Work as Leisure, an investigation into the Open Source Community

by

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Submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Deakin University

August 2013



I am the author of the thesis entitled

Work as leisure, an investigation into the Open Source Community

submitted for the degree of Doctor of Philosophy

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Acknowledgements

There are a number of people I would like to thank for their support during this very long journey.

Firstly, I wish to thank my supervisors, Associate Professor Ken Reed and Dr Betsy Blunsdon. Associate Professor Reed your depth of knowledge is inspiring. Thank you for all of your patience and guidance in developing this thesis.

Dr Blunsdon, without you there would be no thesis. Your ability to help me understand the puzzle and your guidance and commitment to my academic development has meant the world to me, thank you.

Professor Andrew Noblet, Thank you for helping me get to the finish line.

My mother Hilary, thank you for all of the drafts that you have read over the years, your help has been invaluable. I promise never to do another thesis; you can officially retire from chief editing duties!

My amazing husband, Matthew. Thank you for always believing that it could get done, even when I thought otherwise. I am forever in your debt for your unwavering love and support. Lastly to my beautiful boys. My gorgeous Harry for being such a wonderful, caring and loving little boy. And to Dex for.... Well not for being the best behaved, but for all the love and laughter you provide!

Thank you

TABLE OF CONTENTS

TABLE OF CONTENTS	1
INDEX OF TABLES	4
INDEX OF FIGURES	7
ABSTRACT	8
INTRODUCTION	10
AIMS OF THE CURRENT WORK.	11
CHAPTER 1	17
A REVIEW OF THE LITERATURE ON THE OPEN SOURCE COMMUNITY	17
INTRODUCTION. WHAT EXACTLY IS OPEN SOURCE? THE ECONOMIC VALUE OF OPEN SOURCE. HOW OPEN SOURCE SOFTWARE LICENSING WORKS. OPEN SOURCE AND FREE SOFTWARE. OPEN SOURCE AND FREE SOFTWARE. HOW LINUX AND APACHE ORIGINATED. HOW THE OPEN SOURCE COMMUNITY OPERATES. THE BELIEFS BEHIND THE OPEN SOURCE COMMUNITY. THE OPEN SOURCE DEBATE. WHAT IS A COMMUNITY? CURRENT DEFINITIONS OF COMMUNITY. IS OPEN SOURCE A COMMUNITY. IS OPEN SOURCE A COMMUNITY? VIRTUAL COMMUNITY RECAPITULATION. WHY DO PEOPLE PARTICIPATE IN THE OPEN SOURCE COMMUNITY? CONCLUSION.	$ \begin{array}{r} 17 \\ 18 \\ 26 \\ 28 \\ 29 \\ 30 \\ 32 \\ 35 \\ 41 \\ 42 \\ 45 \\ 46 \\ 49 \\ 51 \\ 55 \\ 55 \\ 55 \\ \end{array} $
CHAPTER 2	57
A CONCEPTUAL ANALYSIS OF THE VOLUNTEERING LITERATURE	57
 INTRODUCTION. WHAT IS A VOLUNTEER? OVERVIEW OF VOLUNTEERING IN AUSTRALIA. OPEN SOURCE PARTICIPANTS: ARE THEY VOLUNTEERS? THE MOTIVES TO VOLUNTEER. THE IMPACT OF LIFE STAGE ON MOTIVES FOR VOLUNTEERING. WHAT MOTIVATES PEOPLE TO PARTICIPATE IN OS, WHAT THE LITERATURE TELLS US ABOUT THE MOTIVATIONS? ALTRUISM. SELF-DEVELOPMENT. GAINING A REPUTATION. ALTERNATIVE THEORIES ON MOTIVATIONS TO PARTICIPATE IN THE OS COMMUNITY. BACK TO BASICS, WHAT IS MOTIVATION? DIRECTION, INTENSITY AND PERSISTENCE AND THE OPEN SOURCE COMMUNITY. 	57 57 58 59 61 63 67 70 71 71 71 72 78 80 82
CHAPTER 3	83
A CONCEPTUAL ANALYSIS OF WORK AND LEISURE	83
INTRODUCTION. Preference Theory.	83 84

	1.61
NETWORK ANALYSIS IS EXPLAINED. ANALYSIS OF THE DATA.	155 157 158
CRUSS FABULATION. THE STRUCTURE OF THE OS COMMUNITY	134
REGRESSION ANALYSIS.	154
ONE-WAY ANOVA.	153
FACTOR ANALYSIS.	151
DATA ANALYSIS.	151
SURVEY DESIGN AND RATIONALE FOR WEB BASED SURVEY.	136
THE ONLINE SURVEY.	136
INTRODUCTION.	135
AN EXAMINATION OF THE STRUCTURE OF THE OPEN SOURCE COMMUNITY THROUGH NETWORK ANALYSIS: THE RESEARCH DESIGN	135
CHAPTER 5	135
CONCLUSION.	134
THE INTEGRATION OF THEORIES TO EXPLAIN OPEN SOURCE PARTICIPATION AND COMMITMENT	. 132
NORMS OF RECIPROCITY.	129
BECKERS SIDE BETS THEORY.	127
AN INTRODUCTION TO BECKER'S SIDES BETS THEORY AND THE NORMS OF RECIPROCITY.	127
THE NEED FOR FIRST. THE NEED FOR SELF ENHANCEMENT.	126
THE NEED FOR TRUST	125
THE NEED FOR BELONGING. THE NEED FOR CONTROLLING	124
THE NEED FOR UNDERSTANDING. The need for relanding	123
The need for inderstanding	122
AN INTRODUCTION TO CORE MOTIVES THEORY AND ITS APPLICATION TO OPEN SOURCE PARTIC	CIPATION.
RATIONAL CHOICE THEORY AND THE OS COMMUNITY.	118
RATIONAL CHOICE THEORY.	114
INTRODUCTION.	113
THE INTERCONNECTING THEORIES THAT EXPLAIN OPEN SOURCE PARTICIPA	ATION 113
CHAPTER 4	113
	109
THE EFFECT OF PARENTHOOD ON AVAILABLE TIME. Free Time	107
WHAT ELSE DO WE DO WITH OUR TIME - UNPAID HOUSEWORK?	104
INTERNATIONAL PERSPECTIVE ON WORK TIME.	102
TIME USE SUMMARY.	101
LONGER HOURS FOR FULL-TIME WORKERS.	100
PART-TIME WORK.	99
THE STANDARD WORKING WEEK (35-40 HOURS).	98
AVERAGE WORKING HOURS.	97
WORK TIME REGIMES	97
THE CHANGE IN THE AVERAGE WORKING WEEK: (LONG HOURS, DART TIME, CASUAL)	93
THE CHANGING NATURE OF WORK.	94
OVERVIEW OF TIME USE AND THE TIME USE CATEGORIES.	90
PREFERENCE THEORY AND OPEN SOURCE.	87
THE FOUR TENETS OF FREFERENCE THEORY (HAKIM 2000).	86

INTRODUCTION.	162
RATIONAL CHOICE - DIRECTION AND INTENSITY.	162
DESCRIPTIVE STATISTICS OF THE OPEN SOURCE SAMPLE.	163
TESTING OF SPECIFIC RESEARCH QUESTIONS: RATIONAL CHOICE – DIRECTION, INTENSITY A	ND
PERSISTENCE IN THE OS COMMUNITY.	192
RATIONAL CHOICE -CORE MOTIVES.	211
PERSISTENCE – NORMS OF RECIPROCITY AND SIDE BETS THEORY.	219
CONCLUSION.	237
NETWORK ANALYSIS RESULTS.	239
ANALYSIS OF NETWORKS – K-CORE.	248
DENSITY.	250
Reciprocity.	250
RECIPROCITY IN THE CURRENT SAMPLE.	251
CONCLUSION.	252
CHAPTER 7	253
THE INTENSITY, DIRECTION AND PERSISTENCE OF PARTICIPATION IN THE	E OS
COMMUNITY	253
INTRODUCTION.	253
THE THEORETICAL FRAMEWORK.	254
THE DIRECTION OF PARTICIPANTS MOTIVES, RATIONAL CHOICE THEORY AND CORE MOTIV	'ES THEORY.
	256
TIME USE AND PARTICIPATION IN OPEN SOURCE.	259
INTENSITY (HOW MUCH TIME AND EFFORT DO THEY PUT IN ONCE THEY JOIN (PREFERENCE T	HEORY/TIME
USE).	261
PERSISTENCE (WHY DO THEY STAY INVOLVED) SIDE BETS, NORMS OF RECIPROCITY AND CO	ORE MOTIVES.
	265
THE STRUCTURE OF THE COMMUNITY.	269
IMPORTANT FINDINGS.	270
CONCLUSION.	271
REFERENCES	276
APPENDIX 1	299
DEAKIN UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE	299
PLAIN LANGUAGE STATEMENT	299
APPENDIX 2	300

INDEX OF TABLES

Table 2: Online forum - Dialogue of a new member wanting to become involved in OS 37 Table 3: Typology of Virtual Communities. 53 Table 4: Modified version of the (VFI) explaining the various functions served by 55 Volunteering (Clary and Snyder, 1999) 65 Table 5: Motivations and Prominent Researchers. 69 Table 6: Direction, Motivation and Persistence. 80 Table 7: Benefits and Costs Table. 120 Table 8: Theory and general categories. 139 Table 9: Web design problems and solutions. 142 Table 10: Open Source Survey Questions in Categories. 147 Table 11: Open Source Survey Questions in Categories. 147 Table 12: Gender, Age and Marital status of OS participants. 166 Table 15: Level of education obtained. 168 Table 16: Current Profession 170 Table 18: Currency conversion 171 Table 19: Income from OS participation 172 Table 21: Is working on Open Source projects part of your paid employment? 173 Table 22: The time you spend in a paid job. 174 Table 23: Time spent with friends. 175 Table 24: Time spent with gour family. 175 Tab	Table 1: Open Source Roles.	24
projects. 37 Table 3: Typology of Virtual Communities. 53 Table 4: Modified version of the (VFI) explaining the various functions served by 53 Volunteering (Clary and Snyder, 1999). 65 Table 5: Motivations and Prominent Researchers. 69 Table 6: Direction, Motivation and Persistence. 80 Table 7: Benefits and Costs Table. 120 Table 8: Theory and general categories. 139 Table 10: Advantages and disadvantages of online surveys. 143 Table 11: Open Source Survey Questions in Categories. 147 Table 12: Gender, Age and Marital status of OS participants. 164 Table 13: In which country were you born? 165 Table 14: In which country were you born? 167 Table 15: Level of education obtained. 168 Table 16: Current Profession 171 Table 18: Currency conversion. 172 Table 20: Currency conversion. 172 Table 21: Is working on Open Source projects part of your paid employment? 173 Table 22: The time you spend in a paid job. 174 Table 23: Time spent with friends. 175 Table 24: Time spent on leisure 176	Table 2: Online forum - Dialogue of a new member wanting to become involved in (OS
Table 3: Typology of Virtual Communities. 53 Table 4: Modified version of the (VFI) explaining the various functions served by 65 Table 5: Motivations and Prominent Researchers. 69 Table 6: Direction, Motivation and Persistence. 80 Table 7: Benefits and Costs Table. 120 Table 8: Theory and general categories. 139 Table 10: Advantages and disadvantages of online surveys. 143 Table 11: Open Source Survey Questions in Categories. 147 Table 12: Gender, Age and Marital status of OS participants. 164 Table 13: In which country were you currently live? 165 Table 14: In which country were you born? 167 Table 15: Level of education obtained. 168 Table 16: Current Profession 170 Table 18: Currency conversion 171 Table 19: Income from OS participation 172 Table 20: Currency conversion 172 Table 22: The time you spend in a paid job. 174 Table 23: Time spent with friends. 175 Table 24: Time spent with gon Open Source projects. 176 Table 25: The time you spend in a paid job. 174 Table 26: Time spent with friends. 175 </td <td>projects.</td> <td> 37</td>	projects.	37
Table 4: Modified version of the (VFI) explaining the various functions served by 65 Table 5: Motivations and Prominent Researchers. 69 Table 6: Direction, Motivation and Persistence 80 Table 7: Benefits and Costs Table. 120 Table 8: Theory and general categories. 139 Table 9: Web design problems and solutions. 142 Table 10: Advantages and disadvantages of online surveys. 143 Table 11: Open Source Survey Questions in Categories. 147 Table 12: Gender, Age and Marital status of OS participants. 164 Table 13: In which country were you born? 165 Table 16: Current Profession 169 Table 16: Current Profession 169 Table 19: Income from OS participation. 172 Table 20: Currency conversion. 172 Table 21: The time you spend in a paid job. 174 Table 22: The time you spend in a paid job. 174 Table 23: Time spent with friends. 175 Table 24: Time spent with friends. 175 Table 25: The time you spend in a paid job. 174 Table 27: Time spent with friends. 175 Table 28: Time spent on leisure. 176	Table 3: Typology of Virtual Communities	53
volunteering (Clary and Snyder, 1999). 65 Table 5: Motivations and Prominent Researchers. 69 Table 6: Direction, Motivation and Persistence. 80 Table 7: Benefits and Costs Table. 120 Table 8: Theory and general categories. 139 Table 9: Web design problems and solutions. 142 Table 10: Advantages and disadvantages of online surveys. 143 Table 11: Open Source Survey Questions in Categories. 147 Table 12: Gender, Age and Marital status of OS participants. 164 Table 13: In which country do you currently live? 165 Table 14: In which country were you born? 167 Table 15: Level of education obtained. 168 Table 16: Current Profession 169 Table 17: Average hours of work and annual income 170 Table 18: Currency conversion. 171 Table 20: Currency conversion. 172 Table 21: Is working on Open Source projects part of your paid employment? 173 Table 22: The time you spend in a paid job. 174 Table 23: Time spent with friends. 175 Table 24: Time spent with friends. 175 Table 25: Time spent nelaxing. 176 <	Table 4: Modified version of the (VFI) explaining the various functions served by	
Table 5: Motivations and Prominent Researchers.69Table 6: Direction, Motivation and Persistence.80Table 7: Benefits and Costs Table.120Table 8: Theory and general categories.139Table 9: Web design problems and solutions.142Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion.172Table 20: Currency conversion.172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent with friends.175Table 24: Time spent with friends.175Table 25: Time spent with friends.176Table 26: Time spent vith friends.177Table 27: Time spent relaxing.176Table 28: Time spent with go on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job	volunteering (Clary and Snyder, 1999).	65
Table 6: Direction, Motivation and Persistence80Table 7 Benefits and Costs Table.120Table 8: Theory and general categories.139Table 9: Web design problems and solutions.142Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion.171Table 19: Income from OS participation.172Table 20: Currency conversion.172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 24: Time spent with friends.175Table 25: Time spent with friends.175Table 26: Time spent with go on Open Source projects.177Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that leaves a lot of leisure time.185Table 33: A job that leaves a lot of leisure time.186Table 34: It has good opportunities for advancement. </td <td>Table 5: Motivations and Prominent Researchers.</td> <td> 69</td>	Table 5: Motivations and Prominent Researchers.	69
Table 7 Benefits and Costs Table.120Table 8: Theory and general categories.139Table 9: Web design problems and solutions.142Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion.171Table 19: Income from OS participation.172Table 20: Currency conversion.172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with friends.175Table 25: Time spent not leisure.176Table 28: Time spent with friends.175Table 29: You should help to develop free software.179Table 29: You should help to develop free software.179Table 29: A job that allows you to work independently.181Table 23: A job that allows you to work independently.184Table 23: A job that leaves a lot of leisure time.185Table 24: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 2	Table 6: Direction, Motivation and Persistence.	80
Table 8: Theory and general categories.139Table 9: Web design problems and solutions.142Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 12: Gender, Age and Marital status of OS participants.164Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country were you born?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job174Table 23: Time spent with your family.175Table 24: Time spent with friends.175Table 25: Time spent with friends.176Table 29: You should help to develop free software.179Table 29: You should help to develop free software.179Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work in dependently.184Table 34: It has good opportunities for advancement.186Table 34: It has good opportunities for advancement.186Table 34: It has good opportunities for advancement.186Table 34: I	Table 7 Benefits and Costs Table.	120
Table 9: Web design problems and solutions.142Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job174Table 23: Time spent with your family.175Table 24: Time spent with your family.175Table 25: Time spent with your family.176Table 27: Time spent with your family.176Table 28: Time spent with gon Open Source projects.177Table 28: Time spent working on Open Source projects.177Table 28: Time spent working on Open Source projects.177Table 28: Time spent working on Open Source projects.176Table 28: Time spent working on Open Source projects.177Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33	Table 8: Theory and general categories.	139
Table 10: Advantages and disadvantages of online surveys.143Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 12: Gender, Age and Marital status of OS participants.165Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation.172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 23: Time spent doing household work.174Table 23: Time spent with your family.175Table 26: Time spent with friends.176Table 27: Time spent with gon Open Source projects.177Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job with flexible working hours.186Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 35: A job that sinteresting.188Table 34: It has good opportunities for advancement.186Table 35: A job th	Table 9: Web design problems and solutions.	142
Table 11: Open Source Survey Questions in Categories.147Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.176Table 26: Time spent with friends.177Table 27: Time spent relaxing.176Table 29: You should help to develop free software.179Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 35: A job with flexible working hours.186Table 37: A job that is interesting.187Table 37: A job that is interesting.188Table 33: A job that is interesting.188Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 37: A job that is interesting.188Table 37: A job that is interesting. </td <td>Table 10: Advantages and disadvantages of online surveys</td> <td> 143</td>	Table 10: Advantages and disadvantages of online surveys	143
Table 12: Gender, Age and Marital status of OS participants.164Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation.172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 23: Time spent doing household work.174Table 24: Time spent with friends.175Table 25: Time spent with friends.176Table 26: Time spent with gour family.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193 <td>Table 11: Open Source Survey Questions in Categories.</td> <td> 147</td>	Table 11: Open Source Survey Questions in Categories.	147
Table 13: In which country do you currently live?165Table 14: In which country were you born?167Table 15: Level of education obtained168Table 15: Level of education obtained169Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job174Table 23: Time spent doing household work174Table 24: Time spent with your family175Table 25: Time spent with friends176Table 26: Time spent on leisure176Table 27: Time spent relaxing176Table 28: Time spent vorking on Open Source projects177Table 29: You should help to develop free software179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently184Table 35: A job with flexible working hours186Table 35: A job that is interesting188Table 37: A job that is interesting188Table 38: High income189Table 39: Hours of work in categories193Table 39: Hours of work in categories1	Table 12: Gender, Age and Marital status of OS participants.	164
Table 14: In which country were you born?167Table 15: Level of education obtained.168Table 15: Current Profession169Table 16: Current Profession170Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation.172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent on leisure.176Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent vorking on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 33: A job that leaves a lot of leisure time.186Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.187Table 36: Job Security.187Table 37: A job that is interesting.188Table 39: Hours of work in categories.193Table 39: Hours of work in categories	Table 13: In which country do you currently live?	165
Table 15: Level of education obtained168Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 23: Time spent doing household work174Table 24: Time spent doing household work174Table 25: Time spent with your family175Table 26: Time spent on leisure176Table 27: Time spent relaxing176Table 28: Time spent working on Open Source projects177Table 29: You should help to develop free software179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 35: A job that allows you to work independently184Table 35: A job with flexible working hours186Table 35: A job with flexible working hours186Table 37: A job that is interesting188Table 36: Job Security187Table 37: A job that is interesting188Table 37: A job that is interesting189Table 39: Hours of work in categories193Table 39: Hours of work in categories194	Table 14: In which country were you born?	167
Table 16: Current Profession169Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job174Table 23: Time spent doing household work174Table 24: Time spent with your family175Table 25: Time spent with friends175Table 26: Time spent nelsure176Table 27: Time spent relaxing176Table 28: Time spent working on Open Source projects177Table 29: You should help to develop free software179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently184Table 35: A job with flexible working hours186Table 36: Job Security187Table 37: A job that is interesting188Table 38: High income189Table 39: Hours of work in categories189Table 30: Who would your the per week do you spend working on Open Source189Table 39: Hours of work in categories193Table 30: On average, how much time per week do you spend working on Open Source194	Table 15: Level of education obtained	168
Table 17: Average hours of work and annual income170Table 18: Currency conversion171Table 19: Income from OS participation172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job174Table 23: Time spent doing household work.174Table 24: Time spent with your family175Table 25: Time spent with friends.175Table 26: Time spent nelasing.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 30: On average, how much time per week do you spend working on Open Source194	Table 16: Current Profession	169
Table 18: Currency conversion171Table 19: Income from OS participation.172Table 20: Currency conversion172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent with friends.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.187Table 36: A job that is interesting.187Table 37: A job that is interesting.187Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 30: On average, how much time per week do you spend working on Open Source194	Table 17: Average hours of work and annual income	170
Table 19: Income from OS participation.172Table 20: Currency conversion.172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent no leisure.176Table 27: Time spent relaxing.176Table 28: Time spent vorking on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 36: High income.189Table 37: A job that is interesting.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 30: On average, how much time per week do you spend working on Open Source194	Table 18: Currency conversion	171
Table 20: Currency conversion.172Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent no leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.194	Table 19: Income from OS participation.	172
Table 21: Is working on Open Source projects part of your paid employment?173Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 30: On average, how much time per week do you spend working on Open Source194	Table 20: Currency conversion.	172
Table 22: The time you spend in a paid job.174Table 23: Time spent doing household work.174Table 23: Time spent with your family.175Table 24: Time spent with friends.175Table 25: Time spent on leisure.176Table 26: Time spent relaxing.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.194	Table 21: Is working on Open Source projects part of your paid employment?	173
Table 23: Time spent doing household work.174Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work incategories.193Table 39: Hours of work incategories.194	Table 22: The time you spend in a paid job.	174
Table 24: Time spent with your family.175Table 25: Time spent with friends.175Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 23: Time spent doing household work	174
Table 25: Time spent with friends.175Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 37: A job that is interesting.187Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 24: Time spent with your family	175
Table 26: Time spent on leisure.176Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 25: Time spent with friends.	175
Table 27: Time spent relaxing.176Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 39: Hours of work in categories.193Table 39: Mours of work in categories.193Table 39: Mours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 26: Time spent on leisure	176
Table 28: Time spent working on Open Source projects.177Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31 : Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 27: Time spent relaxing.	176
Table 29: You should help to develop free software.179Table 30: Who would you turn to for advice?180Table 31 : Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 28: Time spent working on Open Source projects	177
Table 30: Who would you turn to for advice?180Table 31: Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 29: You should help to develop free software	. 179
Table 31 : Depressed and wanted to talk: who you would turn to first for help?181Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 30: Who would vou turn to for advice?	180
Table 32: A job that allows you to work independently.184Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 31 : Depressed and wanted to talk: who you would turn to first for help?	. 181
Table 33: A job that leaves a lot of leisure time.185Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 32: A job that allows you to work independently.	184
Table 34: It has good opportunities for advancement.186Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 33: A job that leaves a lot of leisure time.	185
Table 35: A job with flexible working hours.186Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source194	Table 34: It has good opportunities for advancement.	186
Table 36: Job Security.187Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source194	Table 35: A job with flexible working hours.	186
Table 37: A job that is interesting.188Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source194	Table 36: Job Security.	187
Table 38: High income.189Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source194	Table 37: A job that is interesting	188
Table 39: Hours of work in categories.193Table 40: On average, how much time per week do you spend working on Open Source projects?194	Table 38: High income	189
Table 40: On average, how much time per week do you spend working on Open Source projects?	Table 39: Hours of work in categories.	193
projects?	Table 40: On average, how much time per week do you spend working on Open Sou	irce
	projects?	194

Table 41: One way ANOVA - Hours of paid work and time spent on OS	194
Table 42: Linear regression - hours of work and time spent on OS.	195
Table 43: What percentage of your paid work comes from working on OS projects?	196
Table 44: ANOVA What percentage of your paid employment comes directly from	
working on Open Source projects?	197
Table 45: Liner regression of hours of work and percentage of employment from OS.	197
Table 46: How many hours per week do you spend working on Open Source projects	
without receiving any financial payment?	198
Table 47: How many hours per week do you spend working on Open Source projects	
without receiving any financial payment?	198
Table 48: Descriptive statistics for work time variables	199
Table 49: Regression analysis for time spent on OS without financial gain	200
Table 50: Marital status and time spent on OS with out receiving financial	202
Table 51: ANOVA Cohabitating status and time spent on OS without financial gain	202
Table 52: ANOVA Age and contribution.	203
Table 53 : Highest level of education obtained.	204
Table 54: Current Profession.	205
Table 55: Improving my job opportunities and age	207
Table 56: Chi-Square. Age and improving my job opportunities	208
Table 57: Symmetric measures age and improving my job opportunities	208
Table 58: In your own words what initially attracted you to participate in the Open	
Source Community?	210
Table 59: Other reasons for participation in the OS community.	212
Table 60: A job is just a way of earning money.	213
Table 61: I would enjoy having a paid job even if I did not need the money	214
Table 62: Work is a person's most important activity.	215
Table 63: Leisure on OS and the importance of software being free.	217
Table 64: Anova- Leisure on OS and the importance of software being free.	217
Table 65: Leisure on OS and importance of participating in a new form of cooperation	۱.
	217
Table 66: ANOVA - Leisure on OS and importance of participating in a new form of	
cooperation	218
Table 67: Leisure on OS and Importance of helping to limit the power of large softwar	re
companies.	218
Table 68: ANOVA -Leisure on OS and importance of helping to limit the power of lan	rge
software companies	218
Table 69: In your own words what is the most important reason for your continued	
involvement in the Open Source community?	220
Table 70: A job that is useful to society.	222
Table 71: A job that allows you to help other people	223
Table 72: Length of time in the OS community and the number of projects participant	ts
have contributed towards	224
Table 73: ANOVA - Number of projects and length of time in the community	225
Table 74: Length of time in the community and time spent on OS.	225
Table 75: ANOVA - Length of time in the community and time spent on OS.	226

Table 76: Number of projects and the importance of reputation.	. 226
Table 77: ANOVA -Number of projects and the importance of reputation.	. 227
Table 78: KMO and Bartlett's Test.	. 229
Table 79: Rotated Component Matrix:	. 231
Table 80: KMO and Bartlett's Test for Anti corporate ideology variables	. 233
Table 81: Total Variance Explained Anti corporate ideology variables	. 234
Table 82: Rotated Component Matrix - Anti corporate ideology variables.	. 236

INDEX OF FIGURES

Figure 1: Open Source Development.	21
Figure 2: Closed Source Software Development (proprietary software).	21
Figure 3: The Open Source Development process.	22
Figure 4 Diagram of Roles within an OS project.	25
Figure 5: Communication in an online forum.	39
Figure 6: The Threads in a Forum.	40
Figure 7: Average weekly hours.	100
Figure 8: Time spent on domestic activities by age.	106
Figure 9: Time spent on child care by parents under 15 years.	108
Figure 10: Time spent on recreation and leisure by age.	110
Figure 11: Do you believe that you should make money from Open Source projects?	178
Figure 12: All in all, how happy are you with your life these days/ (0= extremely	
unhappy - $10 = \text{extremely happy}$).	182
Figure 13: All in all, how satisfied are you with your job? (0= extremely dissatisfied	- 10
=extremely dissatisfied).	183
Figure 14: First participation in OS.	190
Figure 15: Scree Plot.	229
Figure 16: Scree plot - Anti corporate ideology variables.	235
Figure 17: Online discussion from OS members.	241
Figure 18: Influential members.	243
Figure 19: Sample of Network.	245
Figure 20: Influential people in Network.	247
Figure 21 K-Core.	249

ABSTRACT

This thesis has two aims. The first is to contribute to an understanding of why people join the Open Source community, and the second is to explain what makes some participants commit to it. To meet these aims, the literature on a broad range of issues has been reviewed, interpreted and then applied in order to explain Open Source participation. This includes a review of the literature on such topics as Open Source (OS), communities, volunteering, time use and the changing patterns of work. A Rational Choice Theory explanation is utilised, with Core Motives theory, Norms of Reciprocity and Becker's Side Bets theory employed to thoroughly explain the complexities of joining and participating in the Open Source community

Four research questions were posed

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

Data were collected from 1632 respondents using an online Survey, and this was analysed using various statistical techniques with SPSS. The structure of the community was investigated through archival data obtained from online Open Source discussion boards. The results supported the use of the theories and revealed that the reasons for joining the OS community are different to what sustains participation. Motives tend to evolve from more egocentric needs to more community-focused aspects. There was strong support for both Norms of Reciprocity and Becker's Sidebets theory, with collateral investment and the desire to contribute being key factors for ongoing participation. These finding were further supported by the network analysis, which illustrated that the structure of the community enhances participation through status and reputation building and the ability of the community to satisfy individual's motives as they continue to contribute to the community. Individuals make a rational choice based on their own circumstances not only when joining the community, but also in determining their ongoing participation.

INTRODUCTION

This thesis offers a Rational Choice Theory explanation for participation in the Open Source Community and has the dual aim of (1) better understanding why people volunteer to contribute to activities similar to their paid employment, and (2) explaining what motivates them to continue. The study uses Rational Choice Theory to explain this participation, and utilises other theories to further explain commitment to the community. This thesis differs from current research on participation in the OS community, as it does more than just build on existing theories. Instead it offers a new and more comprehensive explanation that takes into account structural changes, which have presented opportunities for people to become (and stay) involved in this community. Participation in the community is explained by the following tenets.

- 1. Open Source participation and interaction comprises a 'community'.
- 2. Participation in the Open Source community is a form of volunteer activity.
- 3. Structural changes in society have changed the way people use their time, which has provided new opportunities.
- 4. Age, gender and life stage impact on the decision to participate in the community and influence the amount of time spent contributing.

Rational Choice Theory, Core Motives theory, Norms of Reciprocity and Becker's Side Bets theory are each applied in this research, and the use of these theories allows for a unique perspective that provides a comprehensive explanation of participation and sustained commitment. More Specifically the research aims to find out

- Why people choose to spend time on OS (the direction of their motivation which translates to working on OS projects).
- 2. The intensity of their choice (how much time is spent on OS?).
- 3. Why they persist? (Continue to stay involved in OS).
- 4. Does the OS community have a hierarchal structure based on expertise and participation?

Aims of the current work.

A fundamental question arising from the literature is what motivates people to participate in the Open Source community, especially when the activity is very similar to aspects of their paid employment. This question can be analysed in two parts: firstly, in an examination of how people spend their time, and secondly in determining why they choose particular types of activity. To answer the first of these questions, the literature examining why people volunteer will be explored. Volunteering behaviour shares many similar aspects to participation in the OS community, thus the volunteering literature is valuable in explaining what attracts people to particular activities, and what motivates them to continue with them.

Open Source participants are a community of volunteers who use their expertise and skills to contribute to the Open Source community. It is argued that this has largely occurred as a result of increased flexibility in work time, and a lack of physical boundaries (i.e.: you do not physically have to go to work). Globalisation, technological advancements, the increase of women in the workforce, and an increase of individuals engaged in part-time employment can result in employees working varied hours at different times throughout the day and night. Along with these other societal changes, the traditional work model of 9am to 5pm is no longer the standard for many individuals

(Wooden, 2000). This flexibility has created opportunities for people to use their time in a variety of new ways, without the time boundaries that previously existed for the vast majority of workers.

A useful way of examining these issues is to look at the literature on time use. Time is not an infinite resource, and people have restrictions placed on the amount of free or leisure time they have by necessities such as work, sleep and personal care. This thesis is concerned with how people use their extra (or discretionary time). This can be defined as the time they have left after accounting for life's necessities. Open Source (OS) participation, although voluntary, has characteristics (such as use of computer skills) that are similar to paid employment. Because of the nature of the skills required, many OS participants are employed in information technology. The most appropriate framework for understanding time use was developed by Aas (1982), who conceptualised four categories of time: necessary time, contracted time, committed time, and free time. Analysing OS participation within these categories illustrates the challenges in understanding OS involvement, as it does not fit cleanly into any one category, and involves the use of both free time and committed time.

Rational Choice Theory (RCT) is the fundamental theoretical perspective used to address why people choose to participate in particular types of activity (Goldthorpe, 1998; Simon, 1957). This theory is based on the premise that people generally make rational decisions in order to maximise their utility. People make decisions based on the information they have at the time, and are greatly influenced by their desires, needs and the opportunities available to them in their present situation. Using Rational Choice Theory we can analyse why people choose to participate in OS community.

An equally important concept in this study is that of 'choice'. For many people, the amount of time spent at work is a choice. Many people could live off fewer hours of paid employment, but choose not to do so. The reality being that they work a certain number of hours in order to afford the non-essential items they desire. The most useful theory to help explain employment (in terms of time spent at work) as a 'choice' is Hakim's (2000) Preference Theory. Preference Theory is primarily concerned with the choices women make between family responsibilities and paid work. It is used in contemporary research to illustrate the increased changes in patterns of work, which have helped to create opportunities for individuals to utilize their time in different ways. Furthermore, it examines how these changes in work patterns influence the choices made by individuals. Time use can be seen as a trade-off, and as such part of understanding 'choices' means understanding the trade-offs people make.

While the phenomenon of Open Source is certainly new, there are clear continuities with the past, especially with respect to the formation of communities and motives that influence time use choices. The core argument of this thesis is that economic, social, technical and cultural changes result from new circumstances and conditions. The choices people make under these conditions largely reflect a set of basic concerns and interests that show a degree of continuity with the past. What has changed over the years is that the Internet and associated technologies now provide opportunities to satisfy those concerns and interests. In particular, this thesis will argue that the motives for participating in Open Source development are very similar to motives previously found for volunteering or civic engagement, specifically: activism oriented to a 'cause', the benefits of community participation (including the esteem of others), the development of human capital and personal satisfaction in task engagement. To help answer questions relating to what motivates individuals to join and commit to the Open Source community, two areas are addressed in the literature review. Firstly, what people do with their time; and secondly, why they choose to engage in a particular type of activity (in this case participation in the Open Source community). This thesis argues that individuals have multiple motives for participating in the Open Source (OS) community, and that OS involvement looks very much like paid work, but is considered leisure by participants. OS offers many opportunities for social involvement, as well as the enhancement of human capital, and status in a community. All of which are influenced by the various opportunity structures that exist for each individual at their relevant life stage.

A major challenge in studying OS participation is the lack of a clear conceptual framework. This has resulted in fragmented and speculative research that has not thoroughly addressed participation in a comprehensive, empirical manner. The intention of this thesis is to use the proposed tenants to build on the existing knowledge of the OS community. This will be achieved by incorporating a variety of theories to address the research questions. This thesis reviews and integrates a broad range of literature and applies it to explaining Open Source participation. This includes a review of the literature on Open Source, communities, volunteering, time use, and the changing patterns of work. Tenets 1 to 4 are outlined below with the relevant chapter summaries.

Chapter 1 - Tenet One.

This Chapter presents a detailed review of the Open Source (OS) community. It reviews traditional definitions of a community and provides justification for why OS participation should be included under the wide variety of community types. In addition, the Chapter aims to clarify the nature of OS community involvement, and to provide a clear overview of how the OS community functions.

Chapter 2- Tenet Two.

This Chapter argues that Open Source participation can best be understood when viewed as a form of volunteering. It reviews the literature on volunteering and considers why people choose to volunteer their time on activities that are similar to paid employment. The argument is made that Open source participation is a form of volunteering. The general motives for volunteering are discussed and the relationship with the Open Source community is explored.

Chapter 3 – Tenets Three and Four.

Chapter 3 provides a comprehensive review of how people choose to use their time and examines the literature relating to Open Source participation in order to analyse the central debates, issues and themes. The purpose of this Chapter is to demonstrate how changes in time use have evolved. Preference theory is utilised to explain how people now have more choices in the way they use their time

Chapter 4.

A number of theories that can be applied in order to explain motivation to volunteer are integrated in order to enable empirical testing. Rational Choice (in conjunction with the existing literature) provides a theoretical foundation for studying the motivation to volunteer in the OS community. Rational Choice Theory argues that people make choices about their lives based on the information they have, and they generally make choices that maximize their outcomes. Further theories including Norms of Reciprocity, Becker's Side Bets theory and Core Motives theory are utilised to further explain participation and commitment in the OS community. Chapter 4 highlights the limitations of the research completed to date, in particular the lack of empirical research. The aim of this chapter is to re-cast the issues and integrate the various theories in order to more comprehensively understand Open Source participation.

Chapter 5.

Chapter 5 outlines the research design adopted for this study and explains how the data will be used to test the theoretical framework presented in Chapter 4. This thesis addresses the research problems by analysing data from a large international survey completed in 2007. The rationale for using a web-based survey is also discussed. In addition, a large network analysis of the OS community (completed using archived data

from 2000-2008) is also presented in Chapter 5. This was conducted to determine the structure of the OS community.

Chapter 6.

Chapter 6 presents the results from the online survey and the network analysis, based on the theoretical arguments made in Chapter 4. The specific focus of the social network analysis is to investigate the structure of the community and how this fosters participation and commitment.

Chapter 7.

Chapter 7 discusses the findings reported in Chapter 6 by addressing each of the elements reviewed in Chapters 1 - 4 in order to illuminate the results. Overall, these results provide support for the many factors affecting participation and commitment to the community. The specific findings presented in this thesis illustrate that participants in the OS community tend to join the community because they need something, but continue with their participation (become committed) due to the reciprocal benefits received.

CHAPTER 1

A REVIEW OF THE LITERATURE ON THE OPEN SOURCE COMMUNITY

Introduction.

This chapter presents a detailed review of the Open Source (OS) community. It aims to clarify the nature of OS community involvement and to impart a clear overview of how the OS community functions. Furthermore, it provides an overview of traditional definitions of a community and offers justification for why OS participation should be considered as a type of community. Lastly this chapter identifies areas of the OS community requiring further research.

The Open Source world consists of a setting in which individuals voluntarily invest time and effort for the benefit of the broader community. Considering that this mode of operation is still relatively new, there is much that is unknown about each individual's motivation for participating in these initiatives, or the circumstances that enable members of the wider community to invest their time and skills.

The term 'Open Source' in its strictest sense denotes only the type of license under which a product is made available (von Hippel & von Krogh, 2003). The aim of the Open Source community is software development, and involves the idea that by drawing on the contributions of volunteers, software can be created that is technically superior to software created in traditional, closed development environments (Markus, Manville, & Agres, 2000). In this thesis the focus is on what motivates these volunteers' and the external factors that can be used to explain them.

