View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Massey Research Online

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

A Requirements Engineering Framework For Developing COTS GIS Applications

A thesis presented in partial fulfilment of the requirements for the degree of

Master Of Information Science

In

Information Systems

At Massey University, Palmerston North,
New Zealand

Adrienne Kim Bonnington

2002

ABSTRACT

There has been an increase in recent years in the number of Geographic Information System (GIS) applications being developed for stakeholders using Commercial Off-The-Shelf (COTS) software. There are a lack of guidelines in both industry and the literature on how to acquire user requirements for the development of GIS applications in this COTS software environment.

This study investigates process activities in order to build a framework to address these inadequacies. The construction of the framework incorporates requirements engineering and COTS software evaluation and selection process activities from the Information Systems (IS) area. The framework is used to explore three issues related to developing GIS applications and used to determine whether: 1) a life cycle model is used to guide the gathering and analysing of requirements when developing GIS applications, 2) standard IS requirements processes can be used for developing GIS solutions, and 3) standard IS COTS software acquisition processes can be used for developing GIS solutions. Case studies were used to analyse current practices in the GIS industry and to validate the usefulness of these activities in the framework.

The results of this investigation suggest that RE practices associated with the COTS paradigm within the IS arena are suitable for developing GIS applications based on user requirements.

ACKNOWLEDGEMENTS

A special thanks to the four participants from the two organisations used for the multiple-case study. I know time is scarce and is an expensive commodity, so I truly appreciate the effort you all gave in contributing towards this research.

Thank you to my supervisor, Mrs Elisabeth Todd for her patience and the several cups of coffee to make light work of research meetings. I would also like to thank Mr Arthur Todd and Mr Larry Haist for helping me 'fill in the gaps', and to keep my research rigorous. Their advice has been invaluable.

I would like to thank ESRI for giving me the opportunity to work in their professional services section as an intern and gaining wonderful friendships through this experience. I would also like to express my gratitude to Massey University for the financial support of getting me to the USA to carry out the internship.

Most of all I wish to thank my parents who have always been incredibly supportive of my postgraduate studies, particularly my mother for having the patience of proof reading this thesis for me. Also, to my husband, who has been extremely positive and encouraging, and has always been there through my moments of confusion.

PUBLICATIONS

The following refereed paper was based on part of the work in this thesis.

Bonnington, A.K., & Todd, E.G. (2001). Which GIS Product Should I Use? Proceedings from the 29th Annual Conference of AURISA, Melbourne, Australia.

TABLE OF CONTENTS

CHAPTER I INTRODUCTION 1

Overview 1
The Research Problem 2
Research Methodology 3

CHAPTER II LITERATURE REVIEW 7

Introduction 7
Part I: Development Life Cycles 7
Part II: Requirements Engineering 21
Part III: COTS Software Procurement Process 30
Part IV: Geographic Information Systems 40
Summary 47

CHAPTER III BUILD A FRAMEWORK 51

Introduction 51
Synthesis 51
Summary 59

CHAPTER IV EVALUATE THE FRAMEWORK 61

Introduction 61
GIS Development Processes 62
GIS Process Synthesis 68
Framework Evaluation 70
Summary 72

CHAPTER V CASE STUDY RESEARCH DESIGN 73

Introduction 73
Case Study Research 74
Case Study Design 76
Summary 96

CHAPTER VI PROVE THE FRAMEWORK 99

Introduction 99
Part I: Data Analysis 99
Part II: Research Outcome 115
Summary 118

CHAPTER VII CONCLUSIONS 121

The Research Problem 121

The Research Approach....124
Shortcomings....126
Future Work....126

REFERENCES....129

GLOSSARY....137

APPENDIX A RESEARCH INFORMATION SHEET....141

Introduction....141
The Research....141
Consent Form....144

APPENDIX B RESEARCH PROTOCOL....145

Purpose....145
Key Features of the Case Study Method....145
Organisation of This Protocol....146
Procedures....146
Determination of Persons to Be Interviewed....146
Case Study Protocol and Questions....147
Analysis Plan and Case Study Reports....149

APPENDIX C PILOT STUDY QUESTIONS....151

General Questions....151
Detailed Questions....151
Alternative Questions....153
Further Comments....153
Glossary....153

APPENDIX D CASE STUDY QUESTIONS....155

General Questions....155
Development Questions....157
Geographic Information System (GIS) Questions....158
Commercial Off-The-Shelf (COTS) Questions....158
Information Systems (IS) Questions....159
Further Comments....161
Glossary....161

LIST OF FIGURES

Figure 1: Method-Driven Research (Morrison *et al.*, 1997, p. 14) 4

Figure 2: Overview of Research Approach (adapted from Morrison *et al.*, 1997) ..5

Figure 3: Waterfall Model of Software Development (Leffingwell & Widrig, 2000) 9

Figure 4: Spiral Life Cycle Model (adapted from Boehm, 1988, in McConnell, 1996) 12

Figure 5: The Rational Unified Process Iterative Model (Kruchten, 2000b) 14

Figure 6: The Requirements Engineering Process (Sommerville, 1996, p67) 24

Figure 7: First Stage of the Method-Driven Research Process (adapted from Morrison et al., 1997) 51

Figure 8: Second Stage of The Method-Driven Research Process (adapted from Morrison et al., 1997) 61

Figure 9: The ArcInfo Software Life Cycle (Aronson, 1985) 63

Figure 10: Third Stage of the Method-Driven Research Process (adapted from Morrison et al., 1997) 73

Figure 11: Constant Comparative Method of Data Analysis (adapted from Maykut & Morehouse, 1994) 93

Figure 12: Sample Population of this Study 103

Figure 13: GIS Application Development Life Cycle Model from Data Triangulation 105

Figure 14: IS Requirements and Software Procurement Processes and their Relationships with GIS 110

LIST OF TABLES

Table 1: The Iterative Approach with a Synthesis of Process Tasks (Kruchten, 2000a; Kruchten, 2000b; Leffingwell & Widrig, 2000) 16

Table 2: IEEE Std 1074-1997 Life Cycle Activities 20

Table 3: Software Acquisition Phase Milestones (IEEE, 1998) 33

Table 4: COTS Software Acquisition Phases (adapted from ISO/IEC, 1995) 34

Table 5: Synthesis of Processes for COTS Software Procurement Approaches 35

Table 6: Synthesis of Processes Activities for COTS Software Evaluation Instruments 39

Table 7: GIS Functionality 43

Table 8: Descriptions of the GIS High-Level Standards (Crosswell, 1998) 45

Table 9: Initial Requirements & Software Procurement Process Activity Framework 55

Table 10: Updated Requirements & Software Procurement Process Activity Framework 58

Table 11: The GIS Acquisition Model (adapted from Clarke, 1991) 65

Table 12: Synthesis of Process Activities Based on GIS Literature 68

Table 13: Research Validity & Reliability (Yin, 1994) 75

Table 14: Case Study Research Process (Eisenhardt, 1989) 78

Table 15: Six Sources of Evidence Including Strengths and Weaknesses (adapted from Yin, 1994) 85

Table 16: Summary of Case Study Research Processes for Testing Theory (adapted from Eisenhardt, 1989) 97

Table 17: Summary of Replication Across Multiple-Case Study Sites. 116

Table 18: Research Protocol Question Base 149