework	46
Chapter 4 The Ontology Quality Assessment Instrument	53
4.1 Summary of Ontology Quality Criteria.....	55
4.2 Detailed Summary of Ontology Quality Criteria with Definitions.....	56
4.3 The Ontology Quality Assessment Instrument	58
4.4 The 8-step Ontology Quality Evaluation Method	59
4.5 Instrument development lessons	65
Chapter 5 Case Study 1	67
5.1 The Standard Business Reporting Taxonomy	67
5.2 The QUT Standard Chart of Accounts	69
5.3 Application of the Ontology Quality Instrument	70

5.4 Application of the SBR case study.....	70
5.5 A Test of the Criterion - Completeness.....	71
5.6 A test of the Sub-criterion – Fair representation – Alignability.....	74
5.7 A test of the Sub-criterion – Understandability – Annotations.....	78
5.8 A test of the Sub-criterion – Completeness – Concepts.....	81
5.9 Findings based on the sample.....	84
5.10 Is it useful?.....	84
5.11 Case study 1 SBR Adoption by QUT conclusion.....	85
Chapter 6 Case Study 2.....	87
6.1 The Term ‘Information’ in Information System Articles.....	89
6.2 Case study 2 Findings.....	97
6.3 Case study 2 Review a Proposed Taxonomy Conclusion.....	99
Chapter 7 Conclusion.....	101
7.1 Summary.....	101
7.2 Thesis findings.....	104
7.3 Research contributions.....	104
7.4 Limitations of the research.....	105
7.5 Future work.....	106
7.5.1 Developing the ontology quality criteria.....	106
7.5.2 Further development of the 8-step evaluation process recorded in the template.....	106
7.5.3 Development of a vocabulary to support Ontology Quality Assessment instrument.....	107
7.5.4 Development of a vocabulary to support Ontology Quality Assessment instrument.....	107
7.5.5 Development of Process Quality Criteria.....	107
7.5.6 Testing the Construct of the Ontology Quality Assessment Instrument.....	107
7.6 Thesis Conclusion.....	108
7.7 Final Summary.....	108
Appendix 1 – The mapping of the criteria to The Ontology Quality Assessment Instrument.....	109
Appendix 2 Glossary of Terms.....	147
Appendix 3 Ontology Design Attributes in Literature.....	159
Appendix 4 The Ontology Quality Assessment Instrument.....	171
REFERENCES AND BIBLIOGRAPHY.....	191

List of figures

Figure 1 Key Development Stages of the Research Project	9
Figure 2 Ontology life cycle in METHONTOLOGY	19
Figure 3 Ontology Life Cycle.....	19
Figure 4 Stakeholders of Ontology Life Cycle Stages	22
Figure 5 Ontology use by stakeholders across Development Life Cycle stages.....	24
Figure 6 Processes, Sub-processes, Products and Stakeholders in Ontology Life Cycle Stage order ...	26
Figure 7 Core metadata vocabulary (Hartmann, Bontas, Palma, & Gomez-Perez, 2001)	38
Figure 8 Data quality dimensions proposed by academic researchers (Cappiello, 2005)	44
Figure 9 Snapshot of Ontology Design Attributes in Literature.....	45
Figure 10 Classification of Information Quality Metadata Criteria (Pipino, Lee & Wang, 2002).....	48
Figure 11 8 Key Quality Criteria at Ontology Life Cycle Stages.....	52
Figure 12 Example of Excerpt to Criteria development	53
Figure 13 Criteria and Sub-Criteria Count.....	55
Figure 14 Ontology Criteria with Definitions	57
Figure 15 Snapshot of Ontology Quality Assessment Instrument	58
Figure 16 8 Step Template for Assessing Ontology Quality	63
Figure 17 High Level Overview of the SBR Development Process	68
Figure 18 Context of SBR Taxonomy Development Activity	69
Figure 19 Taxonomy Views and Characteristics (McKinney & Yoos, 2010)	88
Figure 20 Case Study 2 Answer Summary.....	97

Acronyms

AGIMO	The Australian Government Information Management Office of the Department of Finance Deregulation
COAG	Council of Australian Governments (COAG)
IQ	Information Quality
IS	Information Systems
OKBC	Open Knowledge Base Connectivity Protocol
QUT	Queensland University of Technology
SBR	Standard Business Reporting of the Department of Treasury
SCOA	Standard Chart of Accounts