What exactly is Open Source?

The Open Source community is a large cohort of individuals who work collectively to produce software that can be dramatically altered to suit the needs of the individual or organisation. For the purpose of this research, Open Source software is considered different to the types of software familiar to many people. This is due to the fact that the source code of the product is accessible, thus allowing the end user to make custom modifications, and this is the key distinction between Open Source and commercial software products. Weber (2004) proposes that the Open Source software process can be considered as a real world researchable example of a community, and as a knowledge production process that has been fundamentally changed (or created) in significant ways by Internet technology.

One aim of the research is to analyse why people volunteer their labour in new forms of community. The Internet plays a major role in modern society, and has increased opportunities to communicate and share information by lowering barriers arising from cost and distance. Consequently, new technologies have contributed to evolving definitions of community, which are needed as traditional forms of communication expand. Members of the Open Source community may live on opposite sides of the world and may never talk in person, but will communicate frequently online. In some cases they may even communicate more with other OS community members than with family. Hence, a more up-to-date and complete definition of community is now required.

To be classified as Open Source, the source code for the program must be made available. The source code of a program is the sequence of actual typed commonlanguage words entered by a programmer. These commands constitute the actual structure of the program. When the source code of a particular application is available to the public, it is said that the source code is 'open' (Johnson, 2001). A competent programmer who has the source code of a program can build a new or extended application, modify or alter the performance, and correct bugs (bugs refer to small glitches in programs). However, the source code of most purchased programs is already compiled to run on a particular operating system. Compiled software is in binary code that speaks to the components of a computer system. It is incredibly difficult to invert a compiled program to obtain the underlying source code and in most instances this is prohibited by the original developer. This form of software is commonly referred to as closed source software.

Open Source products are extremely prevalent in the Western world and protagonists of Open Source development argue that Open Source licensing allows for a superior development process. By having the source code of a program open, it allows the end user to modify and redistribute the software, as well as the right to package and sell the software. Much of this software produced to date has been written in a decentralised manner by a large number of individual programmers scattered across the world. This is in contrast to the 'closed source' (or proprietary software) products offered by the consumer giants such as Microsoft. The influence of Open Source software is more widespread than most people realise. For example: electronic mail is transferred from the sender to the recipient by a piece of software known as an 'Internet mail transfer agent'. 80% of e-mail traffic is handled by the program 'send mail', which is an Open Source product (Myatt & Wallace, 2002). Furthermore, over half of all web servers are powered by Apache, which is also an Open Source project (Myatt & Wallace, 2002). Consequently, the sum of these Open Source programming efforts has produced an impressive collection of software (Johnson, 2001). More recently, many people and organisations use the internet browser Mozilla Firefox. Mozilla Firefox is a free Open Source web browser descended from the Mozilla Application Suite and managed by Mozilla Corporation. A Net Applications survey put Firefox at 24.07% of the recorded usage share of web browsers as of October 2009, making it the second most popular browser in terms of current use worldwide after Microsoft's Internet Explorer. Conservative estimates found that Firefox is used by over 184 million people worldwide, double the number of users in 2006 (Ryan 2007).

The following diagrams provide a simple illustration of the difference between Open Source programs and Closed Source (propriety programs):





Figure 2: Closed Source Software Development (proprietary software)



As can be seen by **Figure 1** and **Figure 2** under the proprietary model the source code is not released to the public. The market is allowed access to the closed source software, which is maintained by a team who produce their product in a compiled executable state. The primary business model for closed-source software involves the use of constraints on what can be done with the software and the restriction of access to the original source code. This can result in a form of imposed artificial scarcity on a product that is otherwise very easy to copy and redistribute. The end result is that an end-user is not actually purchasing software, but purchasing the right to use the software. To this end, the source code is considered to be a trade secret by its manufacturers.

Figure 3 helps to explain the Open Source software development cycle and illustrates how anyone with the appropriate skills can participate in the process. However, having multiple participants' means a massive coordination effort and the Concurrent Versions System is generally used to assist.

Do little document writing

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Vote for a license model



CVS version control

Accept patches and modifications (vote or dictatorship)

Release official version in the foreseeable future

Figure 3: The Open Source Development process.

Figure adapted from (Ming and Ying, 2001)

Write documents and manuals

Decide a license model

The Concurrent Versions System (CVS), also known as the Concurrent Versioning System, is a client-server software revision system in the field of software development. Version control system software keeps track of all work and changes in a set of files and allows several developers (potentially widely separated in space and/or time) to collaborate. In addition to commercial software developers, CVS has become popular with the Open Source software world and is released under the GNU General Public License (Ming and Ying, 2001). Several developers may work on the same project concurrently, each one editing files within their own 'working copy' of the project and sending (or checking in) their modifications to the server. To avoid the possibility of people stepping on each other's toes, the server only accepts changes made to the most recent version of a file. Developers are therefore expected to keep their working copy up-to-date by incorporating other people's changes on a regular basis. This task is mostly automatically handled by the CVS client, with manual intervention only required when an edit conflict arises between a checked-in modification and the yet-unchecked local version of a file. If the check-in operation succeeds, then the version numbers of all files involved automatically increment, and the CVS-server writes a user-supplied description line, the date and the author's name to its log files. CVS can also run external, user-specified log processing scripts following each commit. Clients can also compare versions, request a complete history of changes, or check out a historical snapshot of the project as of a given date or as of a revision number (Ming and Ying, 2001).

Further clarification can be found in **Table 1** which highlights the major roles of participants in the OS community. It should be noted that not all Open Source projects are open to anybody to participate and some Open Source communities only allow participation by some members (Shah, 2004). The right to access and modify the source code itself does not necessarily differentiate open source from closed source software. All developers in a project in any software company may have the same access privileges, however the fundamental difference lay in the role transformation of people

23

connected to a project. In a closed source software project, developers and users are clearly defined and strictly separated. In the OS community there is no such distinction between developers and users; all users are potential developers. People involved in a particular OS project create a community centered around the project, bounded by their shared interest in developing the system. Members of an OS community assume certain roles for themselves according to their personal interest in the project, rather than being assigned a role. Research by Ye and Kishida (2003) identified eight common roles presented which have been adapted for the **Figure 4**.

OS Roles	Description
Core Member:	The members responsible for the guiding and coordinating the development of the OS project. Members tend to be those that have been involved for a long time and have made significant contributions.
Active Developer:	Regularly contribute to new features and fix bugs.
Peripheral Developer	Occasionally contribute to the project
Bug fixer	Help to fix bugs in the program that they discover themselves or other members find
Bug Reporter	Discover bugs and report them to be fixed. The existence of lots of bug reporters assures higher quality software
Peripheral Participant	Are active users of the software and tend to read and actively try to understand the software. This can be a transition stage that leads to becoming an active developer.
Passive user:	Just use the software without making a contribution in the same way propriety software is used.

Table 1: Open Source Roles.



Figure 4 Diagram of Roles within an OS project.

As can be seen by **Figure 4** different roles within the OS community are illustrated, highlighting their contribution and the inter-relation between the roles. There is a certain amount of overlap between all users, especially the developers. The model also reveals how a person's contribution can move them into different roles within the community. Peripheral participants may start in the community by submitting bug reports or suggesting new features, then move to fixing bugs, reviewing code and writing it. The role a developer has within the project can be defined by their contribution, with Project Leaders and Core Members having a greater say in decision-making and the implementation of ideas than active developers or peripheral developers.

The economic value of Open Source.

The Internet and related technologies have enabled the formation of distributed, collaborative networks of individuals who are engaged in the task of cooperatively creating and generating value, while being governed by a loose and informal structure. By enabling an environment that places value on participation, this technology encourages the participation of individuals in collaborative networks without the explicit transfer of money among network participants (Ghosh, 2000). An example of this is the Open Source community: according to Google Analytics (http://www.google.com.au/intl/en ALL/analytics/search.html#q=opensource), Source Forge, which is the world's largest Open Source software development web site, had 44.7 million visits, 103 million page views and 32.5 million unique visitors as of September 2009. In February 2009, more than 230,000 software projects were registered to Source Forge by more than 2 million registered users. The net value of the OS community is difficult to approximate, but based on the 4.9 billion lines of code created by the various Open Source community participants, it would cost \$387 billion to replicate (http://www.blackducksoftware.com/news/releases/seventh-annualfuture-open-source-survey-results-show-culture-quality-and-growth). This is almost twice the value of Microsoft's current net worth of \$226.3 billion as of 10/05/2010 http://www.blackducksoftware.com/news/releases/seventh-annual-future-opensource-survey-results-show-culture-quality-and-growth. This is one of many reasons why it is important to study and understand the OS community; the sheer size and scope of OS demonstrates how large and valuable the community has become.

The above information helps to provide an indication of the size and value of the actual Open Source products produced, however it does not take into account the value of the actual human contribution in terms of time spent working on Open Source projects. Some forms of actual time spent can be quantified, such as time online. This can be measured in various ways, for example: generation of economically valuable goods and services. Yet, difficulties arise as the valuable goods provided become less quantifiable when services are provided to others within (or outside) the network without explicit and direct measurable monetary payment. While such goods may be associated with increased significance and monetary terms, most likely it is measurable for the individuals in terms of indirect income realised through the conversion of reputation, capital or goodwill generated for related or subsidiary services. Consequently, estimates of the primary services provided without the use of monetary terms (or for very little money) would be incredibly difficult, especially since most models and techniques for economic evaluation and measurement are monetary. Generally speaking, the activity of such non-monetary economic networks is left unmeasured, at least in any significant and quantifiably useful sense (Ghosh, 1998).

There have been studies involving the quantitative analysis of non-monetary values in an economy, such as the measurement of knowledge (Pirolli & Wilson 1998). However, these generally tend to only be useful for analysing the influence of specific types of information, such as knowledge within organisations, markets or other social structures for which the forms of measurement are still dominated by monetary indicators. Measurement becomes far more complex in a context where the essential and primary economic activity is the generation of value through collaborative networks. This makes it unusual, as the source community does not use money as a mode of exchange (Ghosh, 1998). This is where this current work is important, as it examines the complex nature of motivation to participate by considering both the economic and social incentives for contribution. This thesis does not attempt to remedy the lack of economic models for measuring Open Source participation, but rather aspires to use this information to highlight the uniqueness of the community. Essentially, participation in the community appears to be very similar to paid work, but it is actually considered a free time activity for those involved with OS. Like other types of volunteering reviewed in Chapter 2, many use work related skills in their volunteering activities. This thesis looks at participation holistically rather than arguing that one simple motive or circumstance creates an environment that fosters involvement.

How Open Source software licensing works.

The next section of this chapter looks at how licensing works for OS software. This is an integral part of how the community operates and is vastly different from proprietary software. A software license is a legal instrument (by way of contract law) governing the usage or redistribution of software. All software is copyright protected irrespective of whether it is in the public domain. A typical software license grants an end-user permission to use one or more copies of software in ways where such a use would otherwise constitute copyright infringement of the software owner's exclusive rights under copyright law. Software licenses can generally fit into two categories: proprietary licenses and open source licenses (which include free software licenses and other open source licenses). The distinguishing feature is significant as it directly affects the enduser's rights. An open source license makes software free for inspection, modification, and distribution of its code. The hallmark of proprietary software licenses grants the software publisher a license to use one or more copies of the software, but ownership of those copies remains with the software publisher (hence the use of the term 'proprietary'). A consequence of this facet of proprietary software licenses is that virtually all rights regarding the software are reserved by the software publisher and only a very limited set of well-defined rights are conceded to the end-user. Therefore proprietary software license agreements typically include many terms that specifically prohibit certain uses of the software, often including uses that would otherwise be allowed under copyright law. The most significant effect of this form of licensing is that, if ownership of the software remains with the software publisher, then the end-user *must* accept the software license (GNU). In other words, without acceptance of the license, the end-user may not use the software at all. One example of such a proprietary software licenses is that of Microsoft Windows. As is usually the case with proprietary software licenses, this license contains an extensive list of activities that are restricted (reverse engineering, simultaneous use of the software by multiple users, and publication of benchmark or performance tests). With an Open Software license, ownership of a particular copy of the software does not remain with the software publisher, instead ownership of the copy is transferred to the end-user, resulting in them by being afforded all rights granted by copyright law by default to the copy owner (Feller and Fitzgerald, 2002).

Software with the source code in the public domain is generally considered to be Open Source software and can be distributed under the popular General Public License (GPL). The GPL is a free software license, created by the Free Software Foundation formed by Richard Stallman, one of the pioneers of the Open Source software movement. The GPL is the most popular license for free software, its purpose being to grant any user the right to copy, modify and redistribute programs and source code from developers who have chosen to license their work under the GPL. The GNU/Linux operating system, together with the Linux Kernel, is by far the most successful product licensed in this manner (Feller and Fitzgerald, 2002).

Open Source and Free Software.

Open Source software is copyrighted and the license restrictions are designed to protect its non-excludable nature. This license stipulates that the source code for a product must be made freely available, and that any new product produced from Open Source software must be distributed under the same license (Myatt and Wallace, 2002). It should be noted that 'free' does not mean without cost. For instance the producer of an Open Source product may charge a fee to install the program. However the key feature is that a subsequent user is able to use the source code in any way they choose (Myatt and Wallace, 2002). The term Open Source in common usage may refer to any software with a publicly available source code. Despite apparent similarities, Open Source software is distinct from free software. The Free Software Foundation (FSF) definition of free software is far more restrictive than the Open Source definition. Free software is always Open Source, however not all Open Source software is free. The decision to adopt the term 'Open Source' was based partly on the confusion caused by the dual meaning of the word 'free'. The FSF intended the term to be interpreted as 'free, as in free speech', not 'free food'. Nevertheless, free software came to be associated with zero cost, a problem that was exacerbated by the fact that a great deal of it is in fact free of charge. It was hoped that the usage of the newer term 'Open Source' would eliminate such ambiguity, particularly for users who might mistakenly associate 'free software' with anti-commercialism.

The Open Source movement is a developmental methodology; free software on the other hand is a social movement. Essentially, the fundamental difference is that free software is without cost, whereas the Open Source movement is about the availability of the source code. The Free Software Foundation is not against the Open Source movement, but they do not want to be placed under the same definition. For the purpose of this research, it is not particularly relevant which movement participants subscribe to, as it is their motivation to participate in the community that is of greatest importance. However, in this instance, the focus is on the Open Source community.

Open Source Software Examples.

It is necessary to provide an overview of the relevant software examples to provide an indication of the size and importance of the community. There are a myriad of examples

of free software, with programs that have evolved from the development of the GNU/Linux operating system including the General Public License, Apache Software License and Mozilla Public License. The Apache Software Foundation (ASF) was formed by the Apache Group, and was incorporated in Delaware, USA in 1999 and which developed the Apache Software License (Feller and Fitzgerald, 2002). The ASF is a non-profit corporation founded to support Apache software projects. The ASF is a decentralised community of developers who work on Open Source software projects. The Apache projects are characterised by a collaborative consensus based development process (Mockus, Fielding, and Herbsleb, 2002). Each project is managed by a self-selected team of technical experts, each of whom is an active contributor to the project. The ASF is a meritocracy, implying that membership to the foundation is granted only to volunteers who have actively contributed to Apache projects. Some of the projects managed by Apache include the HTTP server- Apache server, Perl and XML-XML solution for the web (Hann, Roberts and Slaughter, 2004)

Mozilla.

The Mozilla Application Suite is a free, cross-platform Internet software suite, whose components include a web browser, an e-mail client, HTML editor and an IRC client. Netscape Communications Corporation, based on the source code for Netscape Communicator, initiated its development. In March 1998, Netscape Communications Corporation released its source code under the Open Source license with the name of the application called Mozilla, coordinated by the newly created Mozilla Organisation. The Mozilla Organisation eventually succeeded in producing a full-featured Internet suite, which surpassed Communicator in both features and suitability. Many programs have been developed that rival Microsoft Office products, including Open Office (which was made to mirror Microsoft word). Mozilla Firefox was developed to rival Microsoft Internet Explorer (Feller and Fitzgerald, 2002). Each of these programs is available to be downloaded for free, along with add-on options and technical support. This has

been a significant move for Open Source as it has effectively made these products available to the wider community.

How Linux and Apache originated.

Collaborative Open Source software projects such as Linux and Apache demonstrate that a large and complex system of software code can be built maintained, developed and extended in a non proprietary setting, in which many developers work in a highly parallel, relatively unstructured way (Weber, 2004).

Linux is a UNIX operating system that was developed by Linus Torvalds together with an amorphous community of programmers across the Internet. Torvalds wrote the first version of UNIX for his personal use. Instead of securing property rights to his invention, he posted the code on the Internet and requested other programmers to help upgrade it into a working system. The response was massive and turned a pet project into the operating system called Linux (Kogut and Metiu, 2001). The Linux development model is structured around Torvalds. Legally, anyone can build an alternative community to develop other versions of Linux (from the Linux kernel), however, in practice the process is much more centralised, and distributed subject to hierarchical controls (Kogut and Metiu, 2001). New codes are submitted to Torvalds who decides whether or not to accept or request modifications before they are added to the Linux Kernel. As the popularity of Linux grew Torvalds, unable to work through the amount of code submitted to the kernel, delegated large components to several of his trusted 'lieutenants', who further assigned components to a handful of 'area owners' (Kogut and Metiu, 2001). Nowadays, several developers have comparative control over their particular sub-sections. There is a networking chief, driver chief and so forth, and although Torvalds still has ultimate authority, he seldom rejects a decision made by one of the administrators (Kogut and Metiu, 2001).
Apache.

The Apache HTTP Server Project is a collaborative software development effort aimed at creating a robust, commercial-grade and freely available source code implementation of an HTTP (web) server. The Apache HTTP server project is a web server originally based on the Open Source server from the National Centre for Supercomputing Applications (NSCA). The project originated in 1995 to fix an NCSA program. The development for the Apache model is quite rigid, based on a meritocratic selection process. Put simply, the more you do, the more you are allowed to do. As with all Open Source projects, access to the source code is open and the history of information changes. However, the actual ability to make changes is restricted to the members of the Apache board (Kogut and Metiu, 2001). Changes to the code are proposed on the mailing list and usually voted on by the active members.

The Apache board is selected on the basis of proven ability and past contribution. Other contributors to Apache can participate in three different ways. They can join the developers e-mail list, which consists of technical discussions, proposed changes and automatic notification about code changes – it receives several hundred messages a day. They can also contribute through The Current Version Control (CVC) archive that consists of modification requests that can result in changes to the code or documentation. Lastly, there is the Problem-Reporting Database in the form of a Usenet, which is the most accessible list consisting of messages reporting and questions seeking help. The co-ordination of the development process during 1996 and 1997 to change the master code was called Review Then Commit (RTC). This involved a patch being submitted that would be tested by other developers who would apply it to their systems. This process was later deemed too time consuming (Kogut and Metiu, 2001), so in 1998 a new process was introduced called Commit Then Review (CTR). CTR helped to speed up development, but required more vigilance by the development team, with controversial changes being discussed first on the e-mailing list (Kogut and Metiu, 2001).

Mail list discussions to achieve a consensus are usually submitted, with the more controversial changes calling for a vote.

Even though Apache is a meritocracy, all mailing list subscribers are entitled to offer an opinion; conversely if they are not deemed a serious contributor, their ideas may be ignored. New versions of Apache are released when the developers achieve a consensus that it is viably operational, as opposed to meeting a particular deadline (Kogut and Metiu, 2001). Apache has a 62% share of the Internet server market, and is steadily increasing its market share and outdoing proprietary products such as Microsoft's server suites, with Apache now being used for such projects as XML and Java (Kogut and Metiu, 2001). This gives some insight into the nature of participation in the community. Previous work has shown that contributors who are highly knowledgeable and contribute the most are more likely to direct the projects, rather than lesser known members (Hars et al, 2002). It should be noted that in spite of the large number of participants in the Open Source community, the actual number of people constantly contributing to these particular platforms is small, as in reality only the most superior programmers make the changes.

Kogut and Metiu (2001) analysed the 'changes' file to Apache between March 1995 and February 2000, and this revealed that a small number of developers were responsible for the majority of contributions. Three hundred and twenty six people contributed to patches during the analysed period, with 232 contributing to only one patch and 36 contributing to two patches. The top five providers each made 20 to 30 changes whilst 14 individuals made between 10 and 19 changes. These results, supported by research by Mockus, Fielding and Herbseb (2000), which established that the top 15 Apache developers contributed to more than 83% of basic changes. They found that modifications made by the core developers were substantially larger than those made by the non-core group. These findings corroborated a similar pattern found in the Linux community (Dempsey, Weiss, Jones and Greenberg, 1999). Even though the core members make the main changes, this does not mean that other contributions from newer or less experienced members are ignored. Members can contribute by submitting suggestions or fixes, bug reporting, testing and user support, and are all considered valuable contributions to both the OS community and Open Source program development.

Kogut and Metiu (2001) argue that it is not only hierarchical development that gives Open Source a distinctive advantage, but also the concurrence of development and debugging, where developing and enhancement are an iterative process. This process allows for continual improvements of the software. Interestingly, between 50% and 80% of the average software budget is involved in maintenance, with the largest segment of the developer community involved in debugging, rather than writing code. Kuan (2000) found that Open Source projects ranked higher on the debugging dimension than closed source projects.

What makes this so appealing is that one of the most important contributions by the Open Source community is the release of the source code to the users. This allows them to fix the bugs that appear in the program, which makes the process more dynamic and interactive. Programs such as those offered by Microsoft are released with the end-user unaware of how many bugs the program may contain, and without the ability for alterations to be made. By placing the code in the public domain, Open Source development allows for bugs to be corrected concurrent with design and implementation. Users participate through posting questions and complaints through 'usernets'. This is separate to the design activity explained previously, which remains hierarchically organised in which the more experienced and knowledgeable make the most contribution to OS projects (Kogut and Metiu, 2001). This will be tested in this thesis using Network analysis techniques.

How the Open Source community operates.

Participants in the OS community develop and exercise practical knowledge through deliberation within the context of particular problems of software development

(Welton, 2005). Open Source communities represent a model of a community free from corporate boundaries and which are open to anybody. Intrinsically motivated contributors are vital to its existence, as cooperation in such communities cannot be maintained without these members, who protect the community against exploitation through their purely extrinsically motivated participation - seeking a self-interest opportunity. As a result, new members join Open Source communities such as these, relying on the mutual trust through the presence of intrinsically motivated members like themselves, who are willing to participate to the OS projects for free (Osterloh, 2004).

Participants in the Open Source community join an online group to become involved. An example of such a group would be Source Forge which, as stated earlier, is the world's largest Open Source software development web site with more than 230,000 software projects and in excess of 2 million registered users. The majority of communication is done over the Internet via mailing lists, wikis and forums. Activity on an Open Source project is generally open to all members by means of e-mails and web boards. This communication is well structured, with questions and answers posted on the discussion pages. Generally, new members of the community identify themselves as 'newbies' on the discussion pages and very politely seek advice from existing members to assist them with their problem. **Table 2** on the following page provides an example of such online communication from a web board. From here, existing members provide advice and solutions. In the majority of cases, to join an Open Source discussion, potential members must seek permission from a web administrator and provide a user name and e-mail address. Table 2: Online forum - Dialogue of a new member wanting to become involved in OS projects.

TITLE: How to work in an Open Source community. http://www.libervis.com/user/ashish_jain

Ashish Jain

Posts: 1 Joined: 2005-08-16

I am a newcomer in the world of Open Source and want to have a knowledge about how to be a part of a Open Source community and how to work on ongoing projects. <u>http://www.libervis.com/privatemsg/msgto/421</u> write to author quote subscribe post

Re:How to work on in a Open Source community.http://www.libervis.com/user/tbuitenh

tbuitenh

Posts: 1279 Joined: 2004-08-23

You have no idea how unspecific that question is. I'd say: find an interesting project for which you have some ideas for improvements, join its development mailing list, ask them what you can do for them and also ask them to help you get started with the code. Oh! and make sure you are able to use version control tools such as CVS without breaking stuff. People hate it when you accidentally overwrite their update with something old.http://www.libervis.com/comment/reply/1150/4586

Re: How to work on in a Open Source community. http://www.libervis.com/user/libervisco

libervisco

Posts: 3134 Joined: 2004-07-12

Tbuitenh above pointed out one very good way of getting involved, but I believe that you're becoming part of the FOSS (Free Open Source Software) community the moment you start actively using GNU/Linux and Free Software and even more so if you participate in online discussions with other FOSS users, even submit bug reports, feature requests, write reviews and articles and so on. The deeper involvement is of course always the best and logically most appreciated in the community. It involves getting into a real project to do anything significant from writing documentation to coding and helping the actual software development. I say that participation here in Libervis community or LinuxForums.org community is a good entry point already.

EDIT: Oh and here is a warm welcome to you Ashish Jain, thank you for joining. : Genial:

From this perspective each participant dictates the level of contribution. However, the more a person contributes, the more influence they can have over projects. Anyone is able to start a project or make suggestions regarding an existing project. There are also participants who may be members of a group just for advice or software solutions, but they may not actually contribute to development in any significant manner. Open Source programmers receive rapid constructive feedback about the quality of their work through online networks. Feedback generally has a positive effect in that it shows programmers that people are using their contributions. This feedback mechanism is self-reinforcing, for it encourages the author to expend additional effort to perfect his code, which in turn attracts more favourable feedback (Hars et al, 2002, p.30). Essentially, participation builds skills, and it is highly likely that this leads to a hierarchal structure that has been noted in the literature, with the largest and most skilled contributors having the most say over projects (Hars et al, 2002, p.30). This will be examined further in Chapter 6.

Figure 5 shows an example of communication between two OS members on an online web forum.

Figure 5: Communication in an online forum.



You can see from the example that communication is very friendly and positive. Participants post their problems, and another member generally responds with a solution. In the example, the person asking the question has also identified himself as a new member by including "Newb" after their name. **Figure 6** shows a list of threads (topics) in an online forum where members can ask questions, answer questions and suggest improvements. Figure 6: The Threads in a Forum.

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		<mark>⊻ Limewire…</mark> Dumah		Today 06:01 AM by bigtomrodney ⋗	2	23			
	0	Sunable to run knoppix livecd, Graphics problem? Help this just-born newbie jaydoc		Today 05:18 AM by anomie ⋗	з	38			
		Now to install a program from the desktop linux		Today 05:08 AM by jazzyjerome ⋗	6	31			
	8	Connecting to the Internet		Today 04:01 AM by ^dark_c0de^ ⋗	о	16			
		Sector 2 Stars for 6Mb!!!!!! the bassinvader		Today 03:33 AM by the bassinvader ⋗	0	12			
Find: t	table	😽 Next 🎓 Previous 🖂 Highlight all 📃 Match case							

The above is the typical format for an online discussion forum. The general topic is presented on the left, whilst the person who has posted and the number of views are presented on the right side of the page.

The beliefs behind the Open Source community.

Despite the fact the Open Source software community has been quite a phenomenon over the past fifteen years, it remains misunderstood and relatively unknown for people outside the IT area. The OS community relies on the ideas of 'copy left', which states that the material that would normally be categorised into a copyright agreement should actually be released under licenses that encourage sharing and alteration of the material contained within. The Open Source community bases itself on the ability of developers and users to make changes to the source code (and therefore alter the performance of a program). The term 'openness' has evolved to refer to projects that are open to anyone and everyone wishing to make a contribution, either before, and/or after the actual programming. Both groups assert that this more open style of licensing allows for a superior development process and that 'freedom' is a paramount merit one should prefer, even in cases where proprietary software has spectacular superior technical features.

Open Source advocates argue that since the early 2000s, at least 90% of computer programmers have been employed not to produce software for direct sales, but rather to design and customise software for other purposes such as in house applications. This statistic implies that the value of the software lies primarily in its usefulness to the developer or the developing organisation rather than in its potential sale value and consequently there is no economic reason to keep the source code secret from competitors. Advocates further argue that corporations frequently over-protect software in ways that actually damage their own interests. Basically, this means that companies benefit from having software developed for them to meet their needs rather than using a generic package. Moreover, when software is developed specifically to suit a particular company its usefulness to others is limited. Having the source code unavailable further limits companies from being able to fix and adapt software (Boulanger, 2005).

The Open Source debate.

At times, the debate over Open Source versus Closed Source (propriety software) has become quite passionate. The most obvious grievance against Open Source software involves complaints about the lack of monetary gain from traditional methods such as the sale of individual copies and patent royalty payments, which is much more difficult and impractical with Open Source software. Some proprietary software companies sell the rights to use individual copies of software as their primary source of income, using a combination of copyright, patent, trademark and trade secret laws (collectively referred to as intellectual property right laws). By keeping their software code hidden, they make it impractical for changes to be made to any program they develop, whilst charging fees for its use and improvement. While most software is written for internal use, the fees from sale and license of commercial software are the primary source of income for companies that sell software. The main argument critical of open-source software is that closed source development allows more control over the final product The thought here is that open-source software is primarily a volunteer effort, whilst closed source development is driven by salaried employees each taking charge of a particular aspect, culminating in a more focused project.

Over the last decade, Linux has become Microsoft's biggest rival. The Linux market is growing rapidly and the revenue of servers, desktops, and packaged software running Linux \$35.7 billion 2008 was expected to exceed by (http://www.blackducksoftware.com/news/releases/seventh-annual-future-opensource-survey-results-show-culture-quality-and-growth). The International Data Corporation 2007 report indicated that Linux held 12.7% of the overall server market at that time (IDC Q1, 2007). This estimate was based on the number of Linux servers sold by various companies and did not include server hardware purchased separately, which Linux had installed later. In September 2008, Microsoft CEO Steve Ballmer admitted that 60% of web-servers ran Linux, versus 40% that run Microsoft (Niccolai, 2008). To help put this into perspective, Microsoft spends millions of dollars per year on advertising and has a market share of 59%, while Linux has almost zero advertising and has managed to gain a 33% market share.

Few models have been developed that explain how or why the Open Source community works, or to explain how collaborative networks function without primary dependence on money. Whilst one could argue that not all networks are dependent on money, there is usually a tangible reward for participation that is measurable. The tangible rewards for the Open Source community are not immediately identifiable. Proponents regard it as a paradigmatic change, whereby the economics principles are that private goods built on scarcity of resources are replaced by the economics of public goods, where scarcity is not an issue. Critics argue that Open Source software projects lack the capacity to innovate and will always be relegated to niche areas, and consequently cannot compete with commercial opponents in terms of stability and reliability (Lewis, 1999). Commercial companies still look for adequate responses to Open Source software and legislators discuss its social implications. However, there is still one simple question that remains unanswered, in the absence of direct compensation, what motivates participants to work on open-source projects?

As previously stated, Open Source software development is based on a collaborative effort where software is created by a community of volunteers, or members of organisations who support the Open Source software movement. Software projects have "owners" who initiate projects and have the right to redistribute modified versions of the software (Bergquist & Ljungberg, 2001). Each project's development process often involves a review system that is similar in nature to the peer-review system common in academia (Bezroukov, 1999; Raymond, 1999). Members share their knowledge and skills, the software they write undergoes peer-review by the owners of the Open Source software project and if deemed good enough it is accepted and its contributors gain credit for it (Bergquist & Ljungberg, 2001). Thus, contributors need to

have a reasonable level of expertise and to have this expertise made public in order for them to make a creditable contribution. However, the OS community is not just made up of people who write the software. As illustrated by **Figure 4**, members contribute in different ways within the community. Peripheral participants may contribute by submitting bug reports or suggesting new features.

Existing research into the Open Source community has generally focused on the motivations for individuals to join the Open Source community, and has rarely focused on the reasons why individuals choose to stay involved or the circumstances as to which people initially become involved. More specifically, OS research practitioners have primarily been interested in three sub-areas of research: (1) developer motivation to participate, (2) competitive dynamics and (3) innovation processes, governance and organisation (Fang and Neufeld, 2009). The research to date has not considered other factors which may play a part in encouraging people to participate in the OS community and why they stay. Life stage, gender, age and structural changes in society impact on a person's available time and therefore influence the likelihood of joining the OS community. More free time may lead to increased participation. These areas are critical to understanding the motives to participate and therefore are examined in the current research. Furthermore, multiple motives to join may exist for an individual and all aspects must be considered to thoroughly explain participants desire to join and participate in the community. This has not previously been done.

As stated, this thesis differs from the extant research on participation in the OS community as it does more than just build on existing theories. It offers a new and more comprehensive explanation, taking into account structural changes that have presented the opportunities for people to become and stay involved in the community. Tenet one has been discussed in the current chapter, with the remaining tenets to be discussed in subsequent chapters.

- Tenant 1. Open Source participation and interaction comprises a 'community'
- Tenant 2. Participation in the Open Source community is a form of volunteer activity
- Tenant 3. Structural changes in society have changed the way people use their time, which has provided new opportunities.
- Tenant 4. Age, gender and life stage impact on the decision to participate in the OS community and influence the amount of time spent contributing.

Previous studies have aimed to explain the motives behind why groups of people contribute, whereas this study explains who these individuals are through the use of Rational Choice Theory, and also explains why the various motivations are more likely to arise. The remainder of this chapter will examine the concept of community.

What is a community?

As previously stated, one aim of the research is to analyse why people volunteer their labour in new forms of community. Whilst on the surface the OS community seems unique, it actually shares many similarities with traditional community types, the main difference being that communication in this context occurs online. The Internet plays a major role in modern society and has increased opportunities to communicate and share information by lowering barriers arising from cost and distance. Consequently, new technologies have contributed to evolving definitions of community, which are needed, as traditional forms of communication expand. Throughout the world, members of the Open Source community frequently communicate online, consequently, a more up to date and complete definition of community is now required.

Early definitions of communities.

Originally early theorists, such as Hawley (1950) defined communities with a focus on relationships within geographically and temporally bound areas and where face-to-face contact was considered to be a central characteristic of community. Kaufman's (1959) review of the literature pre-1959 found that most scholars were in basic agreement that

community consists of persons in social interaction within a geographic area and having one or more additional common ties. However, a firm definition was not established with controversies over the meaning of the term 'community' being notorious with 94 separate definitions already offered by the mid-1950s (Hillery, 1955). These early definitions of community did not take into account societal changes due to mass transportation, geographic or social changes that have enabled other forms of community to develop.

From the early 1990s, critiques began to emerge about previous conceptions of community being geographically bounded and heavily reliant on face-to-face interactions. Writers such as Young (1990), Stone (1992), and Phelan (1996) have argued that the ideal of community was highly problematic given that it was based primarily on creating connection through unity and sameness, which ultimately excludes as much as it might include. These authors highlighted the ways in which sameness serves as the basis of inclusion and difference as the basis of exclusion. This led scholars to redefine community within a post-modern context finding that community not only could be, but should be, based on interdependence between diverse individuals and appreciation of differences (Phelan, 1996).

Current definitions of Community.

More recently Brint (2001, p.9) defined a community as an 'aggregate of people who share common activities and beliefs, and who are bound together principally by relations of affect, loyalty, common values or personal concerns'. This definition acknowledges that relations among members of a community do not need to be exclusive or even frequent and that it is not necessary for these relations to be based in every instance on effect, loyalty shared values or personal concern. His assertion is that community is driven by 'aggregates of people', and these collections/aggregates share something (be it a set of beliefs, ideals, desires, activities or concerns) which bind them together. This definition, though thorough, remains vague in that it may also be used to describe a classroom or a group of friends enjoying a camping trip, which is problematic as these are clearly not 'communities'.

Fowler and Krush (2008) attempt to refine the broad definition presented by Brint (2001) by arguing that a community should be defined as a structured and inter-related network between groups of people, where each individual group (as well as the collective network groups) is bound together by relations that may include affect, loyalty, common values, personal concerns, common activities and beliefs. A distinctive feature of a community from this perspective is where the strength of relationships within groups is relatively greater than the tie strength that exists between groups. This explanation is helpful, as it does not assume that members need to be in close physical proximity for the community to exist. The key component of this definition is that it differentiates communities from groups of people who may have similar interests but are not necessarily connected with a particular group.

Equally important in defining what a community comprises of, is the acknowledgement of the 'emotional connection' that one feels when they are part of a community. An important aspect of feeling like one is part of a community is having a 'sense of community'. Sense of community refers to the fundamental human phenomenon of collective experience and it has been studied in a variety of contexts such as neighbourhoods (Brodsky and Marx, 2001; Colombo, Mosso and DePiccoli, 2001; Kingston, Mitchell, Florin and Stevenson, 1999), community organisations (Hughey, Speer, and Peterson, 1999),workplaces (Pretty and McCarthy, 1991), faith institutions (Miers and Fisher, 2002), immigrant communities (Sonn, 2002), and fire fighters (Cowman, Ferrari, and Liao-Troth, 2004). The stronger the sense of community a member feels, the more likely they are to continue to participate. Furthermore, a 'sense of belonging' has been studied in both online (Blanchard and Marcus, 2002; Rovai, 2002b) and offline communities (McMillan and Chavis, 1986). In both cases a sense of belonging was related to a desire to remain in the community and is crucial for community maintenance. Furthermore, researchers such as Block (2008) emphasize the importance of 'belonging' to community stating that 'we are in community each time we find a place where we belong'. Block (2008) argues that belonging has two meanings. First and foremost, to belong is to be related to and a part of something. The second meaning relates to being an owner: to belong to a community is to act as a creator and co-owner of that community. Furman (1998) similarly argues that community has elements of sense of belonging, trust of others, and safety. Within a community individuals form attachments to one another; but they also take action, via their organisations. This last point is exceedingly important for sense of community, as community organisations frequently function with a host of often antagonistic community forces that have been shown to affect important facets of community life, such as community identity and boundary formation/regulation (Hunter and Suttles, 1972).

Internet relationships such as online communities, often involve the interaction of individuals who have never met or may never meet. This raises the issue that the 'sense of belonging' and the 'sense of community' that a member in a group feels must have an impact on the level of 'trust' that operates amongst members within the online community. Feng et al. (2004) concluded that in order for online communities to function and survive there is a definite need for the presence of trust between members. Similarly, Whitworth and De Moor (2003) found that trust plays an important role in the success of e-commerce websites. Trust plays a crucial role in maintaining social order in society in general, but in the context of online communities - authorities are scarce, emphasising the primordial role trust plays (Cook, 2005). Cook claims that without formal agreements or the absence of authorities; it would be difficult for larger networks to carry on their exchange if there were no solid boundaries of trust (2005). Putnam (1993) studied hierarchical and horizontal structures and established a relationship between trust and the likelihood to collaborate. Horizontal structures were linked to collaboration and the generation of trust, while hierarchical relationships often isolated those of lower rank. Rohe (2004) further states that simply being part of, or engaged in a community does not inherently lead one to trust more. He argues that trust comes from the content and extent of the interaction and that without trust social capital is only apparent at a structural level. On the other hand, when trust is well established it creates an array of opportunities for collective action and makes for more successful community development.

A community is a group of people who can communicate through a variety of mediums, including online and face-to-face contact, but are not geographically bound. Communities are characterised as members of a group that share similar interests and through increasing interactions strengthen their relationship with the community. As can been seen, OS participation shares many characteristics of traditional community types. OS is a group of individuals who share common interests, beliefs and work together on projects online (Fowler and Krush, 2008; Aronson and Mills, 1959; Buss and Portnoy, 1967; Porter, 2004).

Is Open Source a Community?

Developments in computer-based technologies have transformed the relationships individuals have with their social networks and larger communities. The Internet has changed the concept of community, blurring the distinction between virtual communities and face-to-face communities (Rosen, Lafontaine and Hendrickson, 2011). Community groups are settings in which individuals commonly raise their concerns and complaints. Through this commonly shared concern a sense of belonging may develop amongst the members (Hunter and Suttles, 1972). The OS community is founded on the philosophy that the source code of a program should be open and free for the user to make alterations and this commonly shared belief is argued to contribute to the participants continued involvement.

The Open Source community can be thought of as a virtual community. The projects that members contribute form a community; they are unique in that they are also production orientated, similar to how work is organised in the IT industry: borderless,

virtual but predominately run by volunteers. Similar to traditional community type's members share common interests and goals and work together collaboratively to achieve them. Open Source communities are an example of a user-community in which information, assistance and innovations are freely shared. Volunteers from many different locations and organisations carry out OS development projects, and these individuals develop and share code to create and improve programs. Individuals in the OS community voluntarily contribute their time, skill and energy to innovation and product development communities. These communities have no paid staff or management, yet they provide participants with a social context and the resources to create useful products. These products have on occasion displaced or significantly improved commercially produced products (Sonali, 2003). OS communities appear to be driven by innovation and as such very little is understood about them.

What we do know is that the Open Source community appears to be very similar to traditional community types. They are a network of people who have similar interests and work in groups on projects. There are numerous projects that run consecutively and participants select the project that interests them. Participants may be involved in only a single project, or in multiple projects at the one time. Participants work collectively but remotely, that is they are spread out geographically. The formation and navigation of communication networks has been fuelled by new media that leaves traces of interactivity (Rosen et al., 2010). As people communicate, they form social network ties that connect them to individuals, groups and communities. In a direct link someone uses to reach another individual is known as the path (Freeman, 1979), and the network becomes more connected as individuals become increasingly reachable through direct links. The Open Source community is an example of a large-scale global social network that connects millions of individuals. Ties are established through information exchange and represent access to resources in an increasingly connected network. The quality and quantity of ties an individual has represent how connected one is, and highly connected individuals typically have access to more resources and thus an increased amount of social capital. As in traditional communities OS members gain friends that are trusting relationships embedded in their social networks.

Virtual community recapitulation.

Open Source can be considered as a 'virtual community' (Sagers, Dickey and Wasko, 2004). To recap, a 'virtual community' is a group of people who primarily interact via communication media such as email, the Internet or instant messages, rather than faceto-face contact. Porter (2004) defines a virtual community as an aggregation of individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms. In many virtual communities dominant members do emerge where they are able to influence each other based on intellectuality, usability or by their high levels of commitment to the community (Brint, 2001). This is important, as the OS community is not just a random collection of people. It is hypothesised in this thesis that the Open Source community contains networks that are based on a hierarchal structure with the most experienced and largest contributors having the most influence over projects (Crowston and Howison, 2006). A hierarchical structure is one that is organised or classified according to status. The stereotypical hierarchy is an organisation with tiers of employees from the bottom to the top linked by reporting relationships. However, the concept can be applied to connections other than organisational reporting. A project with sharp divisions between a few developers who have control over a project would also be hierarchical in terms of code development. This is because the developers would form a tier that has more authority over the code than the others.

Crowston and Howison's (2006) research found that participation and expertise build a reputation, which leads to this hierarchical relationship. Reputation is found to be a motivator for content contributors as well (McLureWasko and Faraj, 2005), and the prospect of gaining reputation motivates people, as it is an asset they can leverage to achieve and maintain status (Jones, Hesterly, and Borgatti, 1997). However, more

research needs to be conducted to provide empirical support for this theory. Given the characteristics of OS participation (frequent contact, common goals and similar interests) this thesis argues that OS participation shares many features of a community, and therefore should be conceptualised as a virtual community. This hierarchal relationship will be further investigated empirically in Chapter 6 through the use of Social Network Analysis. It is hypothesised that respect, prestige and status are gained between members by their contribution to various projects.

Table 3 shows a typology of virtual community attributes developed by Brint (2001). The typology provides an overview of characteristics that exist within virtual communities that may also be found in the OS community. In particular, the characteristics of high levels of support, identification with the community and the pursuit of individual interests are expected to be evident in the current research. Brint's (2001) typology is useful for gaining a greater understanding of how virtual communities operate.

Table 3: Typology of Virtual Communities.					
A. Archetypal Virtues: Fraternalism and Mutual Support	Virtual Community				
High levels of member participation	Varies				
Strong fraternal feelings, typical among members in closest contact	Yes				
High levels of appreciation of individuals as individuals	Usually not, but variable				
High levels of mutual support	Varies				
Strong, self-conscious identification with community	Often				
Oral memory, traditions and/or folklore	Varies, often short lived				
High levels of ritual to integrate	No				

Archetypal Virtues: Informal Dispute Settlement and Low Levels of Stratification

Mutual adjustments through interaction or values?	Varies			
Dispute resolution through rules, discussion, informal mediation or combination	Primarily through rules and discussion			
Stratified/unsatisfied	Relatively unsatisfied			
Interaction strongly influenced by particularistic social identities (e.g. gender)	No			
Archetypal Vices: Enforced Conformity, Liberalism and Intolera	nce			
High levels of enforced conformity	No			
Significant constraints on pursuit of individual interests	Relatively little			
Creation of deviance	Yes			

Strong boundaries between members and non-members Varies

There are four main characteristics that help to define the traits that classify the various OS groups as virtual communities. These characteristics are:

A production orientation, in that participants produce goods and services by voluntarily contributing their time and skills. These products have on some occasions been considered superior to commercially produced merchandise (Sonali, 2003).

Predominantly run by people employed in the IT industry, and who contribute to the OS community through product development in their free time, without any direct monetary payment for services (Ghosh, 1998).

Borderless and virtual, in that the participants are geographically dispersed and the majority of communication is conducted online through the use of the Internet (Feller and Fitzgerald, 2002).

Structured hierarchically, so participants that contribute to the most projects and who have the highest level of technical skills seem to be the members that advice is sought from, and are those that direct the projects (Hars et al, 2002, p.30).

In summary, the Internet has enabled the formation of online communities such as the Open Source community where members create, share and improve software in a collaborative environment. Participation varies greatly amongst the members, with some using only the programs whilst others spend hours updating, designing and fixing them. Members of the OS community share common interests, beliefs and work together to achieve individual and community goals. Open Source is a virtual community.

Why do people participate in the Open Source Community?

The motivation for involvement in Open Source projects is bound to vary from one individual to another. However, involvement in Open Source projects can undoubtedly create other opportunities for participants (friendship, human capital). Light (2004) describes social capital as the collection of trusting and accessible relationships in one's social network. An individual's ability to fulfil their personal needs by accessing resources determines how much social capital they have (Burt, 2000). Lerner and Tirole (2001), argue that one benefit of participation in these communities often downplayed is the fun, enjoyment, and intrinsic motivation that arise through engagement in the task and community. People participate and continue to be involved because they enjoy it or benefit from it.

To understand what motivates people to participate in the Open Source community, when traditional rewards such as monetary payments are not gained, it is useful to examine the volunteering literature. The current research aims to investigate why people join the OS community and what makes them stay. It is argued that the volunteer literature can help to answer these questions. The volunteer literature is extensive and covers many areas that are useful to the current research. Volunteering motives are diverse and directly affected by life stage, gender and occupations. The contention made here is that the Open Source community is essentially a community of volunteers.

Conclusion.

The Open Source community is a large group of individuals who contribute to the development of new software. This software is commonly referred to as Open Source software and is generally distributed under the General Public License (GPL). The purpose of the GPL is to grant any user the right to copy, modify, and redistribute programs. The Open Source community is unique because participants predominately use their free time to complete work type activities to produce software. While the

phenomenon of Open Source is certainly new, there are clear continuities with the past, with respect to the formation of communities and motives that influence time use choices. The core argument of this thesis is that economic, social, technical and cultural changes result in new circumstances and conditions. The choices people make under these conditions largely reflect a set of basic concerns and interests that show a degree of continuity with the past. What has changed over the years is that the Internet and associated technologies now provide new opportunities for satisfying these concerns and interests. These aspects have not been thoroughly explained in previous research and are examined here. The aim of this chapter was to inform the reader about the Open Source community and to highlight that OS development is a virtual community. Furthermore, the chapter described the nature of the software, reviewed previous studies and identified further areas of research.

In Chapter 2, the nature of volunteering is discussed to further clarify OS participation as a form of volunteering. Commonly, voluntary work is related to participant's type of paid employment. Managers, administrators and professionals are more likely than other occupational groups to partake in management and committee work; professionals to teach or provide information, and tradespersons to undertake repairs, maintenance or gardening activities (ABS cat 4441.0). This is also demonstrated in the OS community where the majority of participants are employed in the IT industries, who then participate in the OS community as part of their free time activity.

The next chapter proposes that Open Source participation can be better explained when viewed as a form of volunteering.

CHAPTER 2

A CONCEPTUAL ANALYSIS OF THE VOLUNTEERING LITERATURE

Introduction.

A question central to this thesis is what motivates people to devote time to the Open Source community. One way to consider this question is to review what is known about the motivation to volunteer by examining the existing literature. The body of literature relating to volunteering is diverse, spanning several areas including time use, life stage, gender and employment (DeVoe and Pfeffer, 2007; Warburton and Crosier 2001). This chapter explores why people choose to volunteer their free time on activities very similar to paid employment.

What is a volunteer?

The definition of volunteering and who qualifies to be called a volunteer is debated in the literature (Brudney, 1990; Gora and Nemerowicz 1985; Cnaan and Amrofell 1994; Cutler and Danigelis, 1993; Gallagher 1994). The current research does not enter into this debate, but utilises the most scholarly definitions provided in order to help build a suitable framework to classify an Open Source computer programmer as a 'volunteer'. In essence, volunteering is any activity in which time is given freely to benefit another person, group or cause (Wilson, 2000). However, this definition does not necessarily preclude volunteers from benefiting from their work, although it is debatable as to whether it should include material rewards, with some scholars believing that if volunteer work is remunerated, it is not truly a volunteer activity (Smith, 1994). The ABS (cat 4441.0) study of volunteers in Australia defined volunteer work as someone who, in the last 12 months, willingly gave unpaid help in the form of time, service or skills through an organisation or group. In 2000, 5.2 million people (or 34% of the Australian population aged 18 years and over) participated in voluntary work. They contributed 713 million hours to the community through many different activities. Overall, 32% of men and 36% of women were considered to be volunteers (ABS cat 4441.0). Wilson (2000) describes volunteering as part of a general cluster of helping activities rather than the spontaneous kind of help offered to victims of an assault, whereby the encounter is invariably brief and chaotic and needs a rapid assessment as to whether action is or is not necessitated.

Overview of Volunteering in Australia.

Australian data shows that patterns of volunteering vary with life stage, with people aged 35–44 most likely to volunteer (43%) (ABS cat 4441.0). This age group incorporates a large number of parents with dependent children and is reflected in higher than average volunteer rates, most markedly for women. Thus, females with a partner and dependent children had a volunteer rate of 50%, compared with 32% for females in a similar situation without dependent children. This revealed much higher rates of volunteering among parents of school-aged children, (i.e. with children aged 5–14 years) and indeed much of this activity is related to children's activities and school. Employment status also has an effect on volunteering rates with people in either fulltime (34%) or part-time work (44%) having higher rates of volunteering than those unemployed (26%) or not in the labour force (30%). Although this seems counterintuitive and is inconsistent with the idea that having more time will increase the volunteering level, some groups of people have more flexibility in arranging their paid working hours to accommodate voluntary work, and this may have an effect on the participation rates by different occupational groups. Also, as discussed previously, individuals often use work related skills in their volunteer activities. The older members (35–64 years) of many occupation groups tended to be more likely to volunteer than their younger colleagues. Men employed full-time were as likely to volunteer (34%) as women employed on the same basis (33%).

Volunteering rates vary considerably with educational levels and occupational groupings. People with higher educational qualifications tend to volunteer more than those with lower qualifications. Managers/administrators and professionals (both 46%) and advanced clerical and service workers (45%) have the highest participation rates. Intermediate production and transport workers (26%) and labourers and related workers (25%) had lower volunteer rates (ABS cat 4441.0). The nature of people's voluntary work was to some extent related to their type of paid employment. As highlighted earlier, managers/administrators and professionals were more likely than other occupational groups to do management and committee work, professionals to teach or provide information and tradespersons to undertake repairs, maintenance or gardening activities (ABS cat 4441.0).

Open Source participants: Are they volunteers?

Open Source participation shares many characteristics with volunteering. Volunteering behaviour consists of a set of behaviours that are proactive. A helping activity requires a public element, commitment, and effort and community involvement (Herzog and Morgan, 1993). Open Source participation incorporates all these aspects. It is an online community in which members actively choose to participate and contribute in various ways, including programming and advice. Open Source participation is a public activity, as members make contributions openly in the public online domain. Their involvement is proactive rather than reactive and they produce goods and services under market value. OS participants generally contribute to online discussion boards and offer advice and assistance to other members and the wider community, usually receiving no payment for services offered or time spent. It is not uncommon for individuals to use work related skills in their volunteer activities. Many OS participants employed in the IT industry utilise their skills in the community in their free time (FLOSS, 2002). The intrinsic rewards people gain from their paid work through the enjoyment of their employment can translate to volunteering in similar activities (Herzog and Morgan,

1993). Other factors influencing the decision to volunteer are life stage and time use, which will be further discussed later in the chapter.

The classification of Open Source developers as volunteers provides a clear theoretical framework for examining the motivations and the intrinsic and extrinsic rewards gained through this participation. It also offers a useful comparison for examining if the rewards offered by volunteering in more commonly perceived volunteer activities such as surf life saving, are similar to those experienced by OS participants. It has been found that volunteering can positively affect an individual's wellbeing due to the various intrinsic and extrinsic rewards they gain. Meier and Strutzer (2008) argue that people volunteer in order to receive a by-product of volunteer work.

In Chapter 1 it was argued that OS participants form a community. Open Source participants are a community of volunteers who use their expertise and skill to contribute to the Open Source community. The question arising from this is what the motivation is for individuals to volunteer their time, energy and effort into this community. One way to look at this is to compare the OS community to more traditionally recognised communities, such as a faith based institution like a church. Members of a church are a community of believers; they believe in the same god, share the same values, morals and some members volunteer their time in a church for free because of this shared belief. The OS community members also have a shared belief. They believe that material that would normally be categorised under a copyright agreement should actually be released under licenses that encourage sharing and alteration of the material contained within. This is a fundamental aspect of the community. However, whilst this shared belief may support members to be involved in the OS community, as would the beliefs in a church group; there are more strategic reasons why people volunteer. In particular, the literature reveals that age, gender and life stage generally impact on the decision to volunteer.

The motives to volunteer.

Batson, Ahmad and Tsang (2002) offer a conceptual analysis that differentiates four types of motivation for community involvement: egoism, altruism, collectivism and principlism. An individual may have more than one ultimate goal and therefore more than one motive at any one time. Batson, Ahmad and Tsang (2002) believe that to adequately explain community involvement all four motives should be studied with the relevant interplay considered. For a given individual in any situation, more than one of these motives may be present and may conflict or cooperate with each other.

Egoism- the ultimate goal is to increase one's own welfare.

A common question regarding volunteers in general and which is specifically relevant to this study is why one would act for the common good, or more specifically, why OS developers act for the common good. Batson, Ahmad and Tsang (2002) offer a general explanation to identify motives that might lead to community involvement. They suggest that it would be wise to examine the ethics of those acting for the common good. There is little doubt that most of us value our own welfare and are motivated to enhance it when opportunities arise. Egoism - motivation with the ultimate goal of increasing our own welfare - clearly exists. It is the assumption of virtually every major account of human action in psychology, sociology, economics and political science, that all human action is always and inevitably directed towards the ultimate goal of selfbenefit (Campbell, 1975; Mansbridge, 1990). The supposition being that if someone acts for the welfare of others or for the good of the community, it simply provides an instrumental opportunity to promote one's own welfare. Through the OS community participants have the opportunity to improve their skill set (which may lead to future gains through job opportunities), the volunteer activity also produces a beneficial outcome for the general public by providing better quality software. Ghosh (2002) found that one of the motives for participants to contribute to the community was to improve their skills, as they believe this to be valuable in assisting with career advancement. Hars and Ou (2002) found that whilst OS participants may not be directly compensated for contributions, they still obtain direct rewards by increasing their marketability. In short, participants act in their own self-interest and this may drive participation.

Altruism - Serving the community to benefit one or more individuals.

Altruism theory relates to the way a person responds when serving the community in order to benefit one or more individuals. Altruism is motivation with the ultimate goal of increasing the welfare of one or more individuals other than oneself. The most commonly proposed source of altruistic motivation is empathic emotion, with 'empathy' referring to other-orientated feelings congruent with the perceived welfare of another person Batson, Ahmad and Tsang (2002). As discussed earlier, the OS community advocates that the source code of all software should be available, and they argue that it produces better software and allows people to be able to modify and fix programs to suit their own needs. The assumption is that by contributing, you are acting in the greater good by serving the needs of members and the wider community. Furthermore, as established through the discussion forums (presented in Figure 5) altruistic behaviour in the community can be demonstrated by the way in which new members join the community, generally seeking assistance and guidance with their software problems and the more experienced community members providing the necessary help. There is no obvious benefit for the experienced member to provide such assistance and therefore the act could be viewed as altruistic.

Collectivism - Serving the community to benefit a group.

Collectivism refers to the function of serving the community in order to benefit a group. Collectivism is motivation with the ultimate goal of increasing the welfare of a group or collective (Batson, 1994). The collective may be one's race, religion, sex, political party or social class, though one does not need to be actually a member of the collective, and if one values a group's welfare and this welfare is threatened or can be enhanced in some way, then the collectivist motivation should be aroused, promoting action to benefit a group, and this action may in turn benefit the community as a whole Batson, Ahmad and Tsang (2002). In relation to the OS community, the belief is that by contributing you are potentially benefiting the wider society by producing higher quality software and making it widely accessible.

Principlism - Serving the community to uphold moral principles.

Principlism is motivation with the ultimate goal of upholding some moral principle, such as justice (Batson, 1994), or by doing something for a greater good. They argue for a motive other than altruism and collectivism, as appeals to altruism are based on feelings of empathy, sympathy and compassion. They believe that these emotions are too fickle and circumscribed and dispute appeals to collectivism, because it is bounded by the limits of the collective. Typically they call for motivation with a goal of upholding some universal and impartial moral principle Batson, Ahmad and Tsang (2002). In the case of OS, the philosophy is based around the idea to have the source code available to all users and to limit the perceived power of software companies that manufacture closed source software. Whilst this view provides an overview of the functions that may be obtained from participating in the OS community, it does not help to explain any of the environmental factors that contribute to participation.

The impact of life stage on motives for volunteering.

The literature reveals that there are certain aspects about the person that encourage or discourages volunteering. Life stage affects the amount of free time available to an individual and has an impact on their decision to volunteer. Life stage also has an effect on the motivations of those choosing to volunteer. Gidron (1978) studied 317 volunteers and identified that the age of participants was important in determining their motivations for volunteering. Younger volunteers were found more likely to cite the importance of gaining work experience, whilst older volunteers valued social interaction. Little of the literature acknowledges the fact that volunteers may actually

be making a conscious decision to volunteer in certain activities that increase their skill base (and therefore improve their employment prospects). This is of particular relevance to the OS community who are at an age where career enhancement may be of importance.

In relation to volunteering generally, Clary and Snyder (1999) found similar results to Gidron (1978) using the Volunteer Functions Inventory (VFI), which was used in a National Survey (American Adults giving and Volunteering) (Clary, Snyder and Stukas, 1996) (See **Table 4**). Respondents reported that values and understanding were the most important benefits; however, career enhancement was more important to younger respondents than older ones. The study highlights the complex nature of volunteering motives and shows that volunteers may have a variety of reasons as to why they choose to volunteer, not only for OS developers but also for volunteers in general (Clary and Snyder, 1999). It is quite simplistic to suggest that a volunteer's motivations can be neatly classified as either altruistic or egoistic due to the fact that some specific motives combine, for example a desire to help and/or gain skills through volunteering. The following is a table of the functions gained by volunteering. As can be seen, except for the values, the majority of the functions are egocentric.

Table 4: Modified version of the (VFI) explaining the various functions served byvolunteering (Clary and Snyder, 1999).

Function	Conceptual Definition
Values	The individual volunteers in order to express, or act on important values like humanitarianism
Understanding	The volunteer is seeking to learn more about the world or exercise skills that are often unused.
Enhancement	One can grow and develop psychologically through volunteer activities.
Career	The volunteer has the goal of gaining career-related experience through volunteering.
Social	Volunteering allows an individual to strengthen his or her social relationship.
Protective	The individual uses volunteering to reduce negative feelings such as guilt or to address personal problems.

Katz (1960) and Smith, Bruner and White (1956) argue that the functional approach may uncover the motivational forces underlying activities such as volunteering. The functional approach seeks to understand the psychological and social needs, goals, plans and motives that individuals are attempting to satisfy through their beliefs and behaviours. This approach highlights that similar beliefs or behaviours which may serve different psychological functions for different people. Participants may engage in volunteer work in order to achieve important psychological goals and as such volunteers will seek to satisfy different motivations, including increasing personal relationships or esteem (Clary, Snyder and Stukas, 1996). Accordingly, some people may be attempting to satisfy a Values Function, whereby they participate in volunteer work to express and act on values important to themselves (altruistic concerns). People view volunteer work as an opportunity to increase their knowledge of the world and to develop practical skills, thus serving an Understanding Function. Volunteer work may also allow the individual to engage in psychological development and enhance his or her esteem, thereby satisfying an Enhancement Function. Others engage in volunteer work as part of the Career Function, where they work to gain experience that will ultimately benefit their chosen career path. Volunteering may also help individuals to fit in and get along with social groups that are important to them, thus satisfying a Social Function. Lastly, others may participate in volunteer work to satisfy a Protective Function, engaging in volunteer work to cope with inner anxieties and conflicts, thus affording some protection for the ego (for example: to reduce feelings of guilt or inferiority) (Clary, Snyder and Stukas, 1996).

In summary, volunteering in its simplest sense is the giving of one's time to aid an individual or group. It is a subjective activity to both the volunteer and the spectator and covers a broad range of activities; it includes characteristics of helping, being proactive, demonstrating commitment and community involvement. Life stage and age have an impact on whether individuals volunteer, as well as to the amount of time they contribute. People aged 35–44 reported the highest levels of volunteering. Higher

education levels and being employed also increased volunteering participation. People are most likely to volunteer in a capacity similar to that of their paid employment. This may explain why employed persons are more likely to volunteer, because they have the skills and experiences to contribute to organisations or groups, which rely on volunteers. Therefore, volunteer activities are more like paid work than one might think. Furthermore the amount of available time an individual has to spare is likely to impact the motivation to volunteer. Studies have shown that the need to fill in time is often given as a reason for volunteering (Clary, Synder and Stukas, 1996; Warburton and Crosier, 2001). Similarly, being too busy or having insufficient time is often cited as a reason for not volunteering (Paolicchi, 1995). Previous data shows that time, or perceived time, available is important in understanding the propensity to volunteer. Interestingly, longitudinal analysis of time use diaries reveals that contrary to anecdotal reports, people today generally have far more time to spare than previous generations (ABS, 1997; Bittman, 1999, Gershuny, 1992). Whether or not this translates into more time spent volunteering generally is another issue to explore.

In the next chapter time use will be discussed in depth. However, the environment has essentially created opportunities for individuals to use their free time in more ways. In regards to OS participation, the theories on volunteering provide a framework that helps to explain the behavior, or more specifically the situation and environment, which have enabled the OS community to thrive.

What motivates people to participate in OS, what the literature tells us about the motivations?

A portion of the Open Source literature has focused on identifying the various motivations individuals have for contributing to Open Source initiatives (Lakhani and von Hippel, 2003; Stewart and Gosain, 2006; von Hippel and von Krogh, 2003). A vast variety of motivations have been indicated. An important distinction made as by Lakhani and Wolf (2005) is between intrinsic and extrinsic motivations. Porter and Lawler (1968)

first proposed a model of intrinsic and extrinsic motivations. Intrinsic motivation involves doing an activity to satisfy some immediate personal need and thus the activity 'is valued for its own sake and appears to be sustained' (Deci, 1975). In other words, intrinsic motivation refers to the motivation to engage in work primarily for its own sake because the work itself is engaging, interesting or in some way satisfying. In contrast, extrinsic motivation requires an instrumentality between the activity and some separable consequences. That is, extrinsic motivation is the motivation to work primarily in response to something apart from the work itself, such as reward or recognition or the dictates of others. Therefore, extrinsic motivation involves undertaking an activity to satisfy one's needs indirectly. Extrinsic motivations are instrumental in nature and represent a focus on extrinsic rewards, where the expected benefits of contributing are believed to exceed the contribution costs (Lerner and Tirole, 2002). In the OS world these include, improvement of programming skills (Lakhani and von Hippel, 2003), creation of required or otherwise unavailable code and the enhancement of professional status (Lakhani and Wolf, 2005; McLure-Wasko and Faraj, 2005). Intrinsic motivations on the other hand include motivations such as altruism (Zeityln, 2003), fun (Torvalds and Diamond, 2001), reciprocity (McLure-Wasko and Faraj, 2005), intellectual stimulations and a sense of obligation to contribute (Lakhani and Wolf, 2005).

This research is valuable as it highlights some of the motives that exist in the community, however, that is all it actually explains. No other factors are considered. It does not elaborate on situations that encourage certain motives amongst participants, or help to predict the motives that may or may not be significant to the various groups of individuals involved.

Table 5 provides an overview of some of the more notable motives for participation andtheir retrospective researcher.
Table 5: Motivations and Prominent Researchers.

Motive	Example	Selected References
Need for product	Participating in order to create, customise or improve a product or feature	Raymond 1999 Kuan 2000 Franke & von Hippel 2003
Enjoyment, desire to create and Improve	Participating because one enjoys it; finds creating or improving enjoyable and interesting	Weizenbaum 1976 Gelernter 1998 Gabriel & Goldman 2001
Reputation and status within the community	Participating in order to build or maintain a reputation or status within the community	Rheingold 1993 Raymond 1999 Gabriel & Goldman 2001
Affiliation	Participating in order to socialise or spend time with like-minded individuals	Haring 2002 Raymond 1999
Identity	Participation in order to reinforce or build a desired self image	Haring 2002
Values, ideology	Participating to promote specific ideals e.g.: the free software philosophy	Raymond 1999 Gabriel & Goldman 2000 Stallman 2001
Training, learning, reputation outside of the community, career concerns	Participating to improve one's skills with the belief that such improvement will lead to a better job or promotion	Raymond 1999 Lakhani & von Hippel 2000 Lerner & Tirole 2000 Lancashire 2001 Hann 2002

To acknowledge the existing research on the motives, rather than attempting to explain each of the motives that appear in the literature, a more accurate explanation can be obtained by analysing the key motive areas most frequently cited to explain participation. The first set of motives involves altruistic behaviour, or the desire to help others in the community (Faraj and Wasko, 2001; Hars and Ou, 2002; Lakhani and von Hippel, 2003). The emphasis is on the direct satisfaction and the internal sense of obligation that drives the behaviour. Secondly, the desire to establish a reputation and to gain approval from others in the field (Hars and Ou, 2002; Lakhani and von Hippel, 2003; Lerner and Tirole, 2002; McLure-Wasko and Faraj, 2005). This motivation is considered extrinsic because of its instrumental value in enhancing a contributor's job prospects (Lakhani and Wolf, 2005). The third motivation involves a desire for selfdevelopment through learning from others in the field, receiving feedback and enhancing ones abilities and skills (Bonaccorsi and Rossi, 2003; von Hippel and von Krogh, 2003).

Altruism.

Altruism has been presented as a motivator for sustained participation by Hars and Ou, 2002; Gu and Jarvenpaa, 2003; and McLure-Wasko and Faraj, 200). Empirical studies have found a difference between the contexts in the levels of altruism as a motivator. McLure-Wasko and Faraj's (2005) study of knowledge contribution found a high mean level (4.1 out of 5) for enjoyment from helping as a contributing motivator, whereas Hars and Ou's (2002) study of software contributors found that only 16.5% of the respondents ranked altruism as high (6 out of 7) or very high (7 out of 7). When compared with 43% who ranked peer-recognition and the 88% who ranked human capital enhancement as high or very high, the importance of altruism as a motivator seems less likely for the majority of participants. However, this thesis does not discredit that altruistic motivators exist within the community, but rather argues that there are more instrumental motives that help to explain participation. The literature about the variations in altruistic tendencies is still not definitive, and it is unclear if certain groups

of people are more likely to cite altruism as a motivator. Rational Choice Theory assists with this question and is discussed further in subsequent chapters.

Self-development.

The Open Source software development process involves a peer-review mechanism, through which contributors receive feedback from peers (von Krogh et al., 2003). The peer-review system provides contributors with feedback that can enhance their professional skills (Lakhani and Wolf, 2005). Learning and skill development are cited as a prominent reason for contributing to Open Source software development (Lakhani and Wolf, 2005). Empirical research suggests that self-development is highly important for software contributors: 88% of respondents surveyed by Hars and Ou (2002) ranked human capital enhancement as high or very high – the highest percentage among the motivations studied. Career enhancement has also been highlighted as a motivation (Lerner and Tirole, 2002). Whilst these motives exist in the OS community, it is not known the degree as to which this varies amongst members, or if certain life situations increase the desire to improve one's human capital. It is argued in the current research that to analyse the motivation of self development, a complete analysis of all factors is required. Influences such as age, life stage, gender and the opportunity structure that one exists will play a part in the motivation to improve ones human capital. Very few prior studies have looked at these important factors.

Gaining a reputation.

Building one's reputation is discussed in the literature as a source of motivation (Bezroukov, 1999; Lakhani and von Hippel, 2003; Markus et al., 2000; Perkins, 1999; Raymond, 1999). By contributing to Open Source software initiatives, contributors signal their status (Kollock, 1999; Raymond, 1999), identity (Hertel, Niedner, and Herrmann, 2003), and abilities (Osterloh et al., 2003; Raymond, 1999). Furthermore, companies seeking programmers with particular skills can find potential hires by examining open-source software code (Lakhani and Wolf, 2005). Thus gaining reputation is very

instrumental in helping them to advance their careers in the software industry (Lerner and Tirole, 2002). The prospect of gaining reputation motivates people as it is an asset they can leverage to achieve and maintain status (Jones, Hesterly, and Borgatti, 1997). While gaining reputation and status is acknowledged as a motivator for participation in OS communities, the opportunity structure that exists for individuals to become involved is rarely discussed.

In 2002, a large internet survey was conducted on the Open Source community (FLOSS). The FLOSS research helped to identify important demographics of the OS community, as well as information about the general motives for participation. It was found that the OS community consisted predominately of young males aged between 16 and 36 years (only 1.1% of the sample being female). The majority were tertiary educated (70% having tertiary degrees) and a strong professional background in the IT sector (83 % of all developers were employed in the IT sector). Whilst it has been acknowledged that the majority of the OS community is male, few researchers have actually tried to investigate the reason for such male dominance. Further investigation is warranted and will be investigated in the current work, as gender bias may have important implications as to decisions individuals make when deciding to join and participate in the OS community.

The existence of these three sources of motivation in the current research is not disputed. However, there have been no attempts to examine the contributing structural factors that have provided the opportunities for such motives to be explored.

Alternative theories on motivations to participate in the OS community.

Aside from the motives discussed so far, a number of researchers have proposed other theories to explain participation, namely the Gift Economy, Cooking Pot Markets and Classic Economic Theory. In many cases the literature related to these theories is yet to be expanded on in any significant way, so the discussion of each of the following looks at the seminal literature by the key theorists.

The Gift Economy.

The Gift Economy theory has also been proposed as an explanation as to why people participate in the Open Source community. Cheal (1988) argues that the gift economy is a system of transactions that serve both the representation and the realisation of interpersonal relationships. The rituals of the gift giving economy enable individuals to institutionalise various social ties with an overarching moral economy (Flaherty, 1989, p.650). 'Moral' is defined as gift transactions that are viewed as valuable, not due to the transfer of wealth or influence, but rather to the social bonds that are established, acknowledged and maintained through the workings of the gift economy (Flaherty, 1989, p.650). Cheal (1988) further explains that mass society offers material comforts, but can also be characterised by anonymity, unstable environments and uncertainty. Consequently, human beings still need enduring emotionally charged relationships in which individual identities are integrated into a cohesive micro-solidarity, and whereby trust is a by-product of reciprocal role expectations. The gift economy is therefore a moral economy in which gift transactions constitute a fundamental medium for the social construction of intimacy and community in modern society. Raymond (1999a) expands on this definition by stating that gift cultures are based on gift economies in which social relationships are not regulated by the possession or exchange of money or commodities. Gift cultures are instead characterised by the creating and maintenance of social relationships based on the gift economy of gift exchange. In support of the gift economy, Bergquist and Ljungberg (2001) argue that the Open Source community is successful as a result of the gift economy embracing activities on online communities. They contend that Open Source software development relies on gift giving as a way of getting new ideas and prototypes out into circulation. The results put forward by Wu et al (2006) provide support for Bergquist and Ljunberg's (2001) argument of a gift culture existing in the OS community. Participants receive help and support given as a result of previous contributions, which have created a reciprocity agreement.

Open Source gifts resemble traditional commodities and can be used as both a product and a gift for creating and maintaining relationships. For the end user who does not wish to participate in the community, the difference is irrelevant – Internet technology makes exchange open (Beraquist and Ljungberg,2001), and thus the product becomes available to everyone. This initiative is essential in order to extend products and to make it feasible for as many programmers as possible to take part in the development process, adding their expertise to the ongoing project. Becoming an owner of a project that becomes successful results in the right to decide who should be entitled to give back and who should not. The more attention an Open Source project owner gets from the community, the more status and reputation they receive (Beraquist and Ljungberg, 2001). The gift economy is useful in actually explaining the action of participation (producing a product), but again does not offer a clear conceptual analysis for participation and the motivations and constraints involved. In particular it does not examine the 'self interest' aspect of participation or the opportunities and constraints that may encourage or discourage participation.

Cooking Pot Markets.

Cooking Pot Markets present an alternative explanation for the trade in free goods and services on the Internet (Ghosh, 2002). The Cooking Pot model attempts to provide an explanation for people's motivation to produce and trade in goods and services where a monetary incentive is lacking. It suggests people do not merely produce in order to improve their reputation, but rather that contends that they are expediently reimbursed in miscellaneous goods (in this case ideas) that they acquire from the cooking pot. The cooking pot market is not a barter system, as it does not require individual transactions. It is instead based on the assumption that on the Internet, duplication does not mean a loss. Therefore, each contributor receives their fair return in the form of contributions from others. The cooking pot market is not based on the idea that 'I do this for you, so you do this form me'. Instead it is communal, in that a person contributes and many others may also participate, and the information is then shared. Ghosh (2002) states

that reputations, unlike ideas, have no inherent value like money. They represent things of value as proxies. Reputations are crucial to seed the cooking pot and keep the fire lit, just as money is required to reduce the inefficiencies of pure barter markets. However, reputations require 'a calculus and technology for efficient working, just as money has its price setting mechanisms today' (Ghosh, 2002, p.14). Essentially, there needs to be value in the information that is contained in the cooking pot market, and other members with the expertise to ensure that the pot maintains this value through their participation.

Classical Economic Theory.

The opportunities available to a participant may impact on the decision to be involved in OS. The following section examines the cultural shift that has occurred in OS, and the impact this has had on participation. Lancashire (2001) offers an alternative explanation to explain Open Source development that disputes many of the ideas previously presented, proposing that the nexus of Open Source development appears to have shifted to Europe over the last ten years, and this trend undermines cultural arguments about 'hacker ethics' and 'post-scarcity' gift economies. Hacker ethics is the generic phrase that describes the values and philosophy that are standard in the hacker community. Open Source software is the descendant of hacker ethics, which includes the general principles of sharing, openness, decentralisation, free access to computers and world improvement (Levi, 1984). Post scarcity describes a hypothetical form of economy or society in which things such as goods, services and information are free or practically free. Many advocates of Open Source software and free software attempt to collaboratively create Open Source software programs, which are intended to offer similar capabilities to their proprietary software competitors, albeit with the source code made public and permission granted for users to freely copy the software. Richard Stallman, the founder of the GNU project which designed the free software GNU operating system and co-founder of the free software movement, has explicitly cited the eventual creation of a post-scarcity society as one of his motivations: http://www.gnu.org/gnu/gnu-history.html

Lancashire (2001) suggests that classical economic theory offers a more succinct explanation for the international distribution of Open Source development. What he means by this is that hacking rises and falls inversely to its opportunity cost. Using data available on the Gnome and Linux projects, he compared development across the world, finding that (with figures adjusted to reflect the population differences between nations) the USA drops to a position of relative inactive development, with Northern European democracies at the top of the list. In light of this, Lancashire (2001) disputes arguments about post-scarcity 'gift cultures', arguing that 'if one of the wealthiest countries in the world is one of the least active contributors to Open Source development, it seems incorrect to explain development as a function of postmaterialism' (p14).

Lancashire (2001) proposes that historically, the USA has always been the country most commonly associated with the free software movement. From the late 1960s through to the early 1980s, it was almost single-handedly responsible for the vast majority of free software produced around the world. Many programs were actually given away by major universities in America (Berkeley University) to private research facilities such as Xeroc and Parc. Lancashire argues that 'the modulisation of computer architectures around open standards in America further encouraged software-sharing in ways that did not materialise abroad' (Lancashire, 2001, p.15). Development in Europe and Japan remained slow into the early 1980s, and during this time Microsoft was gaining dominance over the American consumer market with early versions of operating system MS-DOS, while in Europe Micro Focus continued to use outdated languages such as Cobol, aiming their product at the corporate market.

Open Source development is still dominated by English speaking programmers communicating through English based networks. Lancashire (2001) provides further

76

support for his argument by stating that, 'if individuals are drawn to support existing projects because of cultural factors, communities which begin Open Source development should experience cascading support for free software initiatives not diminishment of support relative to countries with less developed communities' (p.15). This is explained by the 'network effect' or endogenous growth hypothesises implicit in 'gift culture' arguments. As Open Source communities expand their ability to encourage participation through extensive intangible benefits such as 'reputation' and 'strengthened identity' should expand as well and help to encourage more people to participate (Lancashire, 2001).

As an alternative, Lancashire (2001) proposes that simple economic logic offers an explanation for the migration of open-source development to Europe. The motivation for individuals to produce free software is the expectation of tangible benefits sometime in the future; for example, increased skills which may lead to improved job prospects. Any economic analysis of Open Source development should take into account the factors that influence the relative value of the future earnings for programmers. On the demand side, so long as barriers to international labour mobility exist, the factor most contributing to a result is the relative vibrancy of national software industries. As the increased demand for programmers within a nation drives up the going wage, it should increase the opportunity cost of coding free software over commercial applications and thereby decrease the amount of free software development production. Consequently, citizens of the US face a higher opportunity cost for free software than the Europeans. The United States of America is the largest software exporting country in the world, and the demand for highly skilled computer professionals has soared in recent years driving up wages and decreasing the attractiveness of doing something for free, especially when conglomerates are willing to pay extraordinary premiums (Lancashire, 2001). Essentially, the shift from the US to Europe is a sign that economic rationality drives participation or the motivation to volunteer. As wages rose in the IT industry in the US, the participants in OS decreased,

77

whilst in Europe where IT wages were not as high, participation in OS increased. The incentive to do something for free was no longer as attractive in the US when financial gain through paid employment was high.

Each of the alternative theories of motivations to participate, provides an attractive overview of the activity, but fails to provide any empirical evidence to support. Lancashire's analysis does provide an interesting base for further research on how one's environment influences the motives to participate and this is investigated further in the current research.

Back to basics, what is motivation?

One limitation from the previous research completed in the OS community is a lack of clarity regarding the definition of motivation. There are many definitions of motivation in the literature. Atkinson defines motivation as 'the contemporary (immediate) influence on direction, vigour and persistence' (p.2, 1964), while Locke and Latham define motivation as 'internal factors that impel action and the external factors that can act as inducements to action' (p.388, 2004,). According to Pinder (1998), motivation refers to 'a set of energetic forces that originates both within as well as beyond an individual's being, to initiate work-related behaviour, and to determine its form, direction, intensity, and duration' (p. 11). All these definitions are principally concerned with factors or events that energise, channel, and sustain human behaviour over time and eventually lead to task performance and well-being. In the literature, many theories have been put forth to explain individual motivation (Pinder, 1998; Parsons, 1968). The early work of Lewin (1938), Tolam (1959), and Vroom (1964) presented the first systematic formulation of expectancy theory. Similarly, Locke and Latham (1990) proposed a theory of goal setting that links goal specificity, goal difficulty, and goal commitment to enhanced task performance.

Most of these theories make meaningful contributions to our understanding of what is obviously a complex process. However, these motivation theories treat motivation as a unitary concept, which is where this research differs. Although these theories recognise variation in the degree of motivation, they do not acknowledge the different types of motivations. This becomes problematic when there are multiple types of motivation influencing individuals' action and intentions (e.g., the OS context) in which intrinsic and extrinsic motivations, social identification, and ideology conviction all play a role in participants' contribution. This is something the current research aims to rectify through further investigation.

Alderfer developed Maslow's hierarchy of needs by categorizing the hierarchy into his ERG theory (Existence, Relatedness and Growth) (1972). This theory is particularly useful to the current research. Alderfer's theory posits that there are three groups of core need. The existence group is concerned with providing our basic material existence requirements, which Maslow considers to be physiological and safety needs, whilst the desire for maintaining important interpersonal relationships falls into the relatedness category. These social and status desires require interaction with others if they are to be satisfied and they align with Maslow's social need and the external component. Finally, Alderfer isolates growth needs', an intrinsic desire for personal development. These include the intrinsic component from Maslow's esteem category and the characteristics included under self-actualization (Alderfer, 1972).

A useful way to utilise ERG theory is to explain the motivation to participate in the OS community, as the processes account for an individual's intensity, direction and persistence of effort toward achieving a goal (Jones, 1955).

- Intensity, or how hard somebody tries.
- Direction, towards beneficial goal.
- Persistence, or how long the participant maintains his/her effort.

By looking at motivation in this way and applying it to the OS community, it enables both the situation and the environment to be taken into consideration, paving the way to explaining participation in its entirety.

Direction	I will choose to get involved in OS.	
	Choice of what?	
	What prompted their involvement (i.e.: maybe they had a need).	
Intensity	How much effort? How much time spent?	
Persistence	Why did they stay involved (if they did)?	

Table 6: Direction, Intensity and Persistence.

Direction, Intensity and Persistence and the Open Source Community.

Direction.

It is important to understand the motives behind the energised behaviour to join the OS community. What needs prompt involvement? The FLOSS survey revealed a varied array of motivations for joining the OS community, ranging from a desire to learn and develop new skills, to wanting to share knowledge and skills with other software developers. Participants wanted to be able to participate in new forms of cooperation associated with OS development and to improve software products of other developers. Lastly, they had undertaken membership and participation in OS with the desire to limit the power of the large software companies like Microsoft. This research does not dispute that these motives exist, but this leaves many questions unanswered. In order to truly understand what energises this behaviour, much more understanding of the environment is needed. What instigated this objective to join the OS community? Did participants become members because they needed something extra? What led to this

objective? Did age, gender, work environment necessitate them to join? How did family life affect this decision? Quite simply, while it is clear that different motives exist in the community, the relationship this has with the individual circumstances of the participants is unclear.

Intensity.

Much is unknown regarding the factors influencing intensity (or how much time and efforta participant contributes to the OS community). Chapter 1, Figure 4 illustrated the various roles within the community, and illustrated how an individuals contribution can propel them into different roles within the community. Peripheral participants may start in the community by submitting bug reports or suggesting new features, then move to fixing bugs, reviewing code and writing it. Each role in the community requires different levels of time contribution. Many factors influence a persons free time, including, age, working status and martial status. How these factors influence time spent in the community will be investigated in the current research. Further information on time use is presented in the next chapter.

Persistence.

There has been little research completed regarding the incentive for people to stay involved in the community. The situations that create the commitment to the OS community (or lack of, in some situations) will be investigated here. To examine the commitment requires looking at the person and the situation. What environmental factors contribute to a person being committed to the OS community? In Chapter 4, Becker's Side Bets theory and Norms of Reciprocity will be incorporated to help answer why people commit to the community.

In summary this research aims to explain.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

Conclusion.

Volunteering is any activity in which time is given freely to benefit another person, group or cause (Wilson, 2000). This chapter has argued that participation in the Open Source community has many elements similar to volunteering, in that participants freely contribute their time and skills to the benefit of the OS community. Life stage, age, education levels and employment status have all been shown to have an impact on whether individuals volunteer and the amount of time they contribute. It has been found that most people volunteer in a capacity that is similar to their paid employment. This is evident in the OS community whereby the majority of participants are employed in the IT industry. Furthermore, this chapter has looked at the different motives that exist in the OS community, and from this has identified areas of further research. In particular, how the situation and environment interact with participant's motives to join and participate.

The next chapter will examine time use trends and how these trends impact on OS participation. Preference theory is introduced and provides an explanation for how the environment impacts on the choices individuals have on how time is spent.

CHAPTER 3

A CONCEPTUAL ANALYSIS OF WORK AND LEISURE

Introduction.

This chapter begins by discussing time use, and highlights the structural changes which have occurred that have encouraged the creation of online communities such as Open Source. It examines the many ways time is used by individuals. People have family commitments, they engage in political activism and civic duties, they study, care for themselves, tend their gardens and maintain their properties, all of which impact on their available free time. Of particular relevance to this study is their propensity to volunteer, in this case by engaging in Open Source activities. Preference theory is utilised to help explain the choices people make with their time. Preference Theory assumes Rational Choice, and it is used here because it focuses not only individual choices and preferences, but on an evaluation of structural, economic, social and cultural changes that makes understanding these choices possible. Preference Theory takes into consideration the changes that have occurred in society which have provided more opportunities for men and women in terms of labor market participation and argues that ultimately people make choices about how they use their time.

Work and free time are often presented as competing alternative uses for time, but if perspectives on Open Source participation are changed, then it is easy to recognise that the organisation of OS projects are characteristic of communities that volunteer. An analysis of major factors influencing an individual's available free time and the various life changes that affect people's choice to participate in the OS community are considered. There is a particular focus in this chapter on how Australians use their time, but since the OS community is a global community, wider time use changes are also discussed. To begin with, Preference Theory is discussed, looking at the seminal literature by Hakim.

Preference Theory.

Preference Theory argues that women make a 'genuine choice' between family commitments and paid work in affluent modern societies. Preference Theory predicts a polarisation of work-lifestyles as a result of the diversity in women's sex-role preferences and the three related models of family roles. It argues that in prosperous modern societies, women's preferences become a central determinant of life choices and in particular, the choice between activities related to children and family life or an emphasis on employment and competitive activities in the public sphere. In this view, the social structural and economic environment still constrains choices available to women to some extent, but social structural factors are of declining importance, most notably social class (Hakim, 2003). Preference Theory is useful for this current research, as it can be equally applied to males and females as a means of explaining the societal changes that have occurred to enable increased flexibility in the way women and men choose to work and spend their time. It also highlights the important fact that many people have a degree of choice in the hours they work, and this choice may in time influence certain groups to become involved in the OS community.

Preference Theory can be drawn on to help explain Open Source participation, as it takes into account the various economic and societal changes that have occurred, which may encourage participation in the OS community. There are now a greater variety of work schedules potentially allowing people more choice as to how they spend their free time. Preference Theory argues that for many people time spent at work is a choice, with many people in a monetary position whereby they can work fewer hours if elected to do so. When combined with other factors such as life stage, gender and age, this may create conditions that make it more likely for certain individuals to participate in the Open Source community. Preference Theory, although originally used to explain patterns of female workforce participation, can help to explain the societal and economic changes that have occurred to encourage male participation in the OS community, as well as the conditions that have encouraged or discouraged women's participation in the workforce (Hakim, 2000).

Preference Theory differs from many theories of social change in that it places greater emphasis on personal attitudes, values and preferences as driving forces in their own right, which can be applied to both males and females. Until now, attitudes and preferences were treated as the separate domain of social psychologists while sociologists and economists focused on social structural, political and economic factors. A multi-disciplinary approach demands that all these threads be brought together to produce a holistic (rather than fragmented) theory of social change (Hakim, 2000). Preference Theory primarily evolved as a way to explain women's choice between family work and market work. Hakim (2000) argues that this is a genuine choice in affluent modern societies, and that existing economic and sociological theory has a male bias. Hakim maintains that the existing theories of labour market participation were developed primarily with reference to the male participation and the characteristics of men's work-life histories. Modifications and extensions were added later, in an attempt to encompass the visibly different patterns of female employment. However, it is not satisfactory to simply explain women's employment as a small deviation from the employment patterns of men, or under the heading of sex discrimination as it is commonly argued in the literature (Hakim, 2000). Preference Theory attempts to remedy this anomaly by presenting evidence on women's work, which focuses on what makes a woman's choices distinct from a men's. Preference Theory is used in the current research as it considers the economic and social changes that impact on peoples work preferences and the choices they make. It provides a possible explanation to clarify the high proportion of males participating in the community.

Preference Theory argues that five historical changes have collectively produced a qualitatively new scenario for women in rich modern societies in the 21st century,

providing options that were not previously available to women. Tenet 1 covers these changes.

The Four Tenets of Preference Theory (Hakim 2000).

Tenet 1: Five separate changes in society and in the labour market which started in the late 20th century are producing a qualitatively different and new scenario of options and opportunities for women in the 21st century. The five causes of a new scenario are as follows:

• The contraceptive revolution that, from about 1965 onwards, gave sexually active women reliable and independent control over their own fertility for the first time in history.

The equal opportunities revolution, which ensured that for the first time in history women obtained equal access to all positions, occupations and careers in the labour market. In some countries, legislation prohibiting sex discrimination went much wider than just the labour market, giving women equal access to housing, financial services and other public services.

- The expansion of white-collar occupations that are far more attractive to women than most blue-collar occupations.
- The creation of jobs for secondary earners, people who do not want to give priority to paid work at the expense of other life interests.
- The increasing importance of attitudes, values and personal preferences in the lifestyle choices of prosperous, liberal modern societies (Hakim 2000).

Tenet 2: Women are heterogeneous in their preferences and priorities on the conflict between family and employment. In this new scenario they are therefore heterogeneous also in their employment patterns and work histories (Hakim, 2000).

Tenet 3: The heterogeneity of women's preferences and priorities creates conflicting interests between groups of women. Sometimes this occurs between home-centered women and work-centered women, sometimes between the middle group of adaptive women and women who have one firm priority whether for family work or employment. The conflicting interests of women have given a great advantage to men, whose interests are comparatively homogeneous; this is one cause of patriarchy and its disproportionate success (Hakim, 2000).

Tenet 4: Women's heterogeneity is the main cause of women's variable responses to social engineering policies in the new scenario of modern societies. This variability of response has been less evident in the past, but it has still impeded attempts to predict women's fertility and employment patterns. Policy research and future predictions of women's choices will be more successful in future if they adopt the Preference Theory perspective and first establish the distribution of preferences between family work and employment in each society (Hakim 2000).

Preference Theory is a universalistic theory of the social development of gender roles. It predicts that in any culture where the labour market changes, a new scenario can be created and the full heterogeneity of women's work-lifestyle preferences will emerge, and women's employment patterns will polarise as a consequence. These changes can also be applied to males. Preference Theory suggests we can now move beyond sex and gender to look instead at the social roles that women and men prefer and adopt for their own lives. In this sense, Preference Theory is a 'unisex' theory (Hakim 2000). Preference Theory helps to explain the changes (economic and social) that may increase the likelihood of someone choosing to participate in the OS community.

Preference Theory and Open Source.

Preference Theory takes into account the various changes that have occurred to encourage participation in the OS community. There are now greater varieties of work schedules, potentially allowing people more choices on how they spend their free time. When combined with other factors such as life stage, gender and age, this may create conditions more likely for certain individuals to participate in the Open Source community. As discussed in earlier chapters, participation in OS may be driven by the desire for more affordable options of software, or perhaps to improve skill levels for career enhancement. The socially isolated may see it as a way to contact people with similar interests. The motives for participation are dependent on individual circumstance and the opportunity structure that exists for each participant in particular life stage and gender are critical factors.

There are many reasons presented in the literature as motivations for participating in the OS community and for volunteering in general, with altruism being one of the most popular. There are elements of altruistic behaviour present in the community and the current research does not dispute this, but the issue with altruism is that it is far too broad. The current model differs as it looks at OS participation more strategically, by analysing both the reasons for joining the OS community, and for committing to it. This will be done by examining the opportunities, constraints and preferences that make participation and joining more likely. As discussed, age and life stage are associated with an individual's free time, which in turn may impact on their decision to volunteer. Younger and older age groups generally have the most leisure time (ABS cat 4153.0). Younger volunteers are more likely to emphasise the importance of gaining work experience whilst older volunteers tend to value social interaction (Gidron, 1978). Much of the literature fails to acknowledge the fact that volunteers may actually be making a rational decision to volunteer in certain activities in order to increase their skill base and therefore improve their employment prospects. Contributors to the Open Source community tend to be relatively young, and of an age where career enhancement is of importance. In 2002, the majority of OS developers were between 16 and 36 years of age, with only 25% over 30 and 10% older than 35 years (FLOSS, 2002).

Furthermore, the characteristics of the OS community have been neglected in previous research. Males overwhelmingly dominate the OS community at 96.6% (FLOSS, 2002).

This is an important aspect of the community, and highlights the 'choices' people make in particular the types of careers males and females select. The majority of OS participants are male with a tertiary education (70%) and a strong professional background in the IT sector (83% of all developers are employed in the IT sector). Information technology (IT) is a vital part of the global economy. Although IT job growth has not been as rapid as the booming growth of the computer industry in the 1990s, information technology still offered favourable job prospects and demands for qualified professionals (U.S. Department of Labor, 2004). As technology becomes more sophisticated and complex, these computer-based job prospects are especially promising for individuals with more advanced levels of training and expertise (U.S. Department of Labor, 2004). Despite the fruitful career opportunities available in the computer field, women are vastly underrepresented in IT. It has been estimated that women, although representative of 46% of the total U.S. workforce, account for less than 30% of the IT work-force (U.S. Department of Commerce, 2003), and constitute only 10% of executives in Fortune 500 computer companies (Xie and Shauman, 2003). Despite the growing need for qualified applicants for IT positions, the number of women in IT is actually declining (U.S. Department of Commerce, 2003).

Preference Theory recognises that occupations offer a mixed basket of rewards, benefits and options. These are not only in the form of earnings but also manifest as social status and prestige, as work tasks that may be perceived as either onerous or attractive according to personal taste, as variable opportunities for social contact with colleagues in and out of the workplace, and in the form of convenience factors such as flexible hours, short hours, or term-time working. The relative weight placed on any of these varies between women, and also between men and women (Hakim, 2000). While it is reasonable to assume that people seek to maximise rewards from employment, this does not necessarily translate into a goal of earnings maximisation, let alone a goal of minimising wage depreciation. Furthermore, people weigh the rewards from employment within the context of all life goals including child-rearing and family work as a major life activity. Again, the relative weight placed on different life goals varies between women, and also between women and men (Hakim 2000). This again highlights the importance of understanding the current way in which individuals use their time, and how life stage, gender, family status and work influence the amount of free time an individual has, and the choices they make.

Preference Theory differs from past theories as it insists women are not a homogeneous group, but rather heterogeneous in tastes and preferences, such as between market work and home activities. At its simplest explanation, one could argue that perhaps the IT field is not attractive to women, and therefore this is why they are underrepresented. The reasons for this under-representation are not explored within the scope of current research. What is important is that Preference Theory offers a diverse approach in explaining the differences in employment preferences. It can explain both important exceptions to the rule as well as the central tendency (Hakim, 2000). Values and preferences are becoming increasingly important determinants of lifestyle choices and behaviour in prosperous modern societies. The structural changes in labour market participation in working time are fundamental in explaining OS participation. The majority of participants in OS are males who are employed in the IT industry. Contributions to the OS community look very similar to paid work in the IT industry but are a form of volunteering. Given that paid work skill sets are often replicated in the types of volunteering people do, it would be a reasonable assumption that this would result in more males being involved in the OS community than females. Potential future research might explore why males are more attracted to this type of work. The next section will provide a review of time use and the time use categories.

Overview of time use and the time use categories.

The first issue that should be considered when looking at motivations to participate in the OS community is how people use their time in general. People have restrictions placed on the amount of free or leisure time they may have due to paid employment, study and care responsibilities. This research considers how people spend their time, after having accounted for life's necessities. The time use literature is reviewed and the impacts that changing patterns of work have on an individual's free time are discussed.

The time use literature distinguishes between various categories of time. The typology developed by Aas (1982) explains four time categories: necessary time, contracted time, committed time and free time, and this is useful in conceptualising how people use their time. Time-use activity classifications have frequently been criticised because of their multiple frames of reference, and for the concepts included in the classification. The uneven treatment of activity areas (where some are extremely detailed and others are very broad) was also a cause of concern. Aas (1982) produced an analysis of time-use activities and behaviour in which he identified three inseparable dimensions of every day time-use activity: what the activity (or action) is, where the activity takes place, and with whom. These three questions enable the activities to be classified into four types of time use previously discussed.

Necessary time is characterised as time spent meeting basic physiological needs, such as sleeping, eating, personal care, health and hygiene. Contracted time includes paid work commitments and regular education (such as university studies). Activities within this category have explicit contracts that control the periods of time in which they are performed, and therefore constraining the distribution of other activities over the rest of the day. For example, if a person were employed for the traditional 8-hour working day they would schedule activities not related to work out of work time due to this time predetermined work obligation. Committed time involves activities to which a person has committed him/herself because of previous acts or behaviours. These acts include community participation, having children, setting up a household or doing voluntary work. The consequent housework, care of children, shopping or provision of help to others is considered committed activity. Lastly, free time describes the amount of time left when the previous three types of time have been taken out of a person's day. The only way to obtain more free time is for contracts, commitments or necessary time to

change as the total time available in a day is constant. For example: a person may reduce their time in paid work (contracted time) to provide them with more free time to participate in a desired activity. To put this into perspective, in 2006 Australians spent an average of 46% of their time on necessary time activities, 16% on contracted time activities, 17% on committed time activities and 21% on free time activities (ABS, cat 4153.0).

The Open Source community is particularly interesting to study in relation to time use, as the activity cannot be easily positioned into one category. OS has many elements that resemble contracted time, even though members of the community view it as a free time activity. If viewed as a form of employment, participation in OS contradicts traditional economic models which state work generates income. Conventional economic theory assumes that when somebody engages in employment they receive a monetary payment for their time. It is argued that people are rational in their decision to partake in paid employment and their desired working time corresponds to their actual working time (Sousa-Poza, Henneberger, 2002). However, Open Source participation is not classifiable as work because in most cases no money is exchanged for the labour, even though commercial companies pay for similar services. Conversely, if participation is viewed purely as a form of free time then it too contradicts the typical definition for free time, as this typically involves activities that resemble hobbies (painting, drawing, bush walking), not an activity that so closely resembles paid work. All of this makes OS participation seems quite unusual, particularly as the activity is unpaid, albeit very similar to many participants paid employment. In Chapter 2, this thesis argued that participation in the OS community closely resembles a volunteering activity. Voluntary work has been found to frequently resemble the participants paid employment (ABS cat 4441.0). This is evident in the OS community as many participants are employed in the IT industry (FLOSS, 2002) and contribute to OS outside of their paid employment.

The next section examines changes that have occurred in working hours, which have increased opportunities for people to use their time in different ways, and which may provide opportunities for people to participate in the OS community.

The changing nature of work.

The physical boundaries of work and home have changed with technological transformations such as the mobile phone and the Internet, enabling people to work and use their time in different ways, and the standard forty hour, five day working week is not necessarily still the norm for the majority of employees (Adams, 1995; Gershuny, Bittman, Brice, 2005; Galinsky, 2007). Improvements in technology have meant there has been a blurring of the boundaries between work and home, with work now being completed at both sites. In particular the Internet has the capacity to affect temporal and spatial boundaries dividing work and home, with Wajcman, Rose, Brown and Bittman, (2010), arguing that the use of the Internet at home for work purposes can actually increase flexibility and family life balance by providing people with more choice about how they use their time. The increased flexibility that has resulted from these technological changes may have increased the opportunities for people to participate in online communities such as OS.

There has also been a shift in the way people work, with increasing numbers working one or more part time jobs (Bardoel, Morgan and Santos, 2007). This increase for parttime employment has been largely driven by the rising incidence of 'dual earner families', with females returning to work part-time after having children (Adam 1995; Hochschild 1997; Schor 1991). The proportion of employees working part-time in Australia has increased from 16% in 1980 to 28% in 2003 (ABS cat 6106) and 36.7% in 2010 (ABS cat 6306.0). Similar growth can be observed in OECD countries such as Britain, the Netherlands and New Zealand (de Ruyter and Burgess, 2000). Of all the OECD countries, only the Netherlands has a similar proportion of part-time workers to Australia at 33% (OECD, 2002). Part-time work is one of the most common flexible work arrangements used to support work/family balance in Australia (Bardoel, Tharenou and Ristov, 2000). The variation in working hours (with some people working longer or shorter hours) plus the introduction of new technologies has created opportunities for individuals to utilise their time in different ways, and this may influence certain groups or individual's participation in the Open Source community. Individual careers have become increasingly diverse, and the casualisation of the workforce may enable people to have more uncommitted time (Evans, Lippoldt & Pascal, 2001). In addition, age and gender influence how much time a person has available as free time. Men generally have more free time than women, due in part to their fewer household and family commitments (Bitman & Wajcman 2000). This gender difference in the amount of free time may also be an influencing factor in OS participation, with research to date showing males overwhelmingly making up the majority of participants in the OS community, as well as generally having more free time than females (Ghosh, 2000).

The distribution of paid work and household work has been a focal point for many sociological theorists, who have provided a variety of explanations to explain time use differences, including scarcity of time, difference in time use patterns and the perceptions of time use among men and women. Becker (1981) argues that people maximise the allocation of time by making Rational Choices between market work and consumption. Becker argues that 'at most' one member of an efficient household could invest in both market and household capital, and would allocate time to both sectors (Becker, 1981, p18). Becker's theory of competitive advantage attempts to explain why men specialise in paid work and women in unpaid work. Effectively, the economically rational household reduces the market time of the wife in response to increases in total household labour time since females wages are usually less with fewer promotional opportunities (1981).

How we use our time.

The next section of this thesis provides a comprehensive overview of time use in Australia, and changes in working time. As discussed previously, the time use literature

distinguishes four categories: necessary, contracted, committed and free time (Aas 1982). For most people, the time spent at work takes up the largest amount of available time other than essential requirements such as self-care and sleep. In order to study and understand OS participation, it is necessary to understand contemporary patterns of working time and the impacts they have on how other time is used. Additionally, there are many factors that influence the amount of free time people have, (age, gender, occupation, marital status), and thus it is important to understand how these factors influence the time people have in order to analyse the environmental conditions which provide opportunities for people to participate in the OS community.

The change in the average working week: (long hours, part-time, casual).

Patterns of work time have changed in Australia, with the core difference being from a standard full time working arrangement (usually performed by males in a 'breadwinner role') to a set of heterogeneous arrangements characterised by fluidity and flexibility, with greater variation between jobs and time periods (Wooden, 2000; ACIRRT, 1998; Bittman and Pixley, 1997; Edgar, 1992). These changes have occurred with the expediential rise of female participation in the labour market since the 1960s, and more recently with the growth of non-standardised employment (Neumark and Postlewaite, 1998). The rise in part time work has increased the overall size of the workforce, and has also provided a way to combine work and family life for many workers. It has also caused a decline in the average weekly hours worked by all Australian workers over the last two decades 1985-2005, and the strong growth in part-time employment (especially by women) has increased the proportion of people working fewer hours, resulting in a slight decline in the overall average hours worked per week (ABS cat 4102.0 - Australian Social Trends, 2006). The following section addresses each of the major changes in working hours for both males and females, in order to examine the impact these have on free time.

Work time regimes.

The standard work week still exists for many workers, although it no longer accurately describes the working time reality for the majority of workers (Wooden and Loundes, 2001). There are now an increasing number of workers participating in either part-time employment, or who are employed on a casual basis where hours can be irregular and vary from week to week. In contrast, there has been an increase in people in full time employment working longer than the standard 40-hour week (Wooden and Loundes, 2001). The standard working week (ABS defines the standard working week 35-40 hrs), has now been superseded by at least two more distinct working time regimes. These three working time regimes encompass those working extended hours each week (i.e. more than forty hours per week), those working part-time hours (i.e. less than thirty five hours per week on a non-permanent basis) and those working standard hours (40 hours per week) (Wanrooy, Buchanan, Considine & Bretherton, 2001). Hence it becomes clear that while some people are working very long hours, others work much shorter hours.

Average working hours.

Between 1985 and 2005 the average weekly hours worked by the Australian workforce declined from 35.8 hours to 34.7 hours, (a reduction from 39.7 hours to 39.3 hours for men and 29.4 hours to 29.0 hours for women) (ABS. cat 4102.0). This decrease can be attributed to the strong growth in part-time employment which has increased the proportion of workers working shorter hours (the ABS definition of part-time employment is thirty five or fewer hours per week in the main job). Australia's part-time employment rate of 27.2% in 2002 was almost double the OECD average of 14.3%. Furthermore, during the 1990s, 75% of employment growth in Australia was in part-time jobs (Gregory, 2002). The incidence of part-time employment and its growth over the last few decades are among the most significant features of the Australian labour market and have implications for understanding how people spend their non-working time. Shorter average working hours may provide some insight into understanding Open

Source participation, because (as argued earlier) if time is finite and individuals are working less hours in paid employment, then consequently they may have more time for other activities including OS.

The standard working week (35-40 hours).

Along with a decline in men's average weekly hours, there has also been a decrease in the proportion of men working a standard week (ABS defines the standard working week as 35–40 hours per week). Between 1985 and 1995, the proportion of employed men working a standard week fell from 41% to 33%. This fall levelled off during the late 1990s, reducing slightly to 32% by 2005. This reduction in men's average hours reflects an increase in the proportion of employed men working part-time hours (from 6% in 1985 to 15% in 2005) and has occurred despite an increase in the proportion of employed men working the proportion of employed men working a standard working more than a standard week (from 36% in 1985 to 42% in 2005) (ABS. cat 4102.0). During this period, women also reduced their standard working week from 37% to 27%, which can again be attributed to the increase in part-time employment for women (ABS. cat 4102.0). The reduction of hours worked has created opportunities for people to use their time in a variety of new ways, one of which may be to participate in the OS community.

Between 1985 and 2005 the proportion of people employed in full-time work has decreased. Men working in a full-time capacity decreased from 94% to 85%, with a fall of 63% to 54% for women. The decline in the proportion of people working full-time has been greatest in younger age groups, reflecting the increasing number of young people (aged 15–24 years) delaying their commencement of full-time work, as they continue their education or combine part-time work with study. For example, the proportion of employed men aged 15–24 years working full-time declined from 87% in 1985 to 64% in 2005 and for women in this age group declined from 75% to 45% over the same period (ABS. cat 4102.0). Students account for approximately 14% of the OS community and the reduced number of contracted hours may have encouraged their participation.

Additionally people may participate in Open Source projects to expand their skill base, personal skills, capabilities and knowledge, which are all a form human capital. Human capital levels can be increased with education, training, learning and practicing, and this may lead to better job opportunities, higher salaries and more fulfilling jobs (Hars and Ou, 2002). Members of the OS community have the freedom to choose tasks that will provide them with the learning experiences that meet their demand and interests. It also enables those entry-level programmers like students to participate in realistic projects at a very early stage, which may encourage participation (Hars and Ou, 2002).

Part-time work.

As previously stated, the proportion of working men and women employed part-time between 1985 and 2005 has increased. The percentage of employed men working parttime more than doubled from 6% to 15% while the number of employed women working part-time increased from 37% to 46%. For both employed men and women, the increase in working part-time has been the greatest in younger age groups where parttime employment is frequently used to balance work and study. For example, the number of employed men aged 15–24 years working part-time increased from 13% to 36% between 1985 and 2005 and from 25% to 55% for women over the same period (ABS. cat 4102.0). Numbers of employed men and women working part-time in the 25-54 year age groups have remained relatively stable, increasing from 3% to 8% for men, and from 41% to 42% for women. There were generally higher proportions of employed men and women working part-time in the 55 years and over age groups in 2005 than in 1985, reflecting the increased use of part-time work to re-enter the labour force after child caring responsibilities (for women) and in the transition from full-time work to retirement (for both men and women) (ABS. cat 4102.0). The increasing percentage of people working part-time allows for people to have more flexibility in how they use their remaining time. As argued earlier, more variation in working hours creates opportunities for individuals to utilise their time in different ways which may have influence on certain groups of individuals participating in the Open Source community.

Longer hours for full-time workers.

Throughout the period 1985 to 2005, the average working hours per week for full-time workers increased from 40.2 hours to 41.9 hours This trend has been similar for both male and female full-time workers, with men's hours increasing 1.9 hours per week (to 43.2 hours) over the period, and women's hours increasing 1.7 hours per week (to 39.3 hours). However, the proportion of full-time workers who work a standard week (35–40 hours per week) fell from 48% to 42% between 1985 and 2005 (ABS. cat 4102.0). In the 20 year period since 1985, the incidence of individuals working very long hours of work (50 hours or more per week) has become more common for full-time workers, particularly men. In 2005, 30% of men working full-time worked 50 hours or more per week, up from 22% in 1985. The number of women working very long hours also increased from 9% in 1985 to 16% in 2005 (ABS. cat 4102.0). Long hours are more common in the occupations characterised by high levels of self-employment, such as full-time managers and administrators (on average 48.1 hours per week in 2005). Full-time workers who work longer hours tend to be employers (51.4 hours per week in 2005) and own account workers (45.6 hours per week) (ABS. cat 4102.0).

Below is a graph illustrating full time average weekly hours between 1985 and 2005.







Source: Labour Force, Australia, Detailed - Electronic Delivery, quarterly (ABS cat. no. 6291.0.55.003).

The graph illustrates that average working hours peaked in approximately 1995, and have been in slow decline since.

Time use summary.

From the information presented, it has been determined that between 1995 and 2005 there has been an overall change in people's working hours, with a decrease in the proportion of men and women working full-time standard hours of 35-40 hours per week (ABS. cat 4102.0). Average hours of employment have declined due to the increase in part-time employment, and this increase was most prevalent among the younger age groups (15–24 years), although there has also been a moderate increase in employed men and women working part-time in the 55 years plus groups. Of note, working hours have increased for those working longer full-time weeks (40.2 hours to 41.9 hours) during the same period of time. Significantly, it has become more prevalent, particularly in men, for individuals to work very long hours, (22% in 1985 to 30% in 2005) compared to women (9% to 16% retrospectively) (ABS. cat 4102.0).

The ABS statistics support the assertion that working time has changed and that there are now at least three distinct work regimes: part-time, standard and long. Life stage and gender have a significant impact on the hours an individual works, which consequently affects the amount of free time available to the worker. This is not to say that just because one has more free time they will become more involved in the Open Source community, but it does support the premise that the changing nature of work (and the opportunities that this has presented, in particular more flexibility with our time) has helped create an environment for participation in the OS community to prosper. In addition, the increase in people working very long hours may also foster participation in online communities, with additional hours of work reducing the amount of free time a person has, participating in an online community may be a convenient way for someone to use what little free time they have. A question to be explored here is whether having more free time fosters OS participation, and if having limited free time due to long working hours, fosters on line leisure activities such as OS participation (because of accessibility and convenience).

Preferences or choice may influence how much one works in paid employment versus time spent doing other activities, but regardless of the role of choice, the evidence shows that there have been structural changes in the labour market which might provide an opportunity for participants in online communities. Part time or more flexible paid work may provide the time, while being 'time poor' due to longer working hours may foster 'online' engagement due to accessibility. Because OS is not only a virtual community but an international one, international time use trends must be considered.

International perspective on work time.

As reasoned above, the international perspective on work time needs to be addressed, given that the OS community exists worldwide. One pre-condition for a worker's acceptance of shorter working hours is an assurance of adequate income. In most industrialised countries there has been a reduction in the number of hours devoted to paid work (OECD, 1992). In 1970 in nearly all countries for which data are available, annual hours were between 1850 and 1950. However, in Sweden and Norway, annual hours were already well below this level (Faggio and Nickell, 2007). By 2004, some countries had seen dramatic changes: in France, Germany and the Netherlands, annual hours fell by around 500 from 1970 to 2004, in Norway and Japan, the fall was around 400, and in Ireland and the UK the fall was closer to 300. By contrast, in Sweden, Australia, Canada and the US, the fall over this same period was between 50 and 150 (Faggio and Nickell, 2007).

The standard working week in most OECD countries is around 40 hours (OECD, 2005). However, this does not accurately illustrate the growing diversity within the labour market. Recent trends show a tendency toward polarisation in hours of work, with three distinct work regimes similar to the Australian findings (short, standard and long working hours) (Figart and Golden, 1998; Jacobs and Gerson, 1998; OECD, 1992, 1998, 2005). More people are also working irregular hours or from home (technological advancements made this possible) and many more can choose their hour arrangements to suit their individual needs (Horrell, Rubery, and Burchell, 1994). Many employers in the UK have introduced a range of flexible working options for employees (Kelliher and Anderson, 2008). The Workplace Employment Relations Surveys 2004 (WERS) found a significant proportion of employers (more than 70%) offered some form of flexible working arrangements to employees and that this had increased markedly since the WERS 1998 survey (Kersley Kersley, Alpin, Forth, Bryson, Bewley, Dix, and Oxenbridge, 2005). This trend has been fuelled by growing concern over work–life balance (Bailyn, Rayman, Bengtsen, Carre and Tierney 2001).

The decline in average work hours (and the changes in their dispersion) have been attributed to structural changes in the characteristics of the working population, namely the growth in part-time employment. Whilst it has become a prominent feature of the workforce (especially in Europe) it is important to note that in many countries (Germany, Denmark, and Portugal) most or the entire decline in working hours is attributable to the decrease in hours of employment for full-timers (OECD, 1998). In many countries, there has been an increase in part-time employment, but it remains below 20% in most countries. The UK, Switzerland, the Netherlands, Japan and Australia have a significant proportion of their workforce made up of part-time employees, and these are mainly women. Southern Europe generally has the lowest level of part-time work (Faggio, and Nickell, 2007). Company and government policies have created more flexible arrangements to promote the competitiveness of firms, but these also to facilitate workers' preferences. Sweden for example is one of the few countries in which the right to make temporary transitions from full time to part-time employment is supported by law (Evans et. al, 2001). Working times are becoming increasingly more flexible in working life: as educational levels rise and labour market entry is delayed, workers are increasingly combining paid work with periods of education and training, with some alternating between periods of full and part time employment (Evans et. al, 2001).

In conclusion, it can be argued that working hours may reflect workers preferences, based on their needs or alternative activities, to choose the extent of time allocated to market work, as well as structural changes in the labour markets. There are now three distinct work regimes (part-time, standard and long), meaning that working arrangements are less homogenous than in the past. The data shows that there has been a decrease in average working hours in both Australia and most OECD countries, with the increase in part-time work having the foremost effect, by reducing overall average hours worked. The next section of the review will look at patterns of time use including the effect that gender and life stage have on available free time.

What else do we do with our time - unpaid housework?

To reiterate, this dissertation encompasses two core issues. Firstly, it examines the way in which people choose to use their time, and secondly, it seeks to answer the question why individuals select a particular type of activity, in this case participation in the Open Source community. To adequately address the first question, the literature review has covered necessary time and contracted time, with a specific focus on working hours. This review has highlighted that changing working conditions provide opportunities for more flexibility in how individuals spend their time. Time is a finite resource and therefore the only way we can spend more time on one activity is to reduce time spent on another. For this reason it is necessary to provide an overview of committed and free time to thoroughly address how we use the remainder of our time. Gender and life stage greatly impact committed and free time so the following literature review will focus on these differences. As discussed previously, the majority of participants in OS are male, and males and females have differing amounts of free time that may influence OS participation.
As discussed previously, paid work comprises the largest percentage of time use for many people. However, one area of committed time that needs to be considered is unpaid work, particularly home duties. There are two paradigms that endeavour to explain the distribution of home duties. The Economic Exchange model argues that women perform housework in exchange for economic support (Walby, 1986; Brines, 1994), and the allocation of labour in the household is seen as fundamentally economic and rational. Men provide income for the household in exchange for women performing unpaid domestic labour. The underlying assumption being that as women's time in paid labour increases (thus increasing household income), the division of labour in the home will become more equal. Childcare and housework are performed in a rational and efficient manner in which the person with the least economic resources performs the most domestic labour (Baxter 2002). The alternative model for understanding the allocation of household labour focuses on the symbolic importance of gender for the organisation of housework as women's work, and as a display of a women's love for her family and sub-ordination to her husband (Baxter 2002). In 2006, findings showed that men spent an average of 1 hour 37 minutes per day on total domestic activities, similar to the 1992 survey results (ABS 4153.0). This resulted in a decline in the average time spent by women on domestic activities (from 3 hours and 2 minutes in 1992 to 2 hours 52 minutes per day in 2006), equating to a reduction of 12% per day (ABS cat 4153.0).

The time allocated to domestic activities increases with age for both men and women

Figure 8. On average, while men aged 15 to 24 years spend a mere 35 minutes per day on domestic activities (compared with 58 minutes for women), the time more than doubled for people in the next age group (25 to 34 years) to 1 hour 11 minutes per day for men and 2 hours 32 minutes per day respectively. The median time for men aged 75 years and over escalated to 2 hours 47 minutes while women spent 3 hours 33 minutes per day on domestic activities (ABS cat 4153.0).





ABS cat 4153.0 1

There are two diverging view points regarding the extent of change that has taken place in men's level of involvement in unpaid household work. Hochschild (1998) coined the phrase 'stalled revolution' to refer to men's lack of involvement in domestic work, while Gerson (1993) referred to 'men's quiet revolution' to classify the group of men interested in fathering and accepting an increased share of domestic work. Research in Australia and overseas has suggested that there is convergence of men's and women's time on domestic labour activities (Baxter, 2002). Even so, the degree to which this can be attributed to women reducing their time on domestic activities, or men increasing their time undertaking household chores or outsourcing is unclear (Gerson, 1993).

In summary, there was an increase in the level of men's involvement with housework, and a reduction for women in the years 1960 - 1990. This change is mainly due to women's increased participation in paid work, coupled with a decrease in family size (Baxter, 2002). Women still partake in more housework compared to males, but the overall amount has been reduced. This is an example of time trade offs. If women are spending more time in paid employment, then they are trading off something else (such

as domestic work or leisure). The fact that men still contribute less time to unpaid household duties may provide them with more free time to utilise on such activities as OS participation, and may also help explain the limited number of female participants, who have less free time for such activities.

The effect of parenthood on available time.

The presence of children has a significant impact on parent's available time because they are no longer solely responsible for themselves. The child's age greatly influences available time, with mothers spending longer periods caring for the children, regardless of whether both parents are employed or not. This is reflected across the age spectrum, with time spent on caring activities decreasing significantly as the age of the youngest child increases (ABS cat 4153.0). When considering only primary activities, employed mothers with children younger than 15 years of age spent 2 hours, 17 minutes on caring activities, compared to 1 hour 9 minutes for employed fathers. Mothers not employed spent 3 hours 56 minutes compared to 1 hour 45 minutes for fathers. Mothers of young children (where the youngest child was aged 0-4 years) spent over 30 hours a week on primary child care activities (fathers spending just over 11 hours). The majority of the time mothers spend on child care was used for physical and emotional nurturing of children, whilst fathers spent more time playing, reading and talking with their offspring. When encompassing primary and secondary activities, mothers of young children spent 83 hours, 51 minutes on childcare per week, while fathers spent 36 hours, 25 minutes. Generally, secondary time for both parents involved 'minding children', which accounted for 91% of secondary child care activities of mothers and 95% of fathers (ABS cat 4153.0). For children aged 5-11 years, the time spent on primary care activities was 10 hours, 21 minutes per week - half the amount spent by parents in families with younger children (20 hours 46 minutes). When taking into account both primary and secondary activities, mothers whose youngest children were aged 5 to 11 years spent 42 hours, 23 minutes a week on child care, while fathers spent 21 hours each week (ABS cat 4153.0).

The pattern of time spent caring for children decreasing continues as expected for parents of children aged 12 to 14 years. The time spent by parents on primary child care activities (4 hours 43 minutes per week), was on average less than half that spent by parents in families where the youngest child was aged 5 to 11 years. For mothers with these older families, the most time-consuming primary care activity had shifted to playing/reading/talking with children (1 hour 59 minutes). On average, mothers with older families spent 24 hours and 19 minutes a week on both primary and secondary child care activities, with minding children again dominating the secondary activities (ABS cat 4153.0).

The following graph illustrates the difference in time spent by parents on childcare, and illustrates how time spent decreases with the age of the youngest child.



Figure 9: Time spent on child care by parents under 15 years.

As can been seen from the evidence presented, the presence and age of children has a considerable effect on available time, with families comprised of young children aged 0-4 spending the most time on childcare. In general, women were found to be responsible for the majority of childcare, regardless of whether they were engaged in employment or not. These factors, in addition to changed working conditions, will undoubtedly

impact on participation in the Open Source community. Children have an impact on the amount of free time both males and females have, with younger children being more time consuming, resulting in less free time. The presence of children may limit or restrict people from becoming involved in the OS community due to such time constraints. In general, females have less free time than males and this effect is more profound when children are added. As stated previously, males are the largest participants in the OS community and given they have more free time than females, this may also provide an environment that supports participation in OS. Alternatively (and as argued earlier), with longer working hours, the OS community may be a convenient way for people with children to spend their limited free time. The impact of life stage and time spent on OS is investigated through the online survey, the results of which are presented in Chapter 6.

Free Time.

With all other time factors having been explored, the last category to be considered is free time. A pivotal question in this research is when and why people participate in the OS community. As previously stated, free time is the amount of time left when the previous three types of time have been taken out of a person's day (Aas, 1982). The only way to obtain more free time is for contracts and commitments to change, as the total time available in a day remains constant. Bittman (2002) proposes that free time is time spent at one's own disposal and discretion. The concept of leisure is usually defined as the opposite of activities that an individual is compelled to carry out. In labour economics, leisure is treated as the opposite of paid employment. Leisure is often thought of as residual, meaning the free time that remains after maintaining one's body in a healthy and socially acceptable state, contracting time to the market, and meeting domestic and family responsibilities (Bittman, 2002).

This thesis has demonstrated that time use surveys show the availability of leisure time significantly depends on an individual's sex, employment status, age and family circumstances (family circumstances include the presence of a spouse, age and employment status of spouse and the presence of children of various ages). In 2006 men spent 4 hours 29 minutes per day on recreation and leisure activities compared with 3 hours 57 minutes for women (ABS cat 4153.0). As age increases, the distribution of time spent on leisure follows similar patterns for both men and women, although the gap narrows to some extent in the higher age category. On average, men aged 15 to 24 years accounted for 4 hours, 51 minutes per day of time spent on recreation and leisure (4 hours, 9 minutes for women). This decreases to 3 hours, 36 minutes per day for men aged 35 to 44 years (2 hours 59 minutes for women), and then increases with each successive age group, reaching 6 hours, 26 minutes per day for men aged 75 and over (6 hours 5 minutes for women).

The table below illustrates the variation in leisure time by age (ABS cat 4153.0).

Figure 10: Time spent on recreation and leisure by age.



(ABS cat 4153.0).

Conclusion.

This Chapter has provided an overview of the many factors that influence the amount of free time individuals have to pursue free time activities. The data presented shows that employment status has had the greatest influence on time available for participation in these activities. Increased free time, associated with decreased hours of employment, results in greater free time for men than women. Parenthood reduces the amount of free time for both sexes, with the maximum impact on women with very young children.

In regards to volunteering, it is known that people are much more likely to volunteer in a capacity similar to their paid employment. This is of particular relevance to the OS community in which a large number of participants are employed in the IT industry. Furthermore, marital status, presence of children and age all impact on the amount of time that one dedicates to volunteering. There are also a large percentage of students who participate in the OS community. The motives to participate may be consistent with the motives reported in the volunteering literature, in that young volunteers may be looking to improve skills for future job prospects. It has also been established that the environment provides opportunities to volunteering due to the ease in which volunteering opportunities are provided through schools and kindergartens etc.

Preference theory was used to highlight that the majority of people now have more choices in how they use their time. Working hours have generally reduced, more flexible working times have evolved and technological advancements have provided more opportunities. For many people, the amount they work is in part a choice. Combined with different environmental factors, life stage influences and the volunteering literature, this information can be applied to examine motives for participating in the OS community. This Chapter has shown that patterns of working time, time spent on unpaid work such as domestic duties, caring for children, and time spent on free time have changed. Data shows that time use varies by demographic factors, so depending on the individual OS participants, it is feasible that these changes have meant they now have more time to involve themselves in OS activities. The argument being presented contends that there is now a greater variety of work schedules potentially allowing people more choices on how they spend their free time. When combined with other factors such as life stage, gender and age, this may create conditions that make it more likely for certain individuals to participate in the OS community.

The next chapter will restate the issues for the reader in order to investigate, the Direction, Intensity and Persistence of participants in the OS community.

Through the use of Rational Choice Theory, Side Bets Theory, Norms of Reciprocity and Core Motives Theory, four essential questions will be answered and subsequently tested with the data in subsequent chapters.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS ? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

CHAPTER 4

THE INTERCONNECTING THEORIES THAT EXPLAIN OPEN SOURCE PARTICIPATION

Introduction.

The majority of theories attempting to explain participation in the Open Source community do not account for the multiple motives which may exist within the community, and do not take into account the various opportunity structures that may influence a participant's motivation to join. The theories do not adequately examine the participant's life stage, or the impact this may have on their decision to become involved. Many factors presented in this thesis have not previously been considered, for instance the changing nature of time use (which may have helped to create opportunities for participation) or the impact that age can have on one's decision to volunteer.

Open Source participation has many aspects similar to volunteering. The volunteering literature is informative and assists with the development of a comprehensive explanation of participation. Rational Choice Theory, in conjunction with the existing literature, is employed to provide a theoretical foundation for studying the motivations to volunteer in the OS community. Rational Choice Theory argues that choices are made based on the information individuals have and generally this is done to maximize their own self-interests. The theory allows for multiple motives to be measured and is able to take into consideration other factors to explain participation in OS. Furthermore, where Rational Choice Theory (RCT) cannot adequately explain the behaviour, additional supporting theories are utilised. The central aim of this Chapter is to explain joining and participation in the OS community by using a RCT explanation and to integrate a variety of theories including Core motives theory, Side bets theory and Norms or Reciprocity

into a comprehensive theoretical framework that will better explain Open Source participation.

Rational Choice Theory.

Rational Choice Theory is arguably one of the most popular and debated theoretical points of reference in the sociological and contemporary political science arenas. Rational Choice Theory (RCT) has substantially changed the way political scientists study issues as diverse as voting, intra-legislative bargaining and political party preferences (MacDonald, 2003, p 551). Supporters regard Rational Choice Theory as a universal premise for political and social behaviours, whereas its critics vigorously dispute its effectiveness, arguing the hypotheses of RCT are unrealistic, the model empirically intractable and the findings trivial (Friedman, 1996).

Rational Choice Theory rests on the assumption that actors have goals that they would like to achieve, and they will take action to achieve their goals in ways they perceive will maximise their utility. Broadly speaking, it focuses on the outcomes of actions and on the interplay between actors' goals, their beliefs and values relevant to the pursuit of these goals and their actual behaviours (Goldthorpe, 1998; Simon 1957). It is assumed that actors will attempt to maximise their utility, meaning that each possible action (or good) in any given situation, will have potential benefits to the actor and the actor will select the option they perceive to yield the greatest benefit.

Rational Choice Theory is useful in the context of this thesis as it assists in the development of hypotheses about human behaviour (MacDonald, 2003) and facilitates analysis of human action. However, it is not intended to imply that this is the way in which humans cognitively process decisions. The search for more clarity regarding RCT ignites debate between the RCT theorists and their critics. MacDonald (2003) argues that part of the reason why such debates have proven so intractable lies in the fact that the definition of Rational Choice Theory varies so widely between the theoretical literatures. To avoid such confusion, MacDonald employs a sparse definition of RCT as a

theory of social behaviour, whose distinctive theoretical assumption is that actors behave according to rational assumptions. The rationality assumption consists of three components: purposive action, consistent preferences and utility maximisation. Purposive action asserts that most social outcomes can be explained by a 'goal orientated' action on the part of the actors, as opposed to being motivated by habit, tradition or social appropriateness. Utility maximisation posits that actors will select the behaviour that provides them the most subjective expected utility from a set of possible behaviours. Consistent preferences refers to preferences that are ranked, are transitive and do not depend on the presence or absence of essentially independent alternatives.

George (1998) argues that Rational Choice theories rest on central premises that individuals behave in ways that maximise their rewards or benefits (Fumio, Altonji and Kotlikoff, 1992; Blau, 1964; Cox and Rank, 1993; Coleman, 1998). In order to make a decision to maximise the benefits, one must employ rational thinking. George (1998) further proposes that for each alternative there are three elements to consider before calculating the expected benefit. Firstly, there is the actual value of the benefits to be reaped. Secondly, a consideration of the relevant costs associated with the choice and lastly, one must consider the benefits that could have been obtained had the alternative decision been chosen.

One of the most frequent criticisms of RCT is that there is no alternate theory to explain what people do when they would like to act rationally but the Rational Choice is unclear to them. According to Elster (1993) human beings have a very strong desire to have reasons for what they do and find indeterminacy hard to accept. They tend to shy away from decision procedures suggested by indeterminacy, such as making one's mind up by the toss of a coin. Instead they put their trust in a fictitious subjective probability. Elster (1993) argues that these practices represent an irrational belief in the power of rationality. Whilst this might be true for trivial situations, the same cannot be said for the decision to participate in the OS community. To participate in the OS community requires that the person is proactive in their decision to join, find an online community that appeals to them and to make a contribution in one form or another.

Other forms of irrational behaviour can be easily identified. Sometimes people fail to choose what they believe to be the best means of realising their desires, and if it happens to be by mistake, then it is not irrational. However, if they knowingly and deliberately act against their desires, it is irrational. Elster (1993) provides an example of irrational behaviour, stating: 'I am offered a cigarette when I am trying to quit smoking, on balance, my desires tell me to refuse; yet I may accept'. The culprit here is a weakness of will, the vulnerability to desires. Nevertheless, he maintains that choice is instrumental: it is guided by the outcome of action. Actions are valued and chosen not for themselves, but as a more or less efficient means to further an end. A simple example is the entrepreneur who wants to maximise profit. To achieve this end he carefully considers which products to offer, how much of them to produce and how to produce them. For example: the decision to participate in the community could be examined as a conscious choice made by an actor who has analysed the alternatives and perceives that the participation will maximise their economic utility.

When Rational Choice is indeterminate or unclear, some other mechanism must take up the slack in order to make a decision to act or not. That could be the principle of 'satisficing', or choosing something that is good enough. The word satisfice was coined by Herbert Simon. Simon (1979) pointed out that human beings lack the cognitive resources to maximise, so they usually do not know the relevant probabilities of outcomes and can rarely evaluate all outcomes with sufficient precision because their memories are weak and unreliable. A more realistic approach to rationality takes into account these limitations, and this is called Bounded Rationality (Byron, 1998). Bounded Rationality is the idea that in decision making, rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make decisions (Simon, 1982). Thus a weakness of RCT is that people do not always make the best possible decision all of the time, people make choices according to the time, information and resources that they have.

The strength of RCT has been well explained by Coleman (1986) who asserts that Rational Choice Theory has 'a unique attractiveness' as a basis for theory because it is such a complete conception of action 'that we need ask no more questions about it' (Boudon, 1998, p.817). Elster (1993) offers an unambiguous assertion that a rational decision is one that is most likely to be of benefit to the individual or achieve the most desired outcome. Coleman (1990) maintains that Rational Choice Theory allows theorists to claim they understand an actor's actions because it is possible to observe the actions, glean the actor's goals and see how the actions taken were perceived by the actor to be likely to contribute to attaining the goal. Whether or not the actor was conscious of this process is immaterial. Further, the alternative theories of rational action can be distinguished on the basis of the goals that actors are considered to work towards. The focus of the economists is on explaining economic decision-making, the actor is presumed to be assessing material or economic gains rather than intangible gains such as social rewards or a feeling of goodwill. Others however, acknowledge that actors may be pursuing considerations other than material gain.

Some of the fundamental premises of Coleman (1990) require further explanation, and need to be kept in mind when examining his discussion of RCT. One of his premises suggests that the actor's actions do not need to be considered rational from an objective point of view. The meaning here is that if the actor believes they are behaving rationally, it is still considered a rational decision, even if an independent observer calculates that the actions did not in fact maximise the actor's utility. This argument is not as controversial as one would expect. Williamson (1985) concedes that actors' rationality is bounded, and Macdonald (2003) argues that the decisions do not need to be conscious or cognitive. Coleman's (1990) argument rests on the assumption that actors take action in order to gain control over resources controlled by another to pursue their interests. He contends that actors do not always have control over the resources they require in order to pursue their interests, which is why they transact. 'Resources' is defined very broadly and includes private goods, events, personal attributes, or anything that may be of interest to others. Therefore, one actor desiring resources in the control of another in order to satisfy their own interests can explain entering any type of transaction.

Rational Choice Theory and the OS community.

Rational Choice Theory (RCT) is used to explain why people choose a particular type of activity. People make decisions based on the information they have at a particular time and are greatly influenced by their desires, needs and the opportunities available to them in their present situation. RCT helps to conceptualise and explain Open Source participation. It rests on the assumption that actors have goals that they would like to reach and they will take action to reach their goals in ways they perceive will maximise their utility. Broadly speaking, it focuses on the outcomes of actions and on the interplay between actors' goals, their beliefs and their values relevant to the pursuit of these goals and their actual behaviours (Goldthorpe, 1998; Simon, 1957). It is assumed that actors will attempt to maximise their utility, meaning that each possible action (or good) in any given situation will have potential benefits to the actor and the actor will select the option they perceive to yield the greatest benefit. The 'utility' function of Rational Choice can be linked to 'direction' aspect in the motivation theory presented in Chapter 3. The potential gains of the utility may provide the direction of the behaviour and influence the level of intensity required to achieve the desired utility. Likewise, people do not always have all the information they require to make the absolute best decision. Humans are restricted by time, energy and resources. If individuals had to examine every single possibility before they made a decision, they would not be in a position to carry out daily life. For example: when Rational Choice is indeterminate, some other mechanism must take up the slack. That could be the principle of 'satisficing', or choosing something that is good enough (Simon, 1955). Human beings lack the cognitive resources to maximise: people do not usually know the relevant probabilities of outcomes, and they can rarely evaluate all the outcomes with sufficient precision (Schwartz, Ward, Monterosso, Lyubomirsky, White, and Lehman, 2002). They therefore make the best decisions they can with the information and opportunities they have. In regards to the Open Source community, one of the reasons for participating could be that one contributes to the community by working and improving the source codes of programs to increase their own level of expertise (personal attributes). Through the online participation, the OS member gains experience in writing codes and designing software through online collaboration. The skills gained through this participation could be viewed as adding to one's personal attributes, or more specifically the direction for one to participate is to is to receive something of value to them from their involvement in the community

Participation in the community, according to Coleman's (1990) argument, can be explained as one possible outcome of a decision-making process in which ego transacts with alter ego in order to attempt to satisfy an interest, in which participation is perceived by ego to maximise ego's utility more than the alternative options. The elements that a rational ego will consider in the decision-making process are the chance of 'winning', relative to the chance of 'losing'. In other words, participation is the Rational Choice for ego when 'the chance of winning, relative to the chance of losing, is greater than the amount that would be lost (if he loses), relative to the amount that would be won (if he wins)' (Coleman, 1990, p. 99). From the information presented in earlier Chapters there are potential gains for the OS member who participates in the OS community, (improved skills, friendship and recognition). The potential gains for the Open Source participant are based on the probability that the Open Source community will provide the resources needed through online collaboration and support from other members. A potential loss is only possible if the Open Source community does not provide the support required for the perceived gains (Coleman 1990). The chance of winning is therefore much greater than the chance of losing, as the community functions through the use of online collaboration.

The criticism of Rational Choice Theory is that the definition of RCT is often dependent on the assumptions of the particular Rational Choice theorist. Etzioni (1987) argues that contrary to an economic decision-making model, actors tend to make decisions by rules of thumb rather than by calculating optimal outcomes, or they rely on habits. Cognitive capacity is a scarce resource like any other; to gather the information and do the calculations implicit in naive descriptions of the Rational Choice model would consume considerable time and energy. Any person who tried to make fully informed, Rational Choices would make only a handful of decisions each week, leaving hundreds of important matters unattended. With this difficulty in mind, most of us rely on habit and rules of thumb for routine decisions, depending on the complexity and which type of decision needs to be made by that actor (Frank, 1987, p. 3-4; Friedrichs and Opp, 2002).

The criticism that can most justifiably be levelled at Coleman, in the context of this research, relates to the consequences (i.e. the chance of winning, the chance of losing). These do not provide any basis for understanding the specific influences on ego when making the decision about whether or not to participate in the Open Source community. As a broad theory of human action, Coleman (1990) provides all the variables which are required in the decision-making process, but this does not illuminate the factors that tend to influence ego's views on what makes participation a worthwhile activity or what gains and losses are considered acceptable. Nor does it illuminate reasons why an actor may deliberately risk material loss for the gain of affective considerations, such as the possible gains associated with producing a piece of software that (if it contained a proprietary source code) could yield considerable financial gains, as many of the products developed could be sold in a commercial sense. However, the other potential gains from participating in the community (friendship, prestige, skill enhancement and ideological beliefs) may actually outweigh any potential loss. In regards to Open Source participation the benefits and costs associated are summarised in Table 7.

Table 7 Benefits and Costs Table.

1) Benefits	Increased skill and expertise gained through participation.
2) Associated Costs	The time associated with participation in the community.
3) Alternative Decision	Time saved by using proprietary software or doing something else

The benefits associated with participation include increased skills that may lead to improved job prospects, or admiration and respect from the wider OS community. Alternatively, the use of a particular program may assist a participant to complete a particular task. The decisions to use the OS community may have 'costs' associated, as the participant may need to spend more time investing in the community than they desire. This leads to the final decision in which the participant needs to weigh up the benefits and costs associated with participation in the community, versus the alternative choice of perhaps saving time by using propriety software. RCT is a useful theory to help explain what motivates individuals to participate in the Open Source community to fulfil a need (i.e. the need for friendship or building human capital), it helps to explain the direction of the behaviour. Additionally, participation is highly dependent on the structure of opportunities available to the individual, and this will be further investigated using Network Analysis in subsequent chapters.

An important aspect that needs to be acknowledged is that behaviour does not have to be considered rational by an objective person. If the actor believes there is a perceived benefit, then that alone qualifies the decision as being rational. What is rational to one person may be completely irrational to another, for example: base-jumping might be considered a highly entertaining leisure activity for one person and considered an irrational, irresponsible behaviour by another. Human beings are complex and individual perceptions should not influence the fundamental principles of Rational Choice Theory by dictating what constitutes rational behaviour. The strength of Rational Choice Theory for understanding an issue like OS participation is that it provides the structure for the explanation of the behaviours but it is also further enhanced by other theories such as Core motives, Side bets and Norms of reciprocity to explain participation in its entirety. The first of these supporting theories to be discussed is Core Motives Theory.

An introduction to Core Motives Theory and its application to Open Source participation.

Core motives theory explains the fundamental elements that help sustain the source community. The core motives of an individual are influenced by the participant's needs and their circumstances, similar to RCT. Certain motives would be more important to some participants over others and the motives importance may change during the course of their involvement. Rational Choice Theory in essence would be guided by an individual's core motives to participate; hence why it is used in the theoretical framework. Furthermore, this thesis has argued that a variety of changes have occurred which have provided some individuals with more choice in the way they utilise their time. The changes (greater variety of work schedules, combined with other factors such as life stage, gender and age) may create conditions more likely for certain individuals to participate in the OS community. The second aspect of time use poses the question: Given the opportunity to participate, what motivates a person to join the Open Source community? The motivations to participate in the OS community are not endless. In Chapter 2, the Intensity, Direction and Persistence aspects of motivation were discussed. Core Motives theory builds on this idea and argues that humans essentially have five core motives that influence their decision-making (Understanding, Belonging, Controlling, Trust and Self Enhancement) (Van Vugt, 2009). To this point it has been argued that OS participation shares many aspects similar to employment, volunteering behaviour and free time activities and therefore has comparable motives for participation. Such motives include extrinsic motives such as human capital improvements and intrinsic motives such as altruism and collectivism.

At the core, people are motivated to maintain affiliations and bonds with others (Baumeister and Leary, 1995; Stevens and Fiske, 1995). Core Motives Theory is regarded by most psychologists as the primary theory for explaining decision making in social situations (Fiske, 2010). Core Motives Theory is based on the argument that individuals do not always act selfishly and generally have some regard for the interest of others (Van Vugt, 2009).

Core Motives Theory helps to explain three areas that the OS community.

- People are motivated by a desire for belonging.
- Open Source participation constitutes a community to which people feel they belong.
- Those who feel they belong to an OS community are more likely to be committed.

Each of the five core motives and there relevance to understanding Open Source participation will be explained below.

The need for understanding.

In order to get along in a group, one must share a common understanding of the environment, and of each other (Fiske, 2004). This shared understanding enables people to function within their community and to satisfy the groups need for established norms. An understanding of a group also helps a person become more sympathetic of the group's needs and more likely to adhere to the norms of the group. The OS community relies on the ideas of 'copy left', which states that material which would normally be categorised into a copyrights agreement should actually be released under

licenses which encourage sharing and alteration of the material contained within (GNU) The Open Source community bases itself on the ability of developers and users to make changes to the source code and therefore alter the performance of a program. This shared belief is the hallmark of community and has contributed to its success with an estimated value of \$387 billion http://www.blackducksoftware.com/news/releases/ seventh-annual-future-open-source. The OS community would not function without the understanding and value sharing of ideas, information and expertise. The norms that develop in the community through this sharing of ideas may contribute to its theorised hierarchal structure, which is further investigated in Chapter 6.

The need for belonging.

The need to belong is imperative for social existence (Operario and Fiske, 1999). This need has evolutionary roots as people depend on each other for shared resources, coordinated responsibilities, protection from harm, reproductive success and survival. The need for belonging also has psychological roots as people depend on each other for social support, interpersonal bonds and mental and physical wellbeing (Operario and People form social bonds readily, even under seemingly adverse Fiske, 1999). conditions. People who have something in common and who share common (even unpleasant) experiences, or who simply are frequently exposed to each other often form friendships or other attachments, and the key to this is shared experience. Moreover, people resist losing attachments and breaking social bonds even if there is no material or pragmatic reason to maintain the bond and even if maintaining it would be difficult. The desire for belonging appears to have multiple and strong effects on emotional patterns and on cognitive processes. Lack of attachments is linked to a variety of ill effects on health, adjustment, and well-being (Baumeister and Leary, 1995). Conveying shared beliefs is a key to belonging. People are motivated to belong which generally encourages members to conform to group norms (Fiske and Von Hendy, 1992). In general it appears that the OS community offers an environment where people with similar interests can connect with others. Therefore, an important motivation to

124

join and continue may be a need for 'belonging'. This will be tested empirically through the on-line survey (details in Chapter 5).

The need for controlling.

At the interpersonal level, people express a motive to be effective and to control their social environment. At a basic level the motive expresses the push to experience some contingency between one's own actions and others responses. People who experience effectiveness and competence last longer in groups than people who experience social interaction as arbitrary and out of control (Van Vugt, 2009).

The method for interaction in the OS community is quite formal, as demonstrated on pages 39 and 40 together with the example of an online discussion post. Members join by introducing themselves to other members and politely seek advice and assistance. The majority of communication is done over the Internet via mailing lists, wikis and forums. Activity on an Open Source project is generally open to all members by means of e-mails and web boards. In the majority of cases, to join an Open Source board, potential members must seek permission from a web administrator and provide a user name and e-mail address. This approach helps members conform to the norms of the community and provides an expectation of the behaviour required and the expected outcomes of requests or offers of assistance. The most experienced members being the ones that tend to lead the discussions, and this leads to the hierarchal structure that has been observed in Chapters 1 and as mentioned earlier will be studied further via a social network analysis in Chapter 6.

The need for trust.

The motive of trust is, at its most basic level, the expectation that other people will be relatively benign with all else being equal (Fiske, 2004). Findings suggest that people construct positively biased impressions of evaluative power holders, seemingly in an attempt to quell feelings of insecurity or inadequacy (Fiske, 2004). Additionally, people's first impressions of others tend to be slightly positive (Sears, 1983), reflecting a need for people to see others as trustworthy, fair and honest. In relation to the Open Source community, members design and contribute to software online, trusting that others follow the guidelines of OS philosophy and keep the source code open. If members did not uphold the general principles of OS development including the process of online collaboration, members would not be as likely to contribute their skills. Participants write programs and release the source code so it can be used by anyone. The regulations of the OS community are clear and transparent and are governed by General Public License (GPL). Members trust that when they ask for assistance or give advice, it will be received by the community in a respectful manner. If this were not the case, it would be highly unlikely that the community could operate or produce the amount and quality of software.

The need for self enhancement.

The motive of self-enhancement is the desire to maintain and possibly improve selfesteem. For any group member, moderate self-esteem motivates a healthy 'in group identity' with other people within the group. The OS Community offers many incentives for self-enhancement. Participation provides opportunities for skill advancement and the ability to connect with people of similar interests. OS appears to be quite unique in that it bases its hierarchy on the participation and expertise of its members, as opposed to perhaps the popularity of its members. This will be further investigated in Chapter 6. Participation is very transparent, it is viewed by the community online and few other factors are considered (gender, ethnicity), the value gained is in the contribution. As discussed in Chapter 1, dominant members do emerge in virtual communities where they are able to influence each other based on intellect, usability or by their high levels of commitment to the community (Brint, 2001). Respect and prestige are gained among the members through their contribution to various projects, skills and participation. It has been argued that developers participate in the Open Source community in order to improve their own skills, and to exchange information and knowledge with other developers (Ghosh, 2002). This will be further tested with the data from the online survey. The next two theories concentrate on the theories that best explain the commitment in the OS community.

An introduction to Becker's Sides Bets Theory and the Norms of Reciprocity.

This thesis seeks to explain how people originally become involved in the Open Source community and what maintains this commitment. Side Bets Theory and Norms of Reciprocity are useful for understanding why people stay involved. People originally participate in the Open Source community for a variety of reasons and will have a range of motives including the need for understanding, belonging, controlling, trust and self enhancement. Combined with the structural changes in society and taking into account demographics such as age and gender, these will all impact on the decision to join (and stay) in the OS community. What maintains this commitment will be different for each individual. For those who become involved in OS by initially downloading the software, the commitment may be slow to form. For others, there may be further instrumental motives for becoming a member and these motives would be vastly different amongst the new members, compared to someone that has been involved for a substantial period of time. People who have been members of the community for longer periods of time are more likely to have developed stronger ideological beliefs and a stronger sense of commitment. Through the ongoing interaction with other members and the sharing of information, the individual makes investments - be it with time or expertise. Becker's Side Bets Theory and Norms of Reciprocity assist in analysing this ongoing participation and commitment. The next section will address these theories.

Beckers Side Bets Theory.

The theory of Side Bets can be used to explain what encourages people to stay involved and to continue participating in the OS community even after their original need for joining has been satisfied. Becker (1960) used the term Side Bets to clarify the concept of commitment. The term 'commitment' is vague and ambiguous. Becker attempts to remedy this ambiguity by using the most accepted definition of commitment and further clarifying the fundamental meaning. As part of this elucidation of commitment, the theory of Side Bets was developed. The deeper meaning of the concept of commitment and Becker's extensive arguments are not pertinent to the current research; however a background is necessary to thoroughly explain the theory of Side Bets and to illustrate its relevance to the current research.

The term 'commitment' has an implicit assumption of an underlying mechanism producing consistent human behaviour. Becker (1960) contends that commitments come into being when a person, by making a side bet, links extraneous interests with a consistent line of activity. Essentially, it is a consequence of deciding to take a particular course of action that leads to an increased commitment to the original decision. Choices are made based on assumptions about the wider world, and previous decisions that have been made. In this 'side bets' are made that are based on a main 'bet' or activity succeeding. If failure occurs on the main bet, then the side bet is also lost. The side bets thus increase commitment to the main bet. An example of a side bet is:

A person refuses to change to a job with a higher salary because the new job is higher risk in terms of potential failure and the person has made a side-bet of buying a new house based on the assumption of a continued and stable income.

Side Bets are often a consequence of a person's participation in social organisations and Becker argues that commitment is actually made by making a side bet. Essentially, the committed person has acted in such a way as to involve other interests of his or her own that were originally extraneous to the action he is engaged in. This can be seen in the OS community where individuals become invested in projects and interact online. These 'side bets' foster commitment which may be different to the original motivation to join.

Chapters 1 and 2 discussed the possible motives that encourage participation and reviewed the situational and structural factors that provide opportunities for acting on motivation. Nevertheless, a crucial element is still missing in explaining OS participation

and in particular what keeps members contributing and being involved in the community. Participants join the OS community for many reasons, which are yet to be explored empirically. If the example of someone joining the community for advice on a particular piece of software is used, it is clear that this was the motivating factor to join. The decision is a rational one, in which the participant uses the community to for filling a particular need. If the same person begins to look at other projects after been given the advice and then makes a contribution to a project, they are making a side bet which encourages them to stay committed. This will be investigated further with the survey results.

The next section explains how the theory of Norms of Reciprocity can be used to describe the factors that maintain participation in the OS community through the norms that develop.

Norms of Reciprocity.

The current research is not intended to contribute to discussions on the underlying motivations regarding behaviour in general, or reciprocity in particular. Instead, the focus is on the form that the reciprocal behaviour takes, and the consequences it has for the (repeated) interaction between individuals in a group. The Norm of Reciprocity is the social expectation that people will respond to each other in kind returning *benefits for benefits* and responding with either indifference or hostility to harm (Gouldner, 1960). Reciprocity is defined as the conditional behaviour where kind acts are rewarded and hostile acts are punished, even when this is costly (Seinen and Schram, 2001). The distinguishing feature of reciprocity is that it is not based on explicit incentive schemes. In other words, the individual decision to reward or punish acts of others is not governed by his or her direct self-interest (Seinen and Schram, 2001), but rather by unwritten rule (or norm) about what is appropriate. The Norm of Reciprocity is by itself a powerful engine for motivating, creating, sustaining and regulating the cooperative behaviour required for self-sustaining social organisations, as well as for controlling the

damage done by the unscrupulous. In effect, when people take something, they feel obliged to return the favour.

In the literature, reciprocity is generally limited to direct reciprocity, requiring repeated encounters between the same two individuals. However many authors have stressed that reciprocity does not need to be restricted to two individuals (Trivers, 1971; Sugden, 1986, Alexander, 1987; Binmore, 1992). According to Alexander (1987), the term indirect reciprocity refers to an individual's use of both the information from their own experience, and also how they react to the interactions they observe between other individuals within their group.

There has been less research conducted for indirect reciprocity where a third actor reciprocates a cooperative action not involved in the original exchange. Alexander (1987) argues that indirect reciprocity plays a central role in human societies. The link between actors is made through 'reputation' or 'social statuses'. Individuals in society are continuously being evaluated and reassessed with respect to how 'cooperative' they are. This gives them a reputation that may be used by others when deciding on how cooperatively to act towards them. In indirect reciprocity the return is expected from someone other than the recipient of the beneficence. This return may come from any individual or collection of individuals in the group. Indirect reciprocity involves reputation and status, and results in everyone in a social group continually being assessed and reassessed by interacting, past and potential, on the basis of their interactions with others (Alexander, 1987, p. 85).

Once the occurrence of reciprocity has been recognised in a group, there is also room for the hierarchal structure of individuals to establish and ensure they gain a reputation for contributing and helping. Even those who would not otherwise act cooperatively might do so in order to increase the probability of being reciprocated. In the OS community there is evidence that those who have contributed the most and have the greatest levels of expertise are well respected and influential in the OS community (Rheingold, 1993; Raymound, 1999; Gabriel and Goldman, 2001). Consequently, it provides necessary conditions for cooperative behaviour to be stable in the long run and is therefore seen as important amongst the group. This is evident in the OS community, where participation builds skills and this leads to a hierarchal structure in the community where the largest and most skilled contributors have the most say over projects (Hars et al, 2002, p.30).

Seinen and Schram (2001) argue that individual norms are at least partly determined by group composition developing similarly within groups, but distinctly across them. This leads to the emergence of 'group norms'. These individual norms refer to the social status of the recipient that is demanded to help him or her. A consequence of distinct group norms across groups is that a specific social status may be sufficient to induce helpful behaviour in some groups. Reciprocity leads to the development of group norms, which therefore foster commitment in the community. When people take something from the community, be it a piece of software or advice, they generally feel obliged to give back. Side Bets Theory and Norms of Reciprocity explain the desire to contribute and the commitment that is evident within the community. Open Source programmers receive rapid, constructive feedback about the quality of their work through online networks. Feedback generally has a positive effect, in that it shows programmers that people are using their contributions. The feedback mechanism is self re-enforcing for it encourages the author to expend additional effort to perfect his code, which in turn attracts more favourable feedback (Hars et al, 2002, p.30).

Norms of Reciprocity can help to explain the desire to stay involved the in Open Source community. It can be argued that many people originally joined the OS community because they are in need of a particular item, be it advice or a specific piece of software. Beyond this point there is no obligation for the member to continue their involvement. However, the literature previously presented shows that participation and sharing are key attributes of the community (Hars et al, 2002).

The integration of theories to explain Open Source participation and commitment.

The approach of this thesis is to use Rational Choice Theory to study the direction of participants' motivation. Each of the theories discussed have an integral part in explaining Open Source participation and each offers an element that produces a multidimensional approach for comprehensively examining Open Source participation. Rational Choice Theory (RCT) is the key theory as it enables the framework to empirically address participation. RCT explains the direction of the participant's motivation and argues that people have goals (which provide direction) to maximise a utility (benefit to the individual). It also helps to provide an explanation of what benefits they expect in return and what purposive action will be taken to achieve such goals.

When Rational Choice Theory is applied directly to the literature presented in Chapter 2, its value becomes clear. Participation in the OS community is a form of volunteering and the literature reveals that many people partake in the activity to receive a possible gain (be that intentional or not). Specifically speaking, the motivation to volunteer in the community generally stems from a need or a requirement that an individual has. This notion of egoism was discussed in Chapter 2 Table 4 presents the various functions served by volunteering and includes (values, understanding, enhancement, career, social and protective elements). Many of these utilities that individuals want maximised are for their self-interest. Specifically speaking, when we look at the motives for volunteering we can see that self-development is highly important for software contributors: 88% of respondents surveyed by Hars and Ou (2002) ranked human capital enhancement as high or very high. This was the highest percentage among the motivations studied. Career enhancement has also been highlighted as a motivation (Lerner and Tirole, 2002). Furthermore, building one's reputation has also be noted (Bezroukov, 1999; Lakhani and von Hippel, 2003; Markus et al., 2000; Perkins, 1999 and Raymond, 1999). Rational Choice Theory is of particular use when explaining the motives that encourage people to join the OS community. Core motives theory provides the understanding of what motivates humans generally, but can be applied to highlight some of the motives discussed for OS participation. These fundamental motives may be the driving force that participants can fulfil through participation in the OS community.

Two additional theories better explain continued participation in the community and can be used in conjunction with RCT. Norms of Reciprocity explain the reasons for the ongoing and repeated commitment to the community. Reciprocity creates an environment for the cooperative behaviour required for the OS community to exist and the norms that develop to support the community. In effect, when people take something from the community (advice, program) they feel obliged to return the favour because of the norms that have developed within the community. Side Bets Theory further explains OS members' commitment to the community through the investments that they make in terms of time spent and contribution. Essentially, the more one contributes to the OS community the less likely they are to want to leave the community. Furthermore, much of the literature points to a hierarchal structure that exists within the community based on expertise and participation (Hars et al, 2002, p.30). This results in some members having a higher status than others and is in part supported by the norms that develop within the community. This hierarchal structure is gained through the participation of OS members and is supported by the norms that develop in the community. Essentially, the members who contribute the highest level of technical skill tend to have the most control over projects and are thus the most sought after for assistance and expertise (Hars and Ou, 2002). This was also demonstrated in Figure 4, which illustrated the various roles in the community. However, there is little empirical research to support the evidence of a hierarchal structure and the current thesis aims to remedy this.

Conclusion.

As presented in earlier chapters, the limited empirical evidence presented on participation in the OS community has encouraged some advocate's to view the OS community as a fundamentally new mode of industrial organisation, a post-materialist one in which people code software simply for the pleasure. Simply put, although it is common to assume that cultural factors drive OS participants to collaborate on Open Source projects, there is little trustworthy evidence to support such a claim. Motives for participation in the community may be far more instrumental and directed at achieving particular goals for participants.

As demonstrated in Chapter 1, the literature on the Open Source community (Raymond, 1999; Franke and Von Hippel, 2003; Hars et al, 2002) provides plausible explanations for the actual dynamics of Open Source development through discussion forums. Their weakness being that they offer very little explanatory power when applied to the most fundamental question of all: Why does Open Source development occur in the first place? The impetus for individuals to produce free software may be the expectation of tangible benefits sometime in the future. This needs to be empirically investigated. Rational Choice Theory is the fundamental explanation of the OS community. However, each of the complementary theories presented assist with building on our understanding of the Open Source community. With each of the theories included, all aspects of participation are covered. RCT predominately explains the decision to join the OS community, whilst Norms of reciprocity and Side bets explain the reasons for continued participation and the norms that have supported the community to thrive. This conceptual approach is unique as it enables multiple motives, circumstances and situations to be considered that see people joining and participating in the community. A major contributing aspect of this research is that it is not limited in its explanation of the OS community.

CHAPTER 5

AN EXAMINATION OF THE STRUCTURE OF THE OPEN SOURCE COMMUNITY THROUGH NETWORK ANALYSIS: THE RESEARCH DESIGN

Introduction.

This research was conducted in order to investigate the motives for individuals becoming involved in Open Source, and what sustains this participation. Furthermore, the structure of the OS community is investigated in this study. Rather than just focusing on the motives, this research aims to investigate the structural changes and life stage impacts that encourage participation. In order to answer these questions, a theoretical framework was presented in Chapter 4 and a multi-mode study was designed comprising of a self-designed on-line survey and social network analysis to empirically analyse the community. The online survey obtained 1632 valid responses and comprised of 37 questions ranging from fixed response answers, Likert scale questions and written responses. The respondent's answers were directly downloaded in to SPSS for analysis. Verbal responses were coded separately. Along with primary data, the researcher also made use of secondary resources in the form of online discussion archives to obtain the data for the social network analysis. Broadly, the online survey was designed to study motives for joining and participating in OS and the social network analysis was conducted to gain a better understanding of the community structure. This chapter will begin by explaining the online survey and how the results contribute to our understanding of the motives for participation in the OS community.

The Online survey.

A survey methodology was deemed to be the most appropriate way to utilise the theoretical framework to examine OS participation utilising - Rational Choice, Core Motives, Side Bets and Norms of Reciprocity. The research questions were developed after reviewing the literature presented in Chapters 1-3. The survey was designed to answer the research questions and to build a detailed overview of the Open Source community, including general preferences for time use and the demographics of the community. The research questions are presented below and framed around the three essential components of motivation (direction, intensity and persistence), with the exception of question 4 which concerns the community structure.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS ? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

Survey Design and rationale for web based survey.

The survey was conducted in the form of an online-survey. The survey was intended to gain an insight into the motives of participants to develop, distribute and exchange information and to research the ways in which the OS community is organised. A number of questions were adapted from the FLOSS 2008 survey¹ (A17 –A21) and The Australian Survey of Social Attitudes AuSSA 2005 Questionnaires (A25-31). The FLOSS survey based on a source code analysis was conducted in parallel to the survey, the FLOSS team was able to identify a sub-sample of approximately 500 OS contributors and to crosscheck some of their answers to the survey by their documented contribution to software code. This sub-sample provided a validated group of OS participants, to which

¹ Please see Appendix for the complete survey

the large majority of OS developers who could not be validated in this way could be compared. The aim of this procedure was to check the validity of the results of the FLOSS survey.

The AuSSA is a biennial survey that began in 2003 and is managed by the Australian Consortium for Social and Political Research Incorporated (ACSPRI). Developed with the co-operation of social scientists around Australia, AUSSA provides authoritative data on the social attitudes and behaviour of Australians. The Survey is the official source of the International Social Survey Program's data for Australia.

The questionnaire consisted of closed questions (meaning every question was associated with a variety of possible answers the participant had to choose from). The structured questioning means that all respondents were asked consistent questions. This provides the opportunity to quantify the information while providing consistency. However, this approach can limit the richness of information, since respondents do not get the opportunity to provide responses in context, so open-ended questions were included which provided participants with this opportunity. The remaining questions were general demographic questions and structured questions that provided the results to thoroughly examine the research questions. A structured approach provides data that is more easily quantifiable.

Within the 10-month period that the survey was conducted, 1632 OS participants filled in the online questionnaire, a number that provides a good basis for a deep-grounded description and analysis of the realm of the OS community. The scope of the survey was not limited, neither by the number of interviewees nor by countries or similar criteria. The researcher has an in-depth understanding of the well-known phenomenon, namely that questionnaires of the described type are distributed within the Open Source community by the participants themselves, it therefore enabled the researcher to reach a large and diverse part of the whole group under consideration. The questionnaire was posted to 160 OS communities and then distributed further within the whole scene by the OS community themselves; the survey covered a broad scope of the OS community as a whole. The size of the sample is, thus, smaller than the size of the sample of the FLOSS survey (2002) but considerably larger than the sample size of the Hars and Ou's (2002) study. The results of the survey are presented in the following chapters.

The survey was created to empirically test the motives to join and participate in the OS community using the theoretical framework provided by RCT, Core motives theory, Norms of reciprocity and Becker's Side Bets. These theories provide the foundation to investigate the motives to participate in OS whilst considering the conditions that make it more or less likely to join and contribute. The literature reviewed in Chapters 1 to 3 revealed that people generally have more free time and structural changes in society have assisted with this change (Hakim, 2000). The time use literature also revealed that age, marital status and the presence of children influence the amount of free time that one has (ABS cat 4153.0). The questions concerned with time use are based on the premise that more free time may result in more time spent contributing to the OS community. The volunteering literature revealed that many participants are volunteering for a specific need and this is influenced by age, life stage and occupation, the amount of time spent contributing to the OS community may influence the motivations of participants. Additionally, it has been argued that contribution may increase ideological beliefs and the desire to contribute with members of the OS community (Brint, 2001; Ghosh, 2002). Lastly, when a participant takes something from the community it may create the bases of a reciprocal relationship with in the community (Trivers, 1971; Sugden, 1986; Alexander, 1987; Binmore, 1992). The research questions are presented over the page in Table 8 and will be tested in the results chapter.

Table 8: Theory and general categories.

Theory	Category
Rational Choice	Direction, Intensity
	Initially, people are more likely to become involved with the OS community to gain equipment or advice, rather than the social aspect.
	Hours of employment will influence available time, and therefore time spent in the Open Source community. Longer hours of employment will result in less time spent participating in the OS community.
	Single and non cohabitating participants will spend more time on OS participation than those that are cohabitating.
	Younger (< than 30) and older participants (> than 50) will spend more time on OS projects.
	Members of the OS community will predominately be tertiary educated and employed in the IT field.
	Younger participants will value skill enhancement as a reason to be involved in the OS community more than older participants.
	People have multiple motives to participate in the OS community.
Norms of	Persistence
Reciprocity and SideBets Theory	The longer a person has been involved in OS, the more they will contribute to projects.
	The more projects participants have contributed, the more likely they are to value gaining a reputation in the community
	The more projects in which a participant is involved, the greater the desire to give back to the OS community.

A number of questions were modelled on the FLOSS (2002) large scale survey. Questions were also taken from the Wilson, S and Gibson, R. *Australian Survey of Social Attitudes 2003,* The Australian National University: ACSPRI Centre for Social Research, 2003 on the satisfaction with life, satisfaction with job and assistance with making difficult decisions. The questions were put forward to examine if the OS community is used as an external support structure for participants or purely as a free time activity with limited actual personal investment.

To ensure the validity of the entire survey, including any questions that had been altered, focus groups were established and led by a moderator to review. The focus groups assisted the researcher to identify specific terminology, definitions and concepts used by respondents to identify potential problems. Expert review was also conducted to insure the validity of the survey instrument. Furthermore, a group was selected to trial the survey online and report their experience to the researcher. This also allowed for the data collection method to be thoroughly tested.

The survey was designed through a program called queXML. A questionnaire written in queXML can be 'exported' to multiple modes of questionnaire formats such as PDF and online. The respondent's answers were directly downloaded in to SPSS for analysis. Verbal responses were coded separately; the procedure to be discussed later in the chapter. The survey comprised of 37 questions ranging from fixed response answers, Likert scale questions and written responses. To attract the most participants possible, a request was sent to 180 online Open Source discussion boards to apply for online membership. This was necessary as no one is allowed to post a message without becoming a member. As a result, membership was approved on 160 boards. A message was posted on each of the discussion boards explaining the survey and requesting participants; the link was then included to direct participants to the survey. The IP address of participants was recorded, but only to ensure multiple responses from the same participant were removed (a list of discussion boards is included in the appendix as well as a copy of the survey and cover letter). The survey was open for 10 months,
and in total 1654 valid responses were received. There are many advantages of an online survey, most significantly the lower overall cost. However, in this case the best way to contact an online community was to simply contact them online.

The emergence of Internet and e-mail, plus the increasing availability of the World Wide Web has provided tremendous opportunities for conducting research and it has created a burgeoning interest in web-based surveys (Dillman et al., 1999). Researchers (Pitkow and Recker, 1995) have noted the following benefits associated with Web surveys; lower overall cost, increased speed and efficiency of data collection (Batageli and Vehovar, 1998; McCullough, 1998), collapsed geography and increased communication between the researcher and respondent (Smith, 1997); higher quality graphics, multimedia and presentation (Sheehan and Hoy, 1999); increased candor (Smith, 1997); fewer transcription errors and potentially increased response rates (Swoboda, Muehlberger, Weitunat and Schneeweiss, 1997). Equally, shortcomings or costs have been noted to include the following; high start up costs (Batagelj et al, 1998; White et al ., 2001); technological or human difficulties in respondent completion (Dillman et al.,1999); inability to observe or communicate with the respondents (Farmer, 1998); lower response rates (Yum and Trumbo, 2000); sample bias (Sheehan and Hoy, 1999); coverage error and difficulty maintaining privacy, anonymity or confidentiality (Stanton and Rogelberg, 2001). It should be noted that many of the start up costs can actually be eliminated or dramatically reduced by using Open Source software and numerous reliability issues can be avoided with the initial survey design. This was one of the many reasons why the program queXML was used as it helped to avoid the potential problems of online surveys.

Table 9 lists common web design problems and possible solutions used in the current research.

Table 9: Web design problems and solutions.

Objective or problem	Design suggestion
Lack of control and consistency in display of pages and large amount of time required for download	Simplify pages and maintain consistency
Multiple browsers adding to design complexity	Use principle of Least Compliant Browser and design for the simplest and most common environment
Double or multiple counting of respondents	Employ personal identification numbers, login credentials, cookies or IP filtering to identify duplicates
High drop-out rates	Make initial questions interesting and use formats that increase read ability and restrain extraneous use of colour. Avoid known measurement problems and the use of drop-down boxes
Incomplete responses	Prompt for missing questions

Tingling, Parent and Wade (2003)

Table 10 presents some advantages and disadvantages of online surveys.

Advantages	Disadvantages
Low marginal cost in logistics and mechanics of survey construction	High start-up and fixed costs (this was avoided through the use of OS software which involved no cost)
Increased geographic reach	A high level of technical expertise may be required of both the researcher and the respondent
Increased response rate due to improved design, better targeting of respondents and identification of interested parties	Inability to communicate with the respondent
Questions may be easily modified at any time prior to completion	Difficult to maintain and ensure anonymity and confidentiality

Tingling, Parent and Wade (2003)

Online surveys have additional benefits over other methods. In traditional mail surveys the response process is unknown to the researcher. The researcher is unable to decipher whether the respondent received the questionnaire, read it or began answering it. If an individual fails to return a questionnaire it is unclear whether this was a genuine refusal (i.e. volitionally-controlled), or whether some artefact was to blame, as in both cases it would just be reported as a non-response (Bosnjak and Tuten, 2001). In the online survey it was possible to see how many people viewed the survey only, or did not complete it in its entirety. The advantage being that you are still able to retrieve the data from questions answered, rather than receiving no information, as would be the case in a traditional mail survey. It also allows for the easy identification of questions respondents are (possibly) avoiding.

The design format of an online survey can have an effect on its success. Dillman et al (1999) recommends avoiding the use of graphically complex or fancy design options in the survey design. More intricate survey designs revealed higher quit rates when

compared to plain designs. This was attributed to the corresponding increase in download time for pages with complex designs. The current survey was designed with simple radio buttons to avoid such problems. Thompson and Cook's (2001) research examined if different response formats change the latent structure of responses. They found that although slider bars are more visually attractive, they require more sophisticated hardware and software. These findings suggest that radio buttons can be used instead of java-based slider bars as a 'lowest common denominator' that can be expected to work on almost any web browser, potentially leading to higher response rates. Web-based survey developers are encouraged to use radio buttons instead of java-based slider bars because they may allow more participants to easily respond to surveys, and they appear to elicit responses with latent structure, closely corresponding to the latent structure elicited by the slider bar (Thompson et.al, 2001). In the survey development for the current research, it was crucial that it appeared very similar on all web browsers for the participants and that the survey was easy to view and complete. Due to financial constraints the survey was only conducted in English and because many participants did not speak English as their first language, it was even more imperative that the survey was clear and concise. Radio buttons were used on all applicable questions to assist with this.

Knapp and Heidingsfelder (1999) show that increased dropout rates can also be found when using open-ended questions. To avoid this problem the open-ended questions were strategically placed at the end of the survey, to ensure that participants were not initially discouraged from participating. Frick, Baechtinger and Reips (1999) investigated the effect the order of topics may have on dropout rates in web-based surveys. In one scenario, personal details were requested at the beginning of the investigation (sociodemographic data and e-mail address). To meet the second requirement, these items were positioned at the end of the questionnaire. The dropout rate was found to be significantly lower in the first condition. Solomon (2001) found that there were two main points in web surveys when respondents stopped completing the survey. Firstly, when respondents encountered a complex grid of questions and responses and secondly, when they were asked to provide their e-mail address. In the current survey demographic questions were asked at the beginning of the survey, but participants were not required to include their email addresses or any other identifying information. Instead, queXML only recorded the IP address of the participants to allow for the removal of multiple responses from the same participant.

Given that the survey contained 37 questions with multiple categories and written responses, it was divided into sections with multiple questions presented on the screen. Participants were also given the option to submit the survey at any time, or to quit without submitting, if they so chose. This was done to increase the speed and accuracy for the participants and to encourage them to submit some of their answers rather than risk losing all the participant's responses, if they decided not to complete the survey. Couper (2001) found that if they altered the presentation of the single item screen to allow multiple items to appear, completion time for the survey was faster, there were fewer non-answered questions and more similarity in answers than when questions were presented individually. In addition to this, Smith (1997) advised that long surveys should be divided into sections and there should be 'clear' and 'reset' buttons so respondents do not have to reset the entire survey if they wish to clear one question. Many of the questions in the survey had fixed response categories or a limit to the amount of information participants could provide. For example: when a participant was asked how many hours a week they participated in the community, there was only enough space provided for a maximum 3 digit response. This allowed the data to be automatically downloaded into a database with minimal clean up of the data required from nonsensical responses. Questions surrounding income earned from OS and employment were converted into four currencies (AUD, GBP, EUR and USD) to elicit the most accurate responses from international participants.

In addition to the fixed response questions, participants were asked three questions requiring a written response. To enable the results to be used in an informative way, a

coding framework was designed for these written responses. To assist with the process, a program called queXC was used. queXC cleans, codes and classifies qualitative and other textual data (such as data collected from a questionnaire). Multiple operators can work on a single data file using only a web browser. Coding/classification schemes can be created on the fly, or imported. In the current case, the coding framework was created by the researcher on the fly due to the volume of answers received. After the coding framework was created, each of the three written questions had 14 categories for which each response could be allocated. queXC displays each survey question response to multiple coders (separately) who assign a code to that question response. In the current research, three independent coders were selected to perform this task. The coded responses can then be reconciled by another coder who selects the most appropriate of the codes if there is a discrepancy (in this case the researcher), otherwise the system automatically accepts identical codes from multiple coders. From this, the results could then be analysed in SPSS. An overview of the survey is presented in Table 11.

Table 11: Open Source Survey Questions in Categories.

Rational choice - Direction and Intensity.

What is your gender?

What is your age?

What is your marital status?

Which country do you live in?

In which country were you born?

What is the highest level of education that you have obtained?

What is your current profession?

On average, how many hours per week do you work in your current job?

What is your average yearly income?

Have you ever earned money directly from an Open Source Project?

How much money have you earned in the last 12 months on Open Source Projects?

How much time per week do you spend working on Open Source projects

Is working on an Open Source project part of your paid employment?

What percentage of your paid employment comes directly from working on Open Source projects?

Are any of your friends also involved in Open Source projects?

If you needed help to make an important decision, for example about a job or moving to another part of the country. Apart from your husband, wife or partner (if you have one) who would you turn to first for help?

Suppose you felt just a bit down or depressed and wanted to talk about it. Apart from your husband wife or partner (if you have one) who would you turn to first for help?

All in all, how happy are you with your life these days?

All in all, how satisfied are you with your job?

Suppose you could change the way you spend your time, spending more time on some things and less time on others. Which of the things on the following list would you like to spend more time on, which would you like to spend less time on and which would you like to spend the same amount of time on as now? The time you spend in a paid job?

The time you spend doing household work?

The time you spend with your family?

The time you spend with your friends?

The time you spend on leisure?

The time you spend relaxing?

The time you spend working on Open Source projects

Core Motives.

How important to you are the following aspects of a job?

Job Security?

High income?

It has good opportunities for advancement?

A job that leaves a lot of leisure time?

A job that is interesting?

A job that allows you to work independently?

A job with flexible working hours?

On a scale of 1-5 how important are the following things in your decision to work on an Open Source project?

Improving my financial situation.

Believing that software should be free.

Helping to limit the power of large software companies.

Solving a problem that could not be fixed by proprietary software.

Getting help realising a beneficial idea for a software product.

Enabling me to distribute a non marketable software project.

Building a reputation in the Open Source community.

Improving Open Source products from other developers.

Improving my job opportunities.

Being a member and participating in the OS community.

Sharing my knowledge and skills with other members of the community.

Learning and developing new skills.

Participating in a new form of cooperation.

To what extent do you agree or disagree with the following? Members of the OS community generally expect you to

Help to develop software that could not be fixed by proprietary software.

Help design new products.

Help to distribute non marketable software.

Respect other peoples' contributions to software development.

Help to improve existing Open Source products.

Write aesthetic programs.

Take part in the main communications and discussions

Share you knowledge and skills.

To what extent do you agree or disagree with the following? Members of the Open Source community generally believe that

You will make money by working on Open Source projects.

It is important to limit the power of large software companies.

Working on Open Source projects will improve job opportunities.

You will learn and develop new skills by working on Open Source projects.

In your own words, what is the most important reason for your involvement in the Open Source community?

Other than the categories listed in the previous question, is there any other reason for your participation on an Open Source project.

Thinking about work in general, to what extent do you agree or disagree with the following statements.

A job is just away of earning money.

I would enjoy having a paid job even if I did not need the money.

Work is a person's most important activity.

Believing that software should be free.

Participating in a new form of cooperation.

Helping to limit the power of large software companies.

Do you believe that people who work on Open Source projects should

Make money from Open Source development?

Help to develop free software?

How important are the following to your involvement in Open Source development?

Entertainment.

Exchange of knowledge.

Career improvements.

Enabling more freedom in software development.

Helping people find project partners.

Communicating with people with similar interests.

Providing more variety of software.

Helping software developers in need of particular tools.

Providing imitations of proprietary software products and services.

Innovative breakthroughs.

Health competition to design better codes.

General discussions about software.

Side best and Norms or Reciproci	ty - Persistence
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How long ago did you work on your first Open Source project?

Less than a year

1 to 3 years

4 to 6 years

6 to 10 years

Over 10 years

How important to you are the following aspects of a job?

A job that is useful to society.

A job that allows you to help other people.

Building a reputation in the Open Source community.

Approximately how many projects have you worked on?

Apart from online communication which methods do you use to communicate with other members of the Open Source community?

Data Analysis.

Initially the preliminary data descriptive, demographics and frequencies were analysed using SPSS and the results reported. Various statistical measures were then used to analyse the data and the rationale for each of the methods is presented below.

Factor analysis.

The method used was to firstly examine the variables in the data set to identify the various questions that highlighted the participant's motivations to participate in the OS community, with a view to selecting a subset of characteristics that may influence further responses. Survey responses were analysed at the item level using figures, tables or text alone, to provide a first impression. Comprehensive demographics were

analysed earlier. These item level responses were scrutinised for underlying patterns via factor analytic procedures (Note that all procedures reported here utilise SPSS). A prerequisite for including an item was that responses were not overly skewed (i.e., 90% or more of responses clustered in a single cell) and more generally, the level of response to that item was not insufficient (<15-20%) to destabilise analysis. The factors identified in this fashion correspond to the primary topics or latent variables to which correspondents seemed to be responding in terms of various related items.

The protocol adopted for factor analysis was to initially use default settings (Principal Axis Factor - PAF) and to rotate the matrix of loadings to obtain orthogonal (independent) factors (Varimax rotation). The prime goal of factor analysis is to identity simple (items loadings >0.40 on only one factor) that are interpretable, assuming that items are factorable (The Kaiser-Meyer-Olkin measure of sampling adequacy tests whether the partial correlations among variables are small. Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, indicating that the factor model is inappropriate). Once the clearly defined and interpretable factors had been identified (Factor loadings =>.10 were illustrated via an included table even though only item loadings >0.40 were considered relevant to factor loadings), the responses related to these factors were saved in the form of factor scores. These Bartlett factor scores are equivalent to sub-scale or scale scores with means of zero and standard deviations of one (z-scores) and with participants credited with separate scores in relation to each identified factor. Since these factor scores translate the ordinal responses to individual items into standardised z-scores with interval properties, the relationship between responses to these factors were probed via multivariate (MANOVA) or univariate (ANOVA) parametric tests.

Where significant main effects or interaction effects were observed, the locus of these was determined via nonparametric tests of significance, usually Chi-Square contingency tables, or Kruskal-Wallis nonparametric analyses of variance. The rationale for the analytic approach outlined here is that it parallels the commonly accepted protocol for

examining univariate and multivariate ANOVA, which typically proceeds by testing for significance at the most general level of association and then, once that is established, tests for significance at specific levels of the independent variable/s (e.g., via pairwise comparisons). The alternative is an item-by-item approach whereby every questionnaire response is crossed with every variable representing personal characteristic; a shotgun process that increases the number of reports of significance, at the cost of exponentially increasing the number of required analyses, whilst missing the insight provided via procedures that identify deeper patterns of responses to items. The other downside of mass item analysis is that the acceptable level of significance per item has to be adjusted to take into account the sheer number of individual tests of significance, an adjustment that excludes all but the most extreme outcomes (i.e., p<.001), thus nullifying the effect of the initial increase in the number of hits.

One-way ANOVA.

A one-way analysis of variance (one-way ANOVA) is a technique used to compare means of two or more samples (using the F distribution). This technique can only be used for numerical data. The ANOVA tests the null hypothesis that samples in two or more groups drawn from the same population. To achieve this, two estimates are made of the population variance. These estimates rely on various assumptions. The ANOVA produces an F statistic, the ratio of the variance calculated among the means to the variance within the samples. If the group means are drawn from the same population, the variance between the group means should be lower than the variance of the samples, following central limit theorem. A higher ratio therefore implies that the samples were drawn from different populations.

The results of a one-way ANOVA can be considered reliable as long as the following assumptions are met:

• Response variable must be normally distributed (or approximately normally distributed).

- Samples are independent.
- Variances of populations are equal.
- Responses for a given group are independent and identically distributed normal random variables (not a simple random sample (SRS).

Regression analysis.

The general purpose of multiple regressions is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable. Regression analysis explains how the value of the dependent variable changes when any one of the independent variables is varied, and when the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables — that is, the average value of the dependent variable when the independent variables are held fixed. The estimation target is a function of the independent variables called the regression function. In regression analysis, it is also of interest to characterise the variation of the dependent variable around the regression function, which can be described by a probability distribution (Francis, 2007).

Cross tabulation.

Cross tabulation is the process of creating a contingency table from the multivariate frequency distribution of statistical variables. A cross-tabulation gives a basic picture of how two variables inter-relate. It helps search for patterns of interaction. Obviously, if certain cells contain disproportionate numbers of cases, then this suggests that there might be a pattern of interaction. To test if the pattern has any substantial relevance the Chi-square statistic is used. Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. The chi-square test is always testing the null hypothesis, which states that there is no significant difference between the expected and observed result (Francis, 2007). This chapter will now outline the Network Analysis research design by providing an overview of the format of the Open Source community, followed by the rationale of the data used and an explanation of Network Analysis. The results are then presented in Chapter 6.

The Structure of the OS Community.

The Open Source community can be considered a 'structure of opportunities' as the level of involvement and reward depends on skill, time committed and the resources available to the individual. Previously conducted research highlights the complex nature of participation (Rheingold, 1993; Raymond, 1999), but has not considered the multifaceted nature of involvement and the circumstances that have enabled the community to thrive. One of the key questions the research aims to answer is what the structure of the OS community is, and whether there is a hierarchal structure as previously identified by Brint (2001), and if how the structure develops. Understanding the structure of the OS community will provide insight into why people continue participation and stay committed. It will also reveal insights into whether or not Side Bets and Norms of Reciprocity foster ongoing participation and commitment. The use of Network Analysis will provide an empirical basis to analyse the structure within the Open Source community and an understanding of how leadership roles emerge and are sustained. One of the ways the current research aims to do this is by looking at discussion posts on online OS discussion boards that form the basis of the data. The data consists of the archival information from an online discussion page taken over a twelve-month period. With this data, the communication between the various members can be analysed. By using archived data we are able to translate large amounts of information into a meaningful data set without using obtrusive techniques.

Network studies can use a substantial amount of information residing in archives not specifically designed for social research. Such data provides unobtrusive measures of social ties. Archives data is often inexpensive especially when in an electronic form:

and if maintained overtime, archives support longitudinal network studies (Carrington, Scott, Wasserman, and Granovetter, 2005). Archival materials are a mainstay source of data for studying networks. Examples of the range of applications for archival network data can be found in Podolny (1993), who measured the status of investments banks, based on their relative positions in announcements of syndicated securities offerings. Hargens (2000) depicted the structure of research areas via citations linking scientific papers. Adamic and Adar (2003) mined homepages on the World Wide Web for connections among university students.

Relatively few methodological studies of archival data appear in the network literature. Although properties vary from source to source, a few generic issues and questions can be raised about such data. The validity of archival data rests on the correspondence between measured connections and the conceptual ties of research interest. Computer mediated systems offer potentially rich data on human communication that network analysts have only begun to exploit (Rice, 1990). However, such records are medium specific: e-mail archives for instance exclude face-to-face communication that may be highly significant. The volume and detail of the data recorded in such sources raised important issues of how to protect privacy of monitored communication. Many of these issues are not pertinent to the current research as members are not personally identified and the focus is on the relationships between the members rather than the actual participants.

Activity on an Open Source project is generally open to all members by means of e-mails and web boards. This communication is well structured, with questions and answers posted on the discussion pages. Through this information it is possible to design a coding framework based on responses to and from participants as the data can be downloaded from the archives. It is possible to identify who sent the post, to whom it is addressed, the number of the post in the chain, how many respondents, the time and date and the numbers of posts that each member has made over a given period. As previously discussed, generally, new members of the community identify themselves as 'newbies' on the discussion pages, and very politely seek advice from existing members to help them with their problem. From here, existing members provide advice and solutions. In the majority of cases, to join an Open Source discussion, potential members must seek permission from a web administrator and provide a user name and e-mail address. This information is made available to all existing members on the discussion board.

Network Analysis is explained.

Social network analysis views social relationships in terms of network theory consisting of *nodes* and *ties*. Nodes are the individual actors within the networks and ties are the relationships between the actors. The resulting graph-based structures are often very complex. There can be many kinds of ties between the nodes. Research in a number of academic fields has shown that social networks operate on many levels, from families up to the level of nations and play a critical role in determining the way problems are solved, organisations are run and the degree to which individuals succeed in achieving their goals (Freeman, 2006). In its simplest form, a social network is a map of all relevant ties between all the nodes being studied.

Several analytic tendencies distinguish social network analysis:

There is no assumption that groups are the building blocks of society: the approach is open to studying less-bounded social systems from non-local communities to links among websites.

Rather than treating individuals (persons, organisations, states) as discrete units of analysis, it focuses on how the structure of ties affects individuals and their relationships.

In contrast to analyses that assume that socialisation into norms determines behaviour, network analysis looks to see the extent to which the structure and composition of ties affect norms (Freeman, 2006).

The power of social network analysis stems from its difference from traditional social scientific studies, which assume that it is the attributes of individual actors that matter; whether they are friendly, unfriendly or smart. Social network analysis produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within the network. This approach is useful for explaining many real-world phenomena, but leaves less room for individual agency (the ability for individuals to influence their success) because so much of it rests within the structure of their network (Kadushin, 2005).

Social networks have also been used to examine how organisations interact with each other, characterising the many informal connections that link executives together, as well as associations and connections between individual employees at different organisations. For example: power within organisations often comes more from the degree to which an individual within a network is at the centre of many relationships, rather than via their actual job title (Wasserman and Faust, 1994). Network analysis provides the tools to analyse the Open Source community in a different way, rather than the qualitative and purely descriptive accounts of the structure seen in the literature presented. Additionally, network analysis provides the visual aids to improve our understanding of the community structure and to analyse how it fosters (or does not) commitment.

Analysis of the data.

Network Analysis will be used to present a visual representation of the hierarchical nature of the OS community. It has previously been argued in Chapter 1 that people participate in the Open Source community for a variety of reasons. The specific focus of Social Network Analysis in this research is to investigate the hierarchal structure of the

community and the how this fosters participation and commitment. It has been suggested (Ghosh, 1998) that Open Source developers rise through the ranks of a hierarchical community based on participation and skill level, with more experienced and advanced programmers having more input over the less proficient. There is however, little empirical evidence to support this notion and that is why it will be tested here.

Network analytic tools are used to represent the nodes (agents) and edges (relationships) in a network, and to analyse the network data. Like other software tools, the data can be saved in external files. The current research utilises UCINET and Netdraw. Network analysis software provides the tools for researchers to investigate large networks like the Internet. These tools provide mathematical functions that can be applied to the network model. Visual representation of social networks is important to understand the network data and convey the result of the analysis. Network analysis tools are used to change the layout, colours, size and advanced properties of the network representation (Wellman, Barry and Berkowitz, 1988).

This thesis analyses the communication patterns between participants intended to elucidate the structure of Open Source community (or communities within). As discussed earlier, to achieve this, archived data was downloaded from online discussion boards. Various analysis techniques were applied to the data using the software UCINET. Net draw was used to visualise the Networks. The following section of this Chapter will explain the procedure for the analysis. It is important to note that the exact procedure for the analysis is difficult to explain, as Social Network analysis is not a step-by-step procedure.

The first phase in the analysis was to clear away the underbrush. Graphs that display all connections among a set of nodes can be very useful for understanding how actors are tied together, but they can also get so complicated and dense that it is difficult to see any patterns. For this reason there are various statistical techniques that can be utilised

to clean up the data and reveal the structure. Net Draw has a number of tools built-in for identifying sub-structures and automatically colouring the graph to identify them visually. The components function was used to locate the parts of the Network that are completely disconnected from each other and colours each set of nodes. Additionally, it is possible to remove the isolates which create a new data set containing all cases that are not isolated. An 'isolate' is a case that has no connection at all to any other actors. While this is usually an interesting social fact, the current research is focused on the community of actors who are connected. Furthermore, you can remove the 'pendants' that create a new data set containing all cases that are not 'pendants'. A 'pendant' is a case that is connected to the graph by only one tie; cases like these will 'dangle' off more central cases that are more heavily connected. As we are looking at a large network with many actors, the decision was made to limit attention to nodes that are connected to at least two other actors so as to focus attention on the 'core' of the network. Removing isolates and pendants can help to clear some of the 'clutter'.

Secondly, a number of statistical measures were conducted to look at the connections and distance of the Network. Some networks are well connected or 'cohesive', whilst others are not. The extent to which individuals are connected to others, and the degree to which the network as a whole is integrated, are essentially the same thing. Differences among individuals in how connected they are can be extremely consequential for understanding their attributes and behaviour. More connections often mean that individuals are exposed to more information. Highly connected individuals may be more influential and may also be more influenced by others. Differences in connections can tell us a great deal about the stratification order of social groups. The following measures were conducted:

Density.

The density of a binary network is simply the proportion of all possible ties that are actually present and may give us insights into such phenomena as the speed at which

information diffuses among the nodes and the extent to which actors have high levels of social capital and/or social constraint.

Reciprocity.

A network that has a predominately or reciprocated ties over asymmetric connections may be a more 'equal' or 'stable' network than one predominance of asymmetric connections (which might be more of a hierarchy).

Conclusion.

A variety of measures have been used to analyse the data to investigate the central questions of the thesis: What motivates individuals to commit their time to OS activities? Why do people spend a lot of time participating in the community (versus not much time)? Why do people stay committed to the OS community; and does the OS community have a hierarchal structure based on expertise and participation? A survey methodology has been used to test the arguments raised by the theoretical framework of RCT, Core motives, Norms of Reciprocity and Side Bets. The structure of the OS community will be examined by the use of Social Network Analysis. The survey results and social network analysis results are presented in Chapter 6.

CHAPTER 6

THE RESULTS

Introduction.

In the previous chapter the research design was explained. The current chapter will present the results from the online survey and social network analysis data. The insights gained from the literature and the theoretical framework was used to formulate the research questions presented below.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

Rational Choice - Direction and intensity.

Participation in the OS community depends on the opportunities that are available for an individual to become involved. This thesis has argued that time use can be classified into four categories: necessary time, contracted time, committed time and free time. OS participation looks very much like an activity that would be conducted in contracted time, but is actually occurring in free time. The thesis is concerned with free time and argues that more variation in working hours has created opportunities for individuals to utilise their time in different ways, which may encourage certain groups of individuals to participate in the Open Source community. In addition, life stage and gender influence one's available time for leisure activities. The largest amount of time use tends to be in the form of contracted time that generally takes place in the form of paid employment. Working hours have become more fluid with the introduction of new technologies and this has enabled people to have more flexibility in the hours and ways they work. As working hours significantly impact on free time, it is fitting to first examine the impact hours of employment have on participant's time spent contributing to the OS community. The argument being that longer hour of employment will reduce the number of hours of free time dedicated to the OS community. Essentially, the more you work, the less free time you have and consequently, this will reduce the time individuals spend on OS participation. The volunteering literature has also revealed people tend to volunteer for specific reasons and this too is influenced by age, gender, occupation etc. (Clary and Snyder, 1999).

Descriptive statistics of the Open Source sample.

The sample consisted of almost 1700 participants who responded to an online invitation posted on 160 Open Source discussion boards to participate in an online survey. Responses were received from participants from 77 countries. The majority of respondents were male at 94.7%, with the average age of participants being 35.5. The eldest participants were 80 and the youngest was 14. 42.7% of the sample was married. Over the page are the participant's demographics.

Respo	ndent Characteristics	n	%
	Male	1546	94.7
	Female	86	5.3
Age			
	Under 20	63	3.9
	20 to under 39	1040	63.7
	40 to under 59	443	27.1
	60 and over	86	5.3
Marita	al Status		
	Single	514	31.9
	Partner, not living together	109	6.8
	Partner, living together	223	13.9
	Married	687	42.7
	Married not living together	11	.7
	Divorced	59	3.7
	Widowed	7	.4

Table 12: Gender, Age and Marital status of OS participants.

Participants were asked which country they currently resided in. There were 1632 valid responses from 77 countries. The majority of participants were currently residing in the USA, accounting for 35.3%, followed by Australia at 12.7% and England 8.5%.

Table 13: In which country do you currently live?

Country	Ν	%
Angola	1	0.1
Argentina	6	0.4
Australia	208	12.7
Austria	12	0.7
Azerbaijan	1	0.1
Bangladesh	3	0.2
Belarus	1	0.1
Belgium	15	0.9
Bolivia	1	0.1
Brazil	24	1.5
Bulgaria	1	0.1
Canada	77	4.7
Cape Verde	1	0.1
Chile	2	0.1
China	2	0.1
Colombia	1	0.1
Congo	1	0.1
Croatia	2	0.1
Czech Republic	6	0.4
Denmark	16	1
Egypt	1	0.1
England	139	8.5
Finland	21	1.3
France	45	2.8
Germany	78	4.8
Holland	1	0.1
Hong Kong	1	0.1
Hungary	8	0.5
Iceland	3	0.2
India	32	2
Indonesia	3	0.2
Ireland	4	0.2
Israel	6	0.4
Italy	20	1.2
Japan	6	0.4
Jordan	2	0.1
Kenya	1	0.1
Kuwait	1	0.1
Latvia	3	0.2
Lithuania	4	0.2
Luxembourg	2	0.1
Macedonia	1	0.1
Malaysia	5	0.3
Mexico	6	0.4
Moldova	1	0.1
Netherlands	38	2.3

New Zealand	41	2.5
Norway	18	1.1
Pakistan	2	0.1
Paraguay	2	0.1
Peru	1	0.1
Poland	22	1.3
Portugal	5	0.3
Romania	12	0.7
Russia	11	0.7
Scotland	11	0.7
Serbia	4	0.2
Singapore	4	0.2
Slovenia	1	0.1
South Africa	11	0.7
Spain	16	1
Sri Lanka	2	0.1
Sweden	27	1.7
Switzerland	17	1
Taiwan	2	0.1
Thailand	1	0.1
Tunisia	1	0.1
Turkey	8	0.5
Ukraine United Arab	4	0.2
Emirates	1	0.1
Uruguay	2	0.1
USA	576	35.3
Venezuela	2	0.1
Wales	2	0.1
Zimbabwe	1	0.1
Total	1632	100

Country of birth.

There were 1654 valid responses from 89 countries. The majority of participants were from the USA, which accounted for 32.1%, followed by Australia at 9.9% and England at 9.6%.

Please see over page.

Table	14: In	which	country	were	vou	born?
Table	T4. III	willen	country	were	you	bonn:

Country	n	%
Argentina	6	0.4
Australia	161	9.9
Austria	11	0.7
Azerbaijan	1	0.1
Bangladesh	3	0.2
Belarus	1	0.1
Belgium	21	1.3
Bolivia	1	0.1
Brazil	25	1.5
Bulgaria	3	0.2
Canada	74	4.5
Cape Verde	1	0.1
Chile	5	0.3
China	6	0.4
Colombia	2	0.1
Congo	1	0.1
Croatia	2	0.1
Czech	6	0.4
Republic		
Denmark	16	1
Dominican	1	0.1
Republic Føvnt	1	0.1
I Salvador	1	0.1
ngland	157	9.6
stonia	13,	0.1
Irone	1	0.1
inland	- 21	1 2
rance	۲ ۲	1.3
ormany	00	5.1
еннану	98	р О.С
leece	10	0.0
uernsey	1	0.1
ioiland	1	0.1
iong Kong	2	0.1
Hungary	9	0.6
Iceland	4	0.2
India	45	2.8
Indonesia	3	0.2
Iran	1	0.1
Iraq	1	0.1
Ireland	4	0.2
Israel	5	0.3
Italy	21	1.3
Japan	1	0.1
Jordan	1	0.1
Kenya	1	0.1

0.1 0.2 0.1 0.2 0.1 0.1 0.2 0.6 2.2 2.4 0.8 0.1 0.1 0.1 0.2 1.5 0.4 0.1 1 1.1 0.6 0.4 0.1 0.1 0.2 0.9 0.8 0.1 0.1 1.5 0.7 0.1 0.2 0.2 0.1 0.4 0.2 0.1 32.1 0.3 0.1 0.1 0.2 0.1 100

Education level.

There were 1610 valid responses from participants. The survey sample shows a large majority of participants are highly educated, with the largest proportion of respondents (47.8%) completing the first stage of tertiary education-not leading to an advanced research qualification and 30.3% of participants obtaining a second stage of tertiary education leading to an advanced qualification. Upper Secondary education accounted for 10.5% and 8.3% of participants had obtained post-secondary education (excluding tertiary). 2.5% had obtained lower secondary stage, 0.2% primary education and 0.2% pre primary education.

Education Level	N	%
First stage of tertiary education - not leading directly to an advanced research qualification (e.g. university or college)	769	47.1
Second stage of tertiary education - leading to an advanced qualification (e.g. Masters of Doctorate)	488	29.9
Upper secondary education (e.g. completed high school)	169	10.4
Post secondary, not tertiary education (e.g. trade or vocational education)	138	8.5
Lower secondary or second stage of basic education (e.g. some high school)	39	2.4
Pre-primary education	3	0.2
Primary education or the first stage of primary	4	0.2

Table 15: Level of education obtained

Current profession.

There were a total of 1530 valid responses. The majority of the sample was employed in the IT sector with 22.2% employed as Software engineers, 13.5% as IT consultants and 12.4% were involved in a non-disclosed capacity of IT.

Profession	Ν	%
Software Engineer	339	22.2
Consultant (IT)	207	13.5
Other (IT)	190	12.4
Student (IT)	125	8.2
Programmer	120	7.8
Manager (IT)	91	5.9
Owner / Manager	91	5.9
Student (other sectors)	88	5.8
University (other sectors)	73	4.8
Engineering (other than IT)	69	4.5
University (IT)	61	4
Consultant (to other sectors)	29	1.9
Manager (other sectors)	24	1.6
Product sales (other sectors)	13	0.8
Marketing (IT)	4	0.3
Marketing (other sectors)	4	0.3
Product sales (IT)	2	0.1
Total	1530	100.0

Table 16: Current Profession

In summary, the sample is predominately male and was aged between 29 and 35 years of age. The largest proportion of participants were married, and were born or currently resided in the USA. The survey sample is highly educated with most participants completing the first stage of tertiary education and currently employed in the IT sector. The next series of questions begins to investigate the direction of participant's choices with how they spend their time. It has been argued that for many people time spent at work is a genuine choice (Hakim, 2000). Participants were asked a number of questions concerning their paid work, hours of employment and time spent on OS.

Hours of employment.

There were 1584 valid responses with respondents working an average of 40hrs per week. The minimum number of hours of employment was zero because many participants were still engaged in full time study. The maximum number of hours of employment was 80hrs per week (Table 17).

Annual income.

This amount of annual income was presented to participants in 6 categories and in USD, AUD, GBP and EUR equivalents. The largest proportion stated that they earned AUD \$100,000 or over (22.9%). 20% stated that they earned less than \$20,000 AUD. This finding represents the difference between the high proportion of students who participated in the sample and those engaged in full time employment. The table below provides an illustration of participants' incomes (Table 17).

In summary, the participants, on average, worked 40 hours per week earning \$100,000 or more AUD. There were a large proportion of people who did not work, or earned less than \$20,000 AUD. This represented the large proportion of students involved in the OS community.

Hours of work and average income	Ν	%
Hours of work		
Less than 20hrs	130	8.2
20 to under 40hrs	335	21.1
40 to under 60 hrs	959	60.5
60 hrs and over	160	10.1
Average yearly income (\$ AUD)		
<\$20,000	287	20.1
>\$20,000 and <\$30,000	139	9.7
>\$30,000 and <\$50,000	203	14.2
>\$50,000 and <\$75,000	268	18.8
>\$75000 and <\$100,000	204	14.3
>\$100,000	327	22.9

Table	17:	Average	hours	of	work	and	annual	incom	e
Iable	т.	Average	nouis	UI.	WUIK	anu	aiiiiuai	mcom	C

Table 18: Currency conversion						
AUD	GBP	EUR	USD			
<\$20,000	<£8,516	<€12,452	<\$15,134			
>\$20,000 and <\$30,000	>£8,516 and <£12,774	>€12,452 and <€18,675	>\$15,134 and <\$22,696			
>\$30,000 and <\$50,000	>£12,774 and <£21,289	>€18,675 and <€31,123	>\$22696 and <\$37,827			
>\$50,000 and <\$75,000	>£21,289 and <£31,932	>€31,123 and <€46,684	>\$37,827 and <\$56,745			
>\$75000 and <\$100,000	>£31,932 and <£42,582	>€46,684 and <€62,246	>\$56,745 and <\$75,661			
>\$100,000	>£42,582	>€62,246	>\$75,661			

Income earned directly from an Open Source project?

There were 1583 valid responses. 78.4 % reported that they had never earned money from an OS project, with 21.6% stating that they had received monetary payment (Please see Table 19).

How much money have you earned in the last 12 months on Open Source Projects?

Of the 21.6 % of participants who stated that they had earned money on OS projects in the last 12 months the majority (58.2 %) reported it to be less than AUD\$10,000 (Please see Table 19).

Table 19: Income from OS participation.

Have you earned money from working on an OS project	N	%
Yes	342	21.6
Νο	1241	78.4
How much money have you earned in the last 12 months working on OS		
<\$10,000	170	58.2
>\$10,000 and <\$20,000	26	8.9
>\$20,000 and <\$30,000	18	6.2
>\$30,000 and <\$75,000	33	11.3
>\$75000 and <\$100000	21	7.2
>\$100,000	24	8.2

Table 20: Currency conversion.

AUD	GBP	EUR	USD
<\$10,000	<£4,258	<€6,223	<\$7,569
>\$10,000 and <\$20,000	>£4,258 and <£8,517	>€6,223 and <€12,452	>\$7,569 and <\$15,134
>\$20,000 and <\$30,000	>£8,517 and <£12,774	>€12,452 and <€18,675	>\$15,134 and <\$22,696
>\$30,000 and <\$75,000	>£12,774 and <£31,932	>€31,123 and <€46,684	>\$22,696 and <\$56,745
>\$75000 and <\$100000	>£31,932 and <£42,582	>€46,684 and <€62,246	>\$56,745 and <\$75,661
>\$100,000	><£42,582	>€62,246	>\$75,661

Time per week spent on Open Source projects.

There were 1604 valid responses with a mean of 12.5 hrs. The minimum reported was 0, the maximum being 80hrs.

Is Open Source part of your paid employment?

From 1582 valid responses, 71.9% stated that OS was not part of their paid employment compared to 28.3% who stated that it was part of their paid employment.

Is OS part of your paid employment?	Ν	%
Yes	445	28.1
No	1137	71.9
Total	1582	100.0

Table 21: Is working on Open Source projects part of your paid employment?

Percentage of paid employment earned directly from working on OS projects.

The total mean reported was 13.5% of paid employment earned directly from working on OS projects. Participants were asked questions regarding their preferences on the amount of time they would like to spend on a variety of activities. This was necessary as this thesis is concerned with how people use their time and the choices people make regarding their working hours and subsequent free time.

Participants were asked:

Suppose you could change the way in which you spend your time, spending more time on some things and less time on others. Which of the following things would you like to spend more time on, which would you like to spend less time on and which would you like to spend the same amount on as now?

The first question asked participants preferences in relation to paid work. The highest proportion of participants (32%) selected that they would like to spend 'a bit less time in a paid job'. Only 4.7% would like to spend 'much more time in a paid job'. Approximately a quarter of respondents stated the same time as now.

	Frequency	Percent	Valid Percent
Much less time	311	18.8	19.8
A bit less time	503	30.4	32.1
Same time as now	422	25.5	26.9
A bit more time	177	10.7	11.3
Much more time	73	4.4	4.7
Does not apply	81	4.9	5.2
Total	1567	94.7	100.0

Table 22: The time you spend in a paid job.

Participants were asked about how much time they would like to spend on household work. The majority of participants 36.3% said they would spend the same as they do now on household work.

Table 23: Time spent doing household work.

	Frequency	Percent	Valid Percent
Much less time	270	16.3	17.3
A bit less time	316	19.1	20.3
Same time as now	565	34.2	36.3
A bit more time	353	21.3	22.7
Much more time	21	1.3	1.3
Does not apply	33	2.0	2.1
Total	1558	94.2	100.0

Participants were asked about how much time they would like to spend with their family. 45.4% stated they would like to spend a bit more time with their family, with 31% reporting that they are happy with the amount of time they spend now.

Table	24: 1	Time	spent	with	your	family.
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	Frequency	Percent	Valid Percent
Much less time	17	1.0	1.1
A bit less time	42	2.5	2.7
Same time as now	485	29.3	31.0
A bit more time	710	42.9	45.4
Much more time	276	16.7	17.7
Does not apply	33	2.0	2.1
Total	1563	94.5	100.0

Participants were asked about how much time they would like to spend with their friends. The majority of participants at 53.4 % stated they would like to spend a bit more time with their friends.

Table 25: Time spent with friends.

	Frequency	Percent	Valid Percent
Much less time	8	.5	.5
A bit less time	19	1.1	1.2
Same time as now	425	25.7	27.1
A bit more time	839	50.7	53.4
Much more time	270	16.3	17.2
Does not apply	10	.6	.6
Total	1571	95.0	100.0

Participants were asked about how much time they would like to spend on leisure. 42.0% responded that they would like to spend a bit more time on leisure.

Table 26: Time spent on leisure.

	Frequency	Percent	Valid Percent
Much less time	26	1.6	1.7
A bit less time	93	5.6	5.9
Same time as now	555	33.6	35.4
A bit more time	660	39.9	42.0
Much more time	217	13.1	13.8
Does not apply	19	1.1	1.2
Total	1570	94.9	100.0

Participants were asked about how much time they would like to spend relaxing.

39.2% of the participants were happy with the time they have now, with 36.3% desiring a bit more time relaxing.

Table 27: Time spent relaxing.

	Frequency	Percent	Valid Percent
Much less time	38	2.3	2.4
A bit less time	115	7.0	7.3
Same time as now	618	37.4	39.2
A bit more time	571	34.5	36.3
Much more time	215	13.0	13.7
Does not apply	18	1.1	1.1
Total	1575	95.2	100.0

Participants were asked about how much time they would like to spend working on OS projects. 46.1% would like to spend a bit more time on working on OS projects
	Frequency	Percent	Valid Percent
Much less time	9	.5	.6
A bit less time	59	3.6	3.8
Same time as now	421	25.5	27.0
A bit more time	720	43.5	46.1
Much more time	320	19.3	20.5
Does not apply	33	2.0	2.1
Total	1562	94.4	100.0

Table 28: Time spent working on Open Source projects.

In summary, the results reveal that the participants would like to spend a bit less time in their jobs, but are generally happy with the amount of time they spend on household activities. Participants generally reported that they would like to spend a 'bit more time' with friends and family and would like more time for leisure and relaxing. Preferences towards time use indicate that participants desire to spend less time in paid work and more time contributing to the Open Source community.

Rational Choice - Core motives.

The next section will begin to examine some of the motives of participants in the OS community.

Do you believe that people who work on Open Source projects should make money?

There were 1584 valid responses. Most participants agreed or strongly agreed that you should make money from OS projects. There were however significant numbers undecided on this issue.



Figure 11: Do you believe that you should make money from Open Source projects?

Open Source participants should help to develop free software?

There were 1531 valid responses of which 53% agreed that they should help to develop free software. A further 35% strongly agreed

Table 29: You should help to develop free software.

Develop free software	N	%
Strongly Disagree	7	.5
Disagree	33	2.2
Undecided	143	9.3
Agree	812	53.0
Strongly Agree	536	35.0
Total	1531	100.0

Are any friends of yours involved with Open Source Projects?

There were 1557 valid responses. 71.0% reported that they had friends also involved in OS projects.

Participants were asked a number of questions about who they would turn to when making important decisions, or if they felt depressed. The questions were asked to examine if the OS community is used as an external support structure for participants, or purely as a free time activity with limited actual personal investment.

If you needed help to make an important decision, for example: about a job or moving to another part of the country. Apart from your husband, wife or partner (if you have one) who would you turn to first for help?

There were 1548 valid responses with 17.8% reporting that they would turn to their parents for help, closely followed by the most relevant person for the job 17.7%

Table 30: Who would you turn to for advice?

Person	n	%	
A parent	276	17.8	
Relevant person for the problem	274	17.7	
A friend who lives nearby	257	16.6	
Friend	133	8.6	
No-one	111	7.2	
A friend who lives further away	108	7.0	
God/Jesus	97	6.3	
Online chat group or discussion board	63	4.1	
A work colleague	59	3.8	
Can't choose	58	3.7	
Another relative	48	3.1	
A son or daughter	47	3.0	
A religious leader	6	.4	
Counsellor / therapist	6	.4	
Someone else	4	.3	
Help line	1	.1	
Total	1548	100.0	
Missing	84		
Total	1632		

Suppose you felt just a bit down or depressed and wanted to talk about it. Apart from your husband wife or partner (if you have one) who would you turn to first for help?

1535 valid responses showed that 25.7% were most likely to turn to a friend who lives nearby followed by a friend 13.9%.

Person	n	%
A friend who lives nearby	395	25.7
Friend	214	13.9
No-one	150	9.8
A friend who lives further away	140	9.1
Relevant person for the problem	126	8.2
A parent	115	7.5
God/Jesus	93	6.1
Another relative	65	4.2
Online chat group or discussion board	57	3.7
Counsellor / therapist	40	2.6
Can't choose	37	2.4
A work colleague	36	2.3
A son or daughter	27	1.8
A religious leader	16	1.0
Someone else	11	.7
Doctor/GP	11	.7
Help line	2	.1
Total	1535	100.0
Missing	97	
Total	1632	

Table 31 : Depressed and wanted to talk: who you would turn to first for help?

Participants were asked on a scale of 1-10 how happy are you with your life these days? (0= extremely unhappy - 10 = extremely happy).

As can be seen from the results the largest percentage of participants scored from 7 out of 10 indicating that they are quite happy with their life.

Figure 12: All in all, how happy are you with your life these days/ (0= extremely unhappy - 10 = extremely happy).



Participants were also asked: *All in all, how satisfied are you with your job? (0= extremely dissatisfied - 10 = extremely dissatisfied).*

Figure 13: All in all, how satisfied are you with your job? (0= extremely dissatisfied - 10 = extremely dissatisfied).



As can be seen from the Figure 13, the largest proportion of participants selected 7 and above indicating that they are satisfied with their job.

In summary, participants reported that if they need to make an important decision, the largest proportion would turn to their parents (17.8 %). If participants felt depressed and needed to talk to someone (other than their spouse or partner), the highest percentage of people said they would turn to a friend (25.7%). Participants were also asked how happy they were with their life in general and how satisfied they were with their job. Both questions scored 7 out 10.

In the following section, participants were also asked a series of question about how important certain aspects of their job are to them. The following questions were asked:

How important to you are the following aspects of a job? A job that allows you to work independently?

The largest proportions of participants (42.8%) believe that it is important to have a job that allows them to work independently; additionally another 33.7% viewed this to be very important.

	Frequency	Percent	Valid Percent
Don't know	7	.4	.4
Not important at all	17	1.0	1.1
Not important	79	4.8	5.0
Neither important or unimportant	259	15.7	16.4
Important	678	41.0	42.8
Very important	534	32.3	33.7
Does not apply	9	.5	.6
Total	1583	95.7	100.0

Table 32: A job that allows you to work independently.

A job that leaves a lot of leisure time?

The largest proportion of participants reported that it is important to have a job that has a lot of leisure time 47.5%. A further 13.7% believed it to be very important. 27% thought it to be neither important nor unimportant.

	-		-
	Frequency	Percent	Valid Percent
Don't know	1	.1	.1
Not important at all	31	1.9	2.0
Not important	141	8.5	9.0
Neither important or unimportant	423	25.6	27.0
Important	746	45.1	47.5
Very important	215	13.0	13.7
Does not apply	12	.7	.8
Total	1569	94.9	100.0

The largest proportion (at 47.4% of participants) reported that it important for a job to have opportunities for advancement.

Table 34: It has good o	opportunities for advancement.
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	Frequency	Percent	Valid Percent
Don't know	2	.1	.1
Not important at all	47	2.8	3.0
Not important	142	8.6	9.1
Neither important or unimportant	355	21.5	22.7
Important	742	44.9	47.4
Very important	269	16.3	17.2
Does not apply	10	.6	.6
Total	1567	94.7	100.0

A job with flexible working hours.

43.3% of participants believe that it is important to have a job with flexible working hours. An additional 37.4% believe flexibility to be very important.

	Frequency	Percent	Valid Percent
Don't know	3	.2	.2
Not important at all	15	.9	.9
Not important	57	3.4	3.6
Neither important c unimportant	r 221	13.4	14.0
Important	684	41.4	43.3
Very important	591	35.7	37.4
Does not apply	10	.6	.6
Total	1581	95.6	100.0

Table	35:	Δ	iob	with	flexible	working	hours.
Table	55.1	n .	JUD	WILLI	TICAIDIC	working	nouis

Job Security?

Participants were also asked how important certain aspects of their job were. 52% of people reported that job security was important.

	Frequency	Percent	Valid Percent
Don't know	4	.2	.3
Not important at all	50	3.0	3.2
Not important	156	9.4	9.9
Neither important o unimportant	r 273	16.5	17.3
Important	823	49.8	52.2
Very important	251	15.2	15.9
Does not apply	19	1.1	1.2
Total	1576	95.3	100.0

Table 36: Job Security.

A job that is interesting.

The majority of participants, at 72.4%, reported that it is very important that a job is interesting.

	Frequency	Percent	Valid Percent
Not important at all	4	.2	.3
Not important	1	.1	.1
Neither important or unimportant	13	.8	.8
Important	413	25.0	26.0
Very important	1149	69.5	72.4
Does not apply	6	.4	.4
Total	1586	95.9	100.0

Table 37: A job that is interesting.

High income.

The majority of participants at 50.8% reported a high income to be important.

Table 38: High income.

	Frequency	Percent	Valid Percent
Don't know	2	.1	.1
Not important at all	37	2.2	2.4
Not important	162	9.8	10.3
Neither important or unimportant	382	23.1	24.3
Important	799	48.3	50.8
Very important	182	11.0	11.6
Does not apply	10	.6	.6
Total	1574	95.2	100.0

Persistence - Side bets and Norms or Reciprocity.

The next section looks at what maintains participant's involvement in the community

Participation in first Open Source project.

The majority of participants reported working on their first OS project within the last 5 years (39.8%), followed by within the last 10 years 23.9% and greater than 10 years ago 13.8%

Figure 14: First participation in OS.



How long ago did you work on your first Open Source project?

Number of hours spent contributing to open Source projects without receiving financial payment?

There were 1607 valid responses with an average of 8.0 hours spent on OS projects without receiving financial payment.

Approximately how many projects have you worked on?

There were 1571 valid responses with participants having worked on an average of 6 projects.

Summary.

In summary, the results revealed that members of the OS community value jobs with good career advancement opportunities, job security and high incomes. Most significantly, the results reveal that the majority of participants highly value jobs that allow a lot of leisure time, with flexible work conditions and the ability to work independently.

Overall, the findings reveal that the sample was predominately male and aged approximately 35 years of age. The majority of participants were born, married and reside in the USA. Participants are highly educated and predominantly employed in the IT sector. On average participants worked 40 hours per week with an annual income of \$100,000 plus (AUD). There were also a large percentage of participants currently engaged in full time study. Participants spent 12.54 hours a week contributing to the OS community, with some participants reportedly working up to 70 hours on OS. The majority stated that OS was not part of their employment; however of those that worked on OS as part of their employment, this accounted for the majority of long hours contributed.

In terms of beliefs, participants generally thought that you should make money by working on OS, but there were also many that were undecided about this. The sample mostly agreed that you should help to develop free software, with participants on average having made contributions to 6 OS projects. In relation to time use, the participants would like to spend either the same or a bit less time in their jobs but would like to spend the same or less time on household activities. Participants would like more time with friends, family and on leisure and relaxing. Preferences towards time use indicate that participants desire to spend the same or less time in paid work and the same or a bit more time contributing to the Open Source community. Lastly, participants were asked to score how happy they were with their life in general and how satisfied they were with their job. Both questions scored 7 out of 10, indicating that they are relatively happy with life and satisfaction with their job. These results provide an important overview of the OS community.

Testing of specific research questions: Rational Choice – Direction, Intensity and Persistence in the OS community.

A number of research questions were asked to investigate two of the fundamental research questions. This was necessary to build a complete picture of participation that could not be achieved by a single question.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS? (The intensity of their motivation).

This thesis argues that working hours have become more fluid and there are now more opportunities for people to utilise their time. The standard 9am to 5pm still exists for a number of workers but there are now a large proportion of people who work a variety of hours.

Hypotheses 1: Hours of employment will influence available time and therefore time spent in the OS community. Longer hours of employment will result in less time spent participating in the OS community.

To examine the impact working hours have on the amount of time the participants spend contributing to the OS community the respondents reported working hours were placed in 4 categories (less than 20hrs, 20 to under 40hrs, 40 to under 60hrs, 60hrs and over).

Table 39: Hours of work in categories.

Hours of work	N	%
Less than 20hrs	130	8.2
20 to under 40 hrs	335	21.1
40 to under 60hrs	959	60.5
60 hrs and over	160	10.1
Total	1584	100.0

As can be seen from Table 40 the mean hours spent contributing to Open Source increases with hours of work. The mean times of hours of contribution were calculated for Open Source participation according to the relevant working hour category. To test the significance of the relationship between hours of work and hours spent contributing to OS a one way ANOVA was conducted. The results revealed that the difference accounted in the mean times was significant (F (3, 1562) = 25.3, P < .000) (Table 41). However, as can be seen from Table 40 the results do not support the hypothesis. The average mean increased with working hours rather than reducing as hypothesised. To further analyse a linear regression analysis was conducted using metric data to test the hypothesis (see Table 42). The results were again significant.

Hours of Work in Categories	Mean	N	Std. Deviation
Less than 20hrs	10.14	129	11.935
20 to under 40 hrs	10.69	331	11.904
40 to under 60hrs	11.86	949	13.620
60 hrs and over	21.95	157	24.346
Total	12.48	1566	14.945

Table 40: On average, how much time per week do you spend working on Open Source projects?

Table 41: One way ANOVA - Hours of paid work and time spent on OS.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16213.725	3	5404.575	25.326	.000
Within Groups	333326.700	1562	213.397		
Total	349540.425	1565			

Mode	9	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9387.418	1	9387.418	46.007	.000 ^a
	Residual	319125.036	1564	204.044		
	Total	328512.454	1565			

Table 42: Linear regression - hours of work and time spent on OS.

On the bases of the above results, it appears that hours of work do affect the amount of time spent on OS. The average mean increased with working hours rather than reducing as hypothesised. Further investigation was conducted using the following variables.

What percentage of your paid employment comes directly from working on Open Source projects?

The result from the analysis of the above mentioned variable is presented later in the chapter. However, the preliminary analysis would suggest that participants in the OS who contribute the most, participate as part of their paid employment. This result was anticipated as a large proportion of participants are employed in the IT field. A further question was asked in the survey to examine non-paid OS contribution

How many hours per week do you spend working on Open Source projects without receiving any financial payment?

This question also produced similar results, with those reported to be working longer hours also contributing more hours to the OS community

The following question was asked "What percentage of your paid work comes directly from working on Open Source projects". The results were analysed according to hours of work. Table 43 shows that the mean percentage of income received directly from working on Open Source projects rises with hours of work. Those reported to be working less than 20 hours on average receive 7.81% of their income from Open Source projects, compared to participants who work over 60hrs reportedly receiving 24.18% of their income from Open Source projects.

Hours of Work in Categories	Mean	Ν	Std. Deviation
Less than 20hrs	7.81	130	24.248
20 to under 40 hrs	12.35	334	28.537
40 to under 60hrs	13.43	959	28.556
60 hrs and over	24.18	160	35.841
Total	13.83	1583	29.268

Table 43: What percentage of your paid work comes from working on OS projects?

A one-way ANOVA was conducted to test for significance (F (3, 1579) = 8.90, P < .000), Table 44

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22733.061	3	7577.687	8.980	.000
Within Groups	1332470.624	1579	843.870		
Total	1355203.685	1582			

Table 44: ANOVA What percentage of your paid employment comes directly from working on Open Source projects?

In addition, a linear regression was conducted to further investigate the relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22341.616	1	22341.616	26.501	.000 ^a
	Residual	1332862.069	1581	843.050		
	Total	1355203.685	1582			

Table 45: Liner regression of hours of work and percentage of employment from OS.

a. Predictors: (Constant), On average how many hours a week do you work in your current job?

b. Dependent Variable: What percentage of your paid employment comes directly from working on Open Source projects?

The results are significant F (1, 1581) = 26.5, p < 0.01 with the more hours participants working in the paid employment the larger the percentage of their work is directly related to OS.

Participants were asked: "How many hours per week do you spend working on Open Source projects without receiving any financial payment"? The mean time of hours revealed that participants working from 40 to fewer than 60hrs contributed the least hours to OS with a mean of 7.52hrs. Those reported working less than 20 hours a week contributed the most

with a mean of 9.71 hours. Interestingly, those that worked (60 hours and over) still on average contributed 9.32 hours.

Hours of Work in Categories	Mean	N	Std. Deviation
Less than 20hrs	9.71	128	10.229
20 to under 40 hrs	7.98	332	8.791
40 to under 60hrs	7.52	948	7.432
60 hrs and over	9.32	158	9.419
Total	7.98	1566	8.229

Table 46: How many hours per week do you spend working on Open Source projects without receiving any financial payment?

To test the significance of the relationship between hours of work and time spent contributing to OS without receiving any financial payments a one-way ANOVA was conducted.

Table 47: How many hours per week do you spend working on Open Source projects without receiving any financial payment?

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	866.942	3	288.981	4.294	.005
Within Groups	105109.269	1562	67.291		
Total	105976.211	1565			

The results were not significant and there was no particular pattern with hours worked on OS without receiving financial payment and hours of employed work.

In summary, the results only provided partial support for the hypothesis.

Hours of employment will influence time spent in the OS community. Longer hours of employment will result in less time spent participating in the OS community

It was found that some participants work on OS as part of their paid employment, which increased the amount of time contributed.

A multiple regression was performed to assess the amount of variance that can be explained by the variables combined. Table 48 below, displays the descriptive statistics for work time variables.

	N	Minimum	Maximum	Mean	Std. Deviation
On average how many hours a week do you work in your current job?	1584	0	70	39.84	14.496
On average, how much time per week do you spend working on Open Source projects?	1604	0	80	12.54	14.937
What percentage of your paid employment comes directly from working on Open Source projects?	1630	0	100	13.54	29.051
Valid N (listwise)	1565				

Table 48: Descriptive statistics for work time variables.

As can be seen from Table 49, the average score on the variables is 6.577 (B = 63.89). All three variables significantly impact on the amount of time participants spend contributing to OS without financial gain (p <0.05). The amount of variance that can be explained by this model is 45.5% (R^2 = .455).

		Unstandardise	ed Coefficients	Standardised Coefficients		
Model		В	Std. Error	Beta	t	Sig.
1	(Constant)	6.577	.455	-	14.459	.000
	On average how many hours a week do you work in your current job?	076	.011	134	-7.069	.000
	On average, how much time per week do you spend working on Open Source projects?	.493	.014	.898	34.843	.000
	What percentage of your paid employment comes directly from working on Open Source projects?	121	.007	435	-16.963	.000

Table 49: Regression analysis for time spent on OS without financial gain.

 $R^2 = .455$

The results reveal that hours of employment does influence time spent contributing to the OS community. Increased hours in paid employment thus results in less time spent participating in the OS community.

In Chapter 3, it was argued that the amount of free time an individual has is influenced by their life stage and marital status. Life stage affects the amount of free time available to an individual, which may impact on their decision to volunteer. In addition, age also has an effect on the motivations of those choosing to volunteer. Younger volunteers are more likely to cite the importance of gaining work experience whilst older volunteers valued social interaction (Gidron, 1978).

It can be assumed that people who have a greater amount of free time are more likely to spend a larger amount of time participating in the OS community. To examine which of the participants have more free time we can look toward the time use and the volunteering literature. In general, people who are single tend to have more free time than those who are married or in cohabitating relationships. Furthermore, the younger and older age group have more available free time, due to the reduced family and work commitments. From this research the following hypotheses were developed.

Hypotheses 2: Single and non-cohabitating participants will spend more time on OS participation, than those that are cohabitating.

Hypotheses 3: Younger (< than 30) and older participants (> than 50) will spend more time on OS projects.

Hypotheses 4: Single and non-cohabitating participants will spend more time on OS participation, than those that are cohabitating.

Participants were asked their marital status, and were then given 7 categories to select (single, partner- not living together, partner-living together, married, married-not living together, divorced, widowed). To simplify the analyses and to better address the hypothesis the categories were recoded into two categories (cohabitating and non-cohabitating).

The mean time of contribution was calculated according to cohabitating status. As can be seen from Table 50, participants that are not cohabitating spend more time on OS with no financial gain (8.92hrs) than those that are cohabiting (7.54hrs). A One-Way ANOVA was performed and the results revealed that there is a significant difference in the mean times of hours spent on OS for participants who are single or in a cohabitating relationship (Table 51). This provides support for research question that single participants will spend more time on OS than the married participants. F (1, 1585) = 10.65, p <.05

Table 50: Marital status and time spent on OS without receiving financial.

Cohabiting status	Mean	N	Std. Deviation
Not Cohabiting	8.92	577	9.134
Cohabitating	7.54	1010	7.759
Total	8.04	1587	8.309

Table 51: ANOVA Cohabitating status and time spent on OS without financial gain

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	690.937	1	690.937	10.065	.002
Within Groups	108802.037	1585	68.645		
Total	109492.974	1586			

To examine the effect that age alone has on hours of contribution the following question was tested - *Younger (< than 30) and older participants (> than 50) will spend more time on OS projects.* The results did not support the hypothesis.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	358.165	3	119.388	1.735	.158
Within Groups	110305.747	1603	68.812		
Total	110663.912	1606			

Table 52: ANOVA Age and contribution.

In summary, the results provide support for the theory that cohabitating status impacts on the time participants dedicate to OS, whereas people cohabitating tend to spend less time in OS participation.

The circumstances in which a person decides to join the OS community are reliant on the opportunity structures that exist. At the most basic level, an individual requires access to a computer and some basic computer skills. Aside from the basic requirements enabling someone to become involved in the OS community, there are conditions that make participation more likely. In previous research, little attention was been paid to the low participation rates of females in the OS community. Males overwhelmingly make up the majority of participants and this important aspect should not be overlooked (FLOSS 2002). The gender make-up of the OS community highlights the 'choices' that individuals make, in particular, the types of careers males and females choose. The majority of OS participants are male with a tertiary education (70%) and have a strong professional background in the IT sector (83 % of all developers were employed in the IT sector). Women only represent 30 % of the IT community and 5% of the OS community. This is interesting as more females enter into tertiary education than males and have a higher completion rate. In 1996, 63,000 males and 82,000 females graduated from universities (cat. 4102.0 - Australian Social Trends). If the majority of participants were employed in the IT field, it would be a safe

203

assumption to argue that they have an interest in the IT field, which includes such things as computer and programs. These interests make it more likely for IT professional to become involved in the OS community, as the activity is similar. This important factor assists in explaining the low participation rates of females in the OS community. Based on the literature the following questions were developed.

Hypotheses 5: Members of the OS community will be predominately tertiary educated and employed in the IT field.

As can be seen from Table 53, the OS sample is highly educated, with the majority of participants obtaining a first stage of tertiary education.

Education level	N	%
Pre-primary education	3	.2
Primary education or the first stage of primary	4	.2
Lower secondary or second stage of basic education (e.g. some high school)	39	2.4
Upper secondary education (e.g. completed high school)	169	10.5
Post secondary, not tertiary education (e.g. trade or vocational education)	138	8.6
First stage of tertiary education - not leading directly to an advanced research qualification (e.g. university or college	769	47.8
Second stage of tertiary education - leading to an advanced qualification (e.g. Masters of Doctorate)	488	30.3
Total	1610	100.0

Table 53 : Highest level of education obtained.

As can be seen from Table 54 the majority of participants are employed in the IT field. The hypothesis was supported as the majority of participants are employed in the IT field and are highly educated.

Profession	n	%
Software Engineer	339	22.2
Engineering (other than IT)	69	4.5
Programmer	120	7.8
Consultant (IT)	207	13.5
Consultant (to other sectors)	29	1.9
Manager (IT)	91	5.9
Manager (other sectors)	24	1.6
Marketing (IT)	4	.3
Marketing (other sectors)	4	.3
Product sales (IT)	2	.1
Product sales (other sectors)	13	.8
University (IT)	61	4.0
University (other sectors)	73	4.8
Student (IT)	125	8.2
Student (other sectors)	88	5.8
Owner / Manager	91	5.9
Other (IT)	190	12.4
Total	1530	100.0

Table 54: Current Profession.

Rational Choice Theory also helps to explain the more strategic reasons for individuals to become involved in the OS community. Aside from the general opportunity and constraints that have been previously identified (hours of employment, education level, occupation and marital status), participants may have more instrumental motives for participation. For example: the desire to improve one's skill level through the online development of software may be a motivating factor for some participants. It is argued in the volunteering literature that younger volunteers were more likely to emphasise the importance of gaining work experience whilst older volunteers valued social interaction. Much of the literature does not acknowledge the fact that volunteers may actually be making a conscious decision to volunteer in certain activities that increase their skill base and therefore improve their employment prospects. It has already been demonstrated from the results that a job with career advancements is of importance to the sample. The following research questions were developed:

Hypotheses 6: Younger participants will value skill enhancement as a reason to be involved in the OS community more than older participants as this may lead to improved job opportunities.

To examine skill enhancement as a motivation the variable 'you will improve job opportunities' was measured on a Likert scale ranging from unimportant to very important. It was then compared to 4 categories of age. To describe the relationship, a cross tabulation was performed. The following results are presented in Table **55**. As can be seen this variable is most important to those 20 to 39 (31%) and 17% very important.

Table 55: Improving my job opportunities and age.

	_	-	Improving my	Improving my job opportunities				
			Unimportant	Of little importance	e Moderately Important	Important	Very important	- Total
Age in categories	Under 20	Count	8	12	15	15	10	60
		% within Age in categories	13.3%	20.0%	25.0%	25.0%	16.7%	100.0%
	20 to under	Count	97	144	275	305	173	994
	39	% within Age in categories	9.8%	14.5%	27.7%	30.7%	17.4%	100.0%
	40 to under	Count	87	70	90	105	57	409
	59	% within Age in categories	21.3%	17.1%	22.0%	25.7%	13.9%	100.0%
	60 and over	Count	46	10	9	7	1	73
		% within Age in categories	63.0%	13.7%	12.3%	9.6%	1.4%	100.0%
Total	•	Count	238	236	389	432	241	1536
		% within Age in categories	15.5%	15.4%	25.3%	28.1%	15.7%	100.0%

To test the significance of these results a chi-Square was performed

	Value	df	Asymp. Sig. (2- sided)
Pearson Chi-Square	172.123 ^a	12	.000
Likelihood Ratio	138.322	12	.000
Linear-by-Linear Association	79.975	1	.000
N of Valid Cases	1536		

Table 56: Chi-Square. Age and improving my job opportunities.

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.22.

Table 57: Symmetric measures age and improving my job opportunities.

	-	Value	Approx. Sig.
Nominal by Nominal	Phi	.335	.000
	Cramer's V	.193	.000
N of Valid Cases		1536	

In the sample, the younger participants in the 20 to 39 tend to view 'improving my job opportunities' as a more important reason to participate in the OS community than older participants. The chi–square statistic is only appropriate if there is sufficient data. In this example zero cells have an expected value less than 5 so the test is valid. This relationship is significant (X^2 (12) = 172.12, p<.00).

Hypotheses 7: Older participants will be more interested in the social aspect of the OS community than the younger participants.

The results did not support the research question that older participants tended to place a higher value on the social aspects of participation.

The results highlight the fact that the reasons for joining the community are different from what keeps participants involved. People may initially be attracted to the OS community if they are searching for software or assistance with a problem. Initially the participants need for software or advice brings them to the community and through this initial communication, a relationship may begin to develop which sustains this involvement. This theory is further developed with the use of Becker's Side Bets theory and Norms of Reciprocity.

Hypotheses 8: People are more likely to become originally involved with the OS community to gain equipment or advice rather than the social aspects.

Participants were asked to respond about the initial attraction to participate in the OS community in their own words. The participant's answers were then coded with three independent coders according to each response. Further information on the procedure was provided in Chapter 5. As can be seen from Table 58, respondents' answers were placed in 15 different categories. The largest percentage initially attracted to the OS community perceived it to have better software than the alternative proprietary products (14.1%). Secondly, becoming involved was due to the contributing and helping nature that exists within the community (9.8%). The social aspects of the community were not as important as the more strategic reasons for originally becoming involved in the community, thus providing support for the research question.

 Attracted you to OS	N	%
OS has better software	233	14.1
Contributing and helping	162	9.8
Free software	141	8.5
Open Source ideology	109	6.6
Personal advancement	79	4.8
Freedom	70	4.2
Sense of community	66	4
Anti corporate ideology	65	3.9
Reciprocity	60	3.6
Interest in coding	57	3.4
Having the source code	48	2.9
Enjoyment	46	2.8
The assistance available	24	1.5
Social interaction	20	1.2
Prestige	13	0.8
Total	1654	100.0

Table 58: In your own words what initially attracted you to participate in the Open Source Community?

Rational Choice -Core Motives.

As previously discussed in Chapter 4, Core Motives theory argues that people are motivated by five core needs. Additionally, an understanding of a group also helps a person become more sympathetic of the groups needs and more likely to follow suit (Fiske, 2000). There is not one simple explanation of what motivates an individual to initially become involved in the OS community. There are however a variety of conditions that may make joining the community more likely (male, interested in IT, single and flexible working hours). After participating in the community (this may simply be gaining some advice) there are many reasons that attract a member to stay involved. Some of these reasons may also contribute to people initially becoming a member and contributing. For example, if a person learns about the Open Source philosophy they may feel sympathetic to the cause and this may be a motivational factor to join and contribute.

Participants were asked in the preceding question how important certain items were to their decision to work on an OS project. A full list of these items is in the Appendix. The variables used were based on the technical aspects and the beliefs of the OS community.

The following question was asked:

Other than the categories listed in the previous question, is there any other reason for your participation on an Open Source project? 2

² The question refers to items in question C1 of the survey. Please see appendix for the complete survey

Other reasons for	-	-
participation	n	%
Enjoyment	225	35.9
Contributing and helping	117	18.7
OS Software is better	63	10.0
Personal advancement	44	7.0
OS Philosophy	31	4.9
Reciprocity	28	4.5
Freedom	24	3.8
Anti corporate ideology	21	3.3
Free Software	19	3.0
Social Interaction	18	2.9
The community aspect	17	2.7
The source code	10	1.6
Prestige	8	1.3
The assistance available	2	0.3
Total	627	100.0

Table 59: Other reasons for participation in the OS community.

As can be seen from Table 59, 35.9% of respondents stated that enjoyment as the most 'other' important reasons for participants decision to work on an OS project. The results revealed that overall the 'other' reason for participating in the OS community was not particularly different from participants 'most important reason for involvement' This suggests that the main reasons for contribution to the community are similar, in that 212
participants most common responses were comparable for both questions. The data supports the argument presented in the literature review that when a participant decides to become involved in a project they are not generally participating in the community for the first time. Contribution to projects is a behavior that develops overtime.

To further examine the beliefs of the OS community, participants were asked about their views on work in general. This was necessary as OS participation shares many characteristics with work, free time and volunteering. The following questions provide an overview of participant's views of their employment in general.

Thinking about work in general, to what extent do you agree or disagree with the following statements.

A job is just a way of earning money.

55% of participants disagreed with the statement that a job is just a way of earning money, with a further 22% strongly disagreeing. 18% neither agreed nor disagreed with the statement.

Job – just earning money	<u>_</u>	<u>-</u>	Cumulative
	n	%	Percent
Strongly Disagree	348	22.2	22.2
Disagree	519	33.1	55.3
Neither agree nor disagree	281	17.9	73.2
Agree	296	18.9	92.0
Strongly Agree	115	7.3	99.4
Does not apply	10	.6	100.0
Total	1569	100.0	

Table 60: A job is just a way of earning money.

I would enjoy having a paid job even if I did not need the money.

The majority of participants, 52.2%, agreed with this statement

Enjoy job	n	%	Cumulative Percent
Strongly Disagree	102	6.5	6.5
Disagree	195	12.5	19.0
Neither agree nor disagree	239	15.3	34.3
Agree	815	52.2	86.5
Does not apply	189	12.1	98.6
Does not apply	22	1.4	100.0
Total	1562	100.0	

Table 61: I would enjoy having a paid job even if I did not need the money.

Work is a person's most important activity.

35% disagreed with this statement, with a further 22.8% strongly disagreeing. Interestingly, 23% neither agreed nor disagreed that work is a person's most important activity.

Work – most important activity	n	%	Cumulative Percent
Strongly Disagree	358	22.8	22.8
Disagree	551	35.0	57.8
Neither agree nor disagree	364	23.1	80.9
Agree	221	14.0	95.0
Strongly Agree	71	4.5	99.5
Does not apply	8	.5	100.0
Total	1573	100.0	

Table 62:	Work is	a person	's most	important	activity.
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In summary, the majority of participants reported that they enjoy their jobs and would work even if they did not require the money. However, they did not believe that work was the most important activity that they do.

The following questions were developed to look specifically at the beliefs of the OS sample. The current data and literature provides support for the argument that the longer a person has been involved in the OS community the more projects they tend to have contributed to. In addition, it has been hypothesised that the more time contributed to OS participation, the more likely it is that the Open Source philosophy will be viewed as an important aspect of the community. There is a strong emphasis in the literature that an anti-corporate ideology is a strong part of the OS philosophy. For this reason the three variables were selected that reflect an anti-corporate nature to test the following hypothesis.

Hypotheses 9 : The more time you spend your leisure on OS, the more you will believe the OS philosophy to be an important aspect.

A summary of the mean times is presented (Table 63, Table 65, Table 67). A one-way ANOVA was conducted to test the significance of the relationship for each variable. The results revealed that the difference accounted for the mean times of hours spent on OS in participant's free time is significant. The amount of hours spent contributing to OS in the participants free time increased with the importance that the participants felt about each statement (Table 64, Table 66, Table 68). This relationship supports the argument presented that more participation in the OS community is linked to a greater belief in the OS ideology.

	Table	63:	Leisure	on OS	and th	e importanc	e of se	oftware	being free.
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Believing that software should be free	Mean	N	Std. Deviation
Unimportant	4.69	84	4.817
Of little importance	6.49	136	6.852
Moderately Important	7.81	289	7.572
Important	8.05	449	8.127
Very important	9.47	542	8.907
Total	8.19	1500	8.153

Table 64: Anova- Leisure on OS and the importance of software being free.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2363.751	4	590.938	9.082	.000
Within Groups	97278.641	1495	65.069		
Total	99642.392	1499			

F (4, 1495) = 9.08, p<.05

Table 65: Leisure on OS and importance of participating in a new form of cooperation.

Participating in a new form of cooperation	Mean	N	Std. Deviation
Unimportant	6.23	108	6.522
Of little importance	6.96	177	7.067
Moderately Important	7.49	360	7.825
Important	8.12	447	8.114
Very important	9.94	373	8.898
Total	8.15	1465	8.104

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1416.958	4	354.239	7.150	.000
Within Groups	66688.132	1346	49.545		
Total	68105.089	1350			

Table 66: ANOVA - Leisure on OS and importance of participating in a new form of cooperation.

F (4, 1346) = 7.15, p<.05

Table 67: Leisure on OS and Importance of helping to limit the power of large software companies.

Helping to limit the power of large software					
companies	Mean	Ν	Std. Deviation		
Unimportant	6.57	218	5.901		
Of little importance	6.98	228	5.871		
Moderately Important	7.37	290	6.554		
Important	7.88	317	7.619		
Very important	8.63	313	8.480		
Total	7.58	1366	7.123		

Table 68: ANOVA -Leisure on OS and importance of helping to limit the power of large software companies.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	693.573	4	173.393	3.442	.008
Within Groups	68567.841	1361	50.380		
Total	69261.414	1365			

F (4,1361) = 3.44, p<.05

Hypotheses 10: Length of time in the OS community will increase beliefs in the OS philosophy.

The results did not support the above statement. Given the findings from the previous set of results (that the more time participants spend in their free time on OS increases participants beliefs in the OS philosophy), one could argue that the current results are a limitation in the data and should be further investigated with additional research.

Persistence – Norms of Reciprocity and Side Bets Theory.

The next section of the results looks at norms that develop in the community. As stated previously, the reasons to become involved in the community are different to what sustains and builds commitment. The more time you have been involved in the OS community the more committed participants are likely to be. This will be demonstrated by the length of time a participant has been involved in the community, the number of projects they have contributed to, and the impact this has had on their ideological beliefs. In addition to this there will be a sense of belonging to the community and a reciprocal belief system will have developed. This section will look at the norms that develop in the community that encourage this commitment and participation. Becker's Side Bets theory and Norms of Reciprocity have been used in the in Chapter 4 to explain participation in OS. Norms of Reciprocity are rules that develop in the community that assist the community to function. Becker's side bets theory helps to explain the collateral investments that participation creates that sustain involvement.

Participants were asked two additional questions that enabled them to answer in their own words. The results are presented below.

What is the most important reason for your involvement in the OS community?

Other than the categories listed in the previous question, is there any other reason for your participation on an open source project? 3

The open ended responses were coded and analysed as previously discussed in Chapter 5.

Table 69: In your own words what is the most important reason for your continued involvement in the Open Source community?

Most important reason for participation	n	%
OS Philosophy	186	14.9
Enjoyment	181	14.5
Contributing	144	11.6
OS has better software	130	10.4
Reciprocity	118	9.5
Personal advancement	111	8.9
Freedom	75	6
Social interaction	68	5.5
Helping	66	5.3
Improving software	62	5
Anti corporate ideology	39	3.1
Free software	25	2
Prestige	25	2
Financial incentives	16	1.3
Total	1246	100.0

³ The question refers to items in question C1 of the survey. Please see appendix for the complete survey

As can be seen from Table 69, the reasons for staying involved in the OS community are quite different from what initially attracted participants to become involved. The largest percentage of participants (14.9%) believed the OS philosophy to be a major reason to continue participating in the community. The second most common response (14.5%) reported the reason that they continued with their involvement in the OS community was because they enjoyed participating. These results provide further support for the argument presented in the literature review and the model presented in Chapter 4 (Rational Choice Theory, Side Bets, Norms of Reciprocity and Core Motives theory). The reasons for initially becoming involved in the OS community are different to what sustains participation. Opportunities and constraints encourage participation and societal norms help to foster participation and commitment.

The next set of results looks at the beliefs participants have in relation to their jobs. These form an important overview of the providers' general beliefs toward their employment.

Participants were asked various questions about how important certain aspects of their job are.

How important to you are the following aspects of a job?

A job that is useful to society?

41.6 % of people surveyed believe it is important to have a job that is useful to society, with another 28.8% believing it to be very important.

Table 70: A job that is useful to society.

Job useful to society	n	%	Cumulative Percent
Don't know	3	.2	.2
Not important at all	41	2.6	2.8
Not important	101	6.4	9.2
Neither important or unimportant	309	19.5	28.7
Important	657	41.6	70.3
Very important	456	28.8	99.1
Does not apply	14	.9	100.0
Total	1581	100.0	

A job that allows you to help other people?

The largest proportion of participants (44.2%) believed that it is important to have a job that helps others, with 28.3% stating that it was very important to have a job that helps people.

Job- help people	Frequency	Valid Percent	Cumulative Percent
Don't know	6	.4	.4
Not important at all	37	2.3	2.7
Not important	77	4.9	7.6
Neither important or unimportant	305	19.3	26.9
Important	700	44.2	71.1
Very important	447	28.3	99.4
Does not apply	10	.6	100.0
Total	1582	100.0	

Table 71: A job that allows you to help other people.

In summary, the results reveal that the participants have a strong desire to help, and believe that it is important to have a job that is useful to society. The literature argues that there is an altruistic element present in the OS community. Essentially the desire to give back when you have taken something (advice, a program etc.) from the OS community is quite strong and contributes to building commitment. (Side bets theory and Norms of Reciprocity). The foundation of the theories presented in Chapter 4 (Norms of Reciprocity and Becker's Side Bets theory) is that when you take something you tend to feel obliged to give back, and secondly, when you contribute to something you tend to become invested – collateral investment (Side Bets theory). Both of these are useful in analysing the nature of committed behaviour demonstrated in the OS community.

Hypotheses 11: The longer a person has been involved in OS the more projects they will have contributed to.

As can be seen from Table 72 this hypothesis has been supported with the exception of (within the 6 months) where the number of projects contributed to varies from 2.27– 2.87. From 12 months and longer, there is a steady increase in the number of projects that participants have contributed to, peaking with an average of 12.71 projects. The results suggest that in the first 12 months participation is unpredictable. However, after 12 months participation becomes more consistent.

 Table 72: Length of time in the OS community and the number of projects participants have contributed towards.

How long ago did you work on your first Open Source project?	Mean	N	Std. Deviation
Within the last month	2.87	107	1.818
Within the last 3 months	2.40	43	1.218
Within the last 6 months	2.27	44	1.283
Within the last year	2.91	129	5.284
Within the last 5 years	4.39	573	4.718
Within the last 10 years	7.63	344	8.546
Greater than 10 years ago	12.71	197	15.069
Total	5.94	1437	8.388

A one-way ANOVA (Table 73) was conducted to test the significance of the relationship between number of projects that participants have contributed to and length of time in the community. There is a significant difference in the length of time in the community and the number of projects that members have contributed to (F (3, 1430) = 40.53, P< .001).

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14687.843	6	2447.974	40.539	.000
Within Groups	86351.395	1430	60.386		
Total	101039.237	1436			

Table 73: ANOVA - Number of projects and length of time in the community.

Hypotheses 12: The longer a person has been a member of the OS community the more time they will spend contributing to the OS community.

As can be seen from Table 74, in the first 6 months the time spent contributing is unpredictable. However, after 6 months there is a steady increase in time spent participating. A one-way ANOVA was conducted to test the significance of the relationship between length of time in the community and time spent on OS. There is a significant difference in the length of time in the community and time spent on OS (F (6, 1456 = 5.4, P< .001).

How long ago did you work on your first Open Source project?	Mean	N	Std. Deviation
Within the last month	11.86	109	12.890
Within the last 3 months	9.88	43	11.552
Within the last 6 months	9.07	43	7.698
Within the last year	10.27	131	10.817
Within the last 5 years	12.68	584	14.118
Within the last 10 years	16.29	352	16.702
Greater than 10 years ago	15.67	201	18.145
Total	13.50	1463	14.986

Table 74: Length of time in the community and time spent on OS.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7136.949	6	1189.491	5.392	.000
Within Groups	321212.272	1456	220.613		
Total	328349.221	1462			

Table 75: ANOVA - Length of time in the community and time spent on OS.

Hypotheses 13: The more projects participants have contributed the more likely they are to value gaining a reputation in the community.

As seen from Table 76, participants who have contributed to the most projects value the importance of gaining a reputation in the community more so than those who have not contributed to as many projects. A one-way ANOVA was conducted to test the significance of the relationship between the numbers of projects contributed to and the importance of gaining a reputation. There is a significant difference (F (26, 1452 = 1.7, P< .05). It should be noted that whilst significant the difference is quite small; this can be explained by the possibility of a group of long-term participants to whom reputation is not important or not motivating.

Building a reputation in the Open Source community	Mean	N	Std. Deviation
Unimportant	5.55	316	9.119
Of little importance	5.26	312	7.960
Moderately Important	5.64	380	6.441
Important	6.11	280	9.077
Very important	5.79	191	7.794
Total	5.65	1479	8.071

	Table 76: Number of	project	s and the im	portance of r	eputation.
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	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	75.973	26	2.922	1.704	.015
Within Groups	2490.258	1452	1.715		
Total	2566.231	1478			

Table 77: ANOVA -Number of projects and the importance of reputation.

Lastly, the current research has argued that people have a variety of motives to participate in the community. The following results investigate if there are key motivators for participation. A variety of variables were selected to examine this.

Hypotheses 14: People have multiple motives to participate in the OS community.

There are a considerable number of elements to this statement so a systematic and structured approach to adequately answer the issues is required. Firstly factor analysis was conducted on a number of questions to examine if there were sets of motives that influence participation. The questions predominately asked participants to select items based on how important they are to their decision to participate in the Open Source community.

- Improving my financial situation
- Helping limit the power of large software companies
- Solving a problem that could not be fixed by proprietary software
- Getting help in realising a beneficial idea for a software product
- Enabling me to distribute a non-marketable software project
- Improving Open Source products from other developers
- Improving my job opportunities
- Being a member and participating in the Open Source community
- Sharing my knowledge and skills with other members of the Open Source community
- Learning and developing new skills
- Participating in a new form of cooperation

The procedure outlined in the methodology section was followed. Initially 13 variables were included in the analysis. However, believing that software should be free, and building a reputation in the Open Source community was removed due to cross loadings. The factor analysis was completed on the 11 remaining variables and the results are presented below for the following question.

'On a scale of 1 to 5 how important are the following things in your decision to work on an open source project?'

The factorability of the 11 items from the online survey was examined. The items were a list of the most common reasons for participation. Several well-recognised criteria for the factorability of a correlation matrix were used. Firstly, the Kaiser-Meyer-Olkin measure of sampling adequacy was .770 (above the recommended value of .6) and Bartlett's test of sphericity was significant (< .05). The diagonals of the anti-image correlation matrix were all over .5, supporting the inclusion of each item in the factor analysis. Finally, the communalities were all above .4, further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was conducted with the 11 items.

Principal components analysis was used to identify the different types of motivations for participation. The initial Eigenvalues showed that the first factor explained 32.6% of the variance, the second factor 13.7% of the variance, and a third factor 11.6% of the variance. A principal-component factor analysis of the 11 items, using varimax rotations was conducted, with the three factors explaining 58.11% of the variance. All items had primary loadings over .4 and with no cross loadings at this level. The factor-loading matrix for this final solution is presented in Table 79.

Table 78: KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.770
Bartlett's Test of Sphericity	Approx. Chi-Square	3013.960
	df	45
	Sig.	.000

The Scree plot suggests that it was appropriate to retain three factors. The line begins to flatten out at about the fourth factor

Figure 15: Scree Plot.





It is clear from Table 79 that the five items which load on factor 1 all relate to the being part of the community and participating. This factor was labelled, "Community values".

The three items that load onto the second factor relate to the entrepreneurial aspects of the community. This factor was labelled, "entrepreneurial". The two items that load onto Factor 3 relate to the financial aspects of the community. This factor was labelled, "Human capital improvement".

Table 79: Rotated Component Matrix:

	Component		
	1	2	3
Improving my financial situation	086	.104	. <mark>832</mark>
Helping to limit the power of large software companies	.139	<mark>.557</mark>	231
Getting help in realising a beneficial idea for a software product	.182	<mark>.690</mark>	.228
Enabling me to distribute a non marketable software project	.062	<mark>.764</mark>	.152
Improving Open Source products from other developers	<mark>.498</mark>	.351	.053
Improving my job opportunities	.339	.027	<mark>.786</mark>
Being a member and participating in the Open Source community	<mark>.840</mark>	.064	.013
Sharing my knowledge and skills with other members of the Open Source community	<mark>.845</mark>	.104	.006
Learning and developing new skills	. <mark>670</mark>	.042	.201
Participating in a new form of cooperation	<mark>.636</mark>	.332	.010

These results provide an empirical base to support the findings in the literature of the most prominent reasons for participation. These are sense of community, OS values and the desire to improve one's skills. Combined with the opportunities and constraints, these motivators contribute to participants joining and sustained participation. Further analysis was conducted on items that examined the anti corporate ideology motivation of participants. Anti corporate ideology has been suggested as a reason for participation in the community. However, rather than simply asking participants about the reasons and beliefs for participating in the OS community, various variables were selected that are concerned with the anti corporate beliefs to examine if multiple factors were concerned. This was important as previous research has tended just summarise anti corporate behaviour rather than to examine the specific motives involved.

The factorability of the 7 items from the online survey was examined.

- Believing that software should be free
- Helping to limit the power of large software companies
- Solving a problem that could not be fixed by proprietary software
- Participating in a new form of co-operation
- It is important to limit the power of large software companies
- Providing imitations of proprietary software products and services
- Enabling more freedom in software development

Several well-recognised criteria for the factorability of a correlation were used. Firstly, the Kaiser-Meyer-Olkin measure of sampling adequacy was .711 (above the recommended value of .6) and Bartlett's test of sphericity was significant (< .05), (see Table 80). The diagonals of the anti-image correlation matrix were all over .5, supporting the inclusion of each item in the factor analysis. Finally, the communalities were all above .4, thus further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was conducted with all 7 items.

Principal components analysis was used to identify the main anti-corporate ideology motives The initial Eigenvalues showed that the first factor explained 35.85% of the variance, the second factor 16% of the variance, and a third factor 14% of the variance (Table 81).

A principle components factor analysis of the 7 items, using varimax rotations was conducted, with the three factors explaining 66% of the variance. All items had primary loadings over .4 and with no cross loadings at this level. The factor-loading matrix for this final solution is presented in Table 82.

Table 80: KMO and Bartlett's Test for Anti corporate ideology variables.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.711
Bartlett's Test of Sphericity	Approx. Chi-Square	1670.669
	df	21
	Sig.	.000

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Loadings	n Sums s	of	Squared
Component	Total	% of Variance	Cumulative %	Total	% o Variance	f Cumulative %	Total	% Variance	of Cı %	umulative
1	2.510	35.859	35.859	2.510	35.859	35.859	1.829	26.127	20	5.127
2	1.123	16.041	51.900	1.123	16.041	51.900	1.623	23.191	49	9.319
3	1.007	14.381	66.281	1.007	14.381	66.281	1.187	16.963	60	5.281
4	.809	11.550	77.831							
5	.666	9.521	87.352							
6	.499	7.123	94.475							
7	.387	5.525	100.000							

Table 81: Total Variance Explained Anti corporate ideology variables.

Extraction Method: Principal Component Analysis.

Figure 16: Scree plot - Anti corporate ideology variables.



Scree Plot

Table 82: Rotated Component Matrix - Anti corporate ideology variables.

-	Component				
-	1	2	3		
Believing that software should be free	<mark>.760</mark>	.216	054		
Helping to limit the power of large software companies	.346	<mark>.776</mark>	.149		
Solving a problem that could not be fixed by proprietary software	.072	050	<mark>.864</mark>		
Participating in a new form of cooperation	<mark>.710</mark>	054	.188		
It is important to limit the power of large software companies	.012	<mark>.898</mark>	.052		
Providing imitations of proprietary software products and services	.113	.348	<mark>.606</mark>		
Enabling more freedom in software development	<mark>.781</mark>	.201	.103		

It is clear from Table 82 that the three items, which load on factor 1, all relate to the fundamental principles of participation in the community (software development, freedom and participation). This factor was labelled, "Freedom and Participation". The two items, which load onto the second factor, relate to the fundamental anti corporate elements of the OS community (Helping to limit the power of large software companies and it is important to limit the power of large software companies). This factor was labelled, "Anti corporate ideology". The two items that load onto Factor 3 relate to the development of OS software. This factor was labelled, "Software development".

In Summary, these factors are important as previous research tended to group a number of elements under the category of Anti-corporate ideology when there are in fact a number of distinctive and specific elements that contribute to this general motive for participation. The results support the argument that participants may have varied anti corporate beliefs that motivate their participation in the OS community.

Conclusion.

In conclusion, the results from the online survey revealed that the majority of the sample is male, aged 35, tertiary educated and employed in the IT field. Participants on average work 40hrs a week with an annual income of \$100,000. Participants value jobs with good career advancement opportunities, job security, high incomes, flexible work conditions, the ability to work independently and jobs that still allow adequate leisure time. Respondents generally believed that it was important to have a job that was useful to society and helped people.

Participants spent 12.54 hours a week contributing to the OS community; however some participants reported working up to 70hrs on OS. Those that contribute considerable hours to the OS community tended to do this as part of their paid employment. Participants generally believed that you should make money by working on OS but that members should also help to develop free software. On average, participants had contributed to 6 projects.

In relation to time use, the participants reported that they would like to spend a bit less time in their jobs and would like to have bit more time for friends, family and leisure. Participants also expressed a desire to spend more time participating in the Open Source community, and appeared to be quite satisfied with their life and jobs in general.

In relation to the specific research questions, hours of employment influenced the amount of time that participants contributed to the OS community, with more hours of paid employment resulting in less time spent on OS (without financial gain). Additionally, cohabiting participants spent less time on OS than non-cohabitating participants. Age alone did not appear to influence time spent on OS. Younger participants in the 20-39 year age group valued improving their job opportunities more than older participants, whilst older participants did not appear to value the social aspects of the community more than the younger members as hypothesised. The results supported the arguments that participants are more likely to initially become in involved in the community for equipment or advice rather than the social aspect. However, greater participation in the community did strengthen member's belief in the OS philosophy. Increased length of time in the community resulted in members contributing to more projects and more time spent on OS. Furthermore, the more projects that a member had participated in, the more like they were to value gaining a reputation in the community.

Lastly, three general motives for participation emerged consisting of community values, entrepreneurial and human capital improvements. It was also found that the anti-corporate ideology could be categorised into three general motives, software development, freedom and participation and a very specific anti corporate ideology belief. All of the research questions will be discussed in more depth in the Discussion.

The next section of this chapter will review the network analysis results to analyse the structure of the community.

Network Analysis Results.

The following section will explain the results and some of the limitations of network analysis, particularly when dealing with large data sets. The programs NetDraw and UCINET, like the majority of network analysis programs, have limitations on the amount of data that can be analysed and displayed while maintaining visual quality. As a consequence the sample size for this study was reduced to 200 to enable a better visual representation of the network. An additional sample of 200 was analysed to demonstrate that the results have not occurred by chance and these results are presented as well. The samples were selected from posts on an online discussion board. The online discussion board was created by members of an OS community in order to seek and provide assistance on OS projects. The reciprocal lines in blue and red demonstrate the correspondence between participants. The participants are identified by their email address (email addresses were altered to ensure anonymity). As can be seen from Figure 17 there are people who seem to receive the most correspondence in the network. :

Joe.Buck@synopsys.com driw@false.org bkorb@gnu.org dberlin@dberlin.org dnovilla@redhat.com dewar@adacore.com Christian.Iseli@ilcr.org Dave.korn@artimi.com

These participants can be found by looking at the larger black clusters and writing situated toward the middle of the network. However, as can be seen from Figure 17 it is still quite difficult to interpret the graph so further analysis is required. A central aspect to this

research is to analyse the structure of the OS community and to determine whether the level of contribution to the community is evident and contributes to the structure. To further examine the network and the role of influential members, additional analysis was conducted, and this is shown in Figure 18. If you look closely at Figure 17 you can see that all of the members are connected by a blue and/or red coloured line which indicates the direction of the conversation. This indicates that all members of group are connected in one way or another. They have either provided information, sought information or both. In addition to this the participants also have a coloured dot next to their name (pink, black, green, blue, grey and red). These groups of colours represent subgroups of participants that communicate more frequently which each other, rather than the group as a whole. Lastly it can be seen that each person has an arrow attached to a coloured line. The arrows illustrate the direction of the conversation (seeking information or providing). Highly connected members are situated to the middle of the graph.

Figure 17: Online discussion from OS members.



An additional benefit of Network analysis is that it also provides the ability to examine the data for influential sub networks. A close examination of Figure 18 shows the names in the graph correspond with the names with the larger black clusters found in Figure 17. These eight people not only communicate with the wider network but with each other. These members are the most active within the group and could be considered the most dominant.

Joe. Buck@synopsys.com driw@false.org bkorb@gnu.org dberlin@dberlin.org dnovilla@redhat.com dewar@adacore.com Christian. Iseli@ilcr.org Dave.korn@artimi.com Figure 18: Influential members.



To provide further support of the results, an additional sample was selected from the online discussion group. Similar analysis was conducted as the first sample. In Figure 19 the large black dots situated to the middle of the graph again indicate the members who are highly active in the community. A list of these active members is provided below. Members are connected by a blue and/or red coloured line which indicates that all members are connected in one way or another. Highly connected members are situated to the middle of the graph. Lastly, the arrows indicate the direction of the conversation. The main difference between the sample networks presented in Figure 17 and Figure 19 is that the second sample has more members who are actively involved.

In Figure 20 further analysis was conducted which highlights the highly 'active' participants that are listed below.

mrs@apple.com geoffk@apple.com mark@codesourcery.com howarth@bromo.msbb.uc.edu hjl@lucon.org Jason@redhat.com ant@google,com joseeph@codesourcery ant@google.com Gerald@pfeifer.com Figure 19: Sample of Network.



In Figure 20 it is clear that the findings are replicated from the first sample, in that the highly connected people within the network also communicate frequently with each other. However, in this example there are a higher proportion of very active members who make the most contributions. Logically, this provides support for the argument that those members that contribute the most (or who are the most active) have the most influence over OS projects. Communication between members is almost exclusively conducted online through the discussion boards. If the communication were simply unidirectional (for example a new member seeking advice) they would not be considered influential, despite perhaps making lots of posts. Figure 20 displays the members that are involved in the most multidirectional communication in the sample. For this reason it would be plausible to argue that these members are the most influential due to their increased involvement in the group.

Figure 20: Influential people in Network.



Analysis of Networks – K-Core.

In the first example of a network it was discussed that there were different coloured groups of people that are more closely linked to each other than to other people. The K-Core provides information on sets of Nodes (people) that are more closely connected to one another than they are to other nodes. K- Core is a subgroup. The different colours of nodes represent the different groups. In the **Figure 21** you can see that there are 8 main subgroups in the network represented by the varying colours (green, red, blue, black, grey, dark green, light blue and pink.
Figure 21 K-Core.



Density.

Network density is the mean strength of connections among units in a network (Marsden, 1990). Measuring the density of a network can be problematic if a network has lots of subgroups, and that comparisons of density measures across networks differ in size can likewise be misleading (Marsden, 1990). The density of the network is the proportion of all possible ties that are actually present. The current network has a density of 0.5444, which means that 54% of all possible ties are present. This would indicate that the network is moderately dense, and that the influence of subgroups may have reduced the overall density score. The subgroups reduce the overall density of a group as communication may occur more frequently amongst the subgroup members rather than expanding or including the entire group.

Reciprocity.

Reciprocity in the network can also be measured. With directed data it is possible to measure the extent to which ties (relationships) are reciprocated. With directed data, there are four possible dyadic relationships: A and B are not connected; A sends to B; B sends to A; or A and B send to each other. In the current sample it is useful to examine the directed dyadic relationships to see the extent to which ties are reciprocated. It can be argued that there is an equilibrium tendency toward dyadic relationships to be either null or reciprocated, and that asymmetric ties may be unstable (Hanneman and Riddle, 2005). A network that has a predominance of null or reciprocated ties over asymmetric connections may be a more "equal" or "stable" network than one with a predominance of asymmetric connections (which might be more of a hierarchy). Essentially the more members who communicate across the group rather than in a hierarchal format, the more stable the group becomes.

Reciprocity in the current sample.

What is the prevalence of reciprocity in the current network? In large populations, most actors usually have no direct ties to most other actors and it may in fact be more sensible to focus on the degree of reciprocity among pairs that have ties (Hanneman and Riddle, 2005). This is relevant to the current network, so rather than focusing on individual participants, it is better to focus on the relationships between the participants. To measure reciprocity in this sample the question then becomes:

What percentage of all possible ties, or 'arcs' of the directed graph, is parts of reciprocated structures?

In the current sample, the relations that exist within the group of all pairs of actors are 0.3790. This means that 37% of the pairs in the network have a reciprocated connection. This is neither particularly high nor low in itself, but it does seem to suggest a considerable degree of vertical connection within this community population. In short, a reciprocal relationship exists within the sample; however there a vertical or hierarchal relationship that is most likely to exist among the network that reduces the overall reciprocity score. The greater communication between group members increases the reciprocated percentage. When a hierarchal relationship exists in a group, the communication is usually directed vertically rather than horizontal, which reduces the overall amount of communication. This result is not surprising when considering **Figure 18** and **Figure 20** which illustrates that there are groups of influential members who communicate frequently and have the most ties with other members. This result provides further evidence of a hierarchal or status structure existing within the community based on level of participation.

Conclusion.

In conclusion, the results from the network analysis support the argument that there is a hierarchal structure based on influence and measured by member contributions. The network analysis graphs demonstrate that key people (dominant/the most active, as measured by communication) emerge in the community, and that there is also a high level of communication between these key members. These key members are influential in the direction of OS projects. The calculations demonstrate when the large size of the network is taken into consideration the network is highly reciprocated and quite dense, which supports the arguments of Norms of Reciprocity. Reciprocity helps to build the stability of a group or community, as members become more invested each time they contribute or receive something from the group. These ties help to strengthen the group as the more invested members become, the less likely they are to leave to group. These characteristics contribute to the overall stability of the network, as well as to the OS community's growth.

CHAPTER 7

THE INTENSITY, DIRECTION AND PERSISTENCE OF PARTICIPATION IN THE OS COMMUNITY

Introduction.

This thesis has provided an explanation for participation in the Open Source Community using Rational Choice Theory. The dual aim of this work was to contribute to understanding why people volunteer their time in the Open Source community, while explaining what motivates them to continue. This thesis has offered a new and comprehensive explanation of participation in the OS community that takes into account structural changes that present opportunities for people to become and stay involved in the OS community. The current work examined the seminal research in the fields of time use, volunteering and communities and from this has proposed that structural changes in society have helped to create online communities such as the Open Source community. Participation in the community is thus explained by the following tenets which provide a holistic explanation covering all aspects of participation in the community.

- 1. Open Source participation and interaction comprises a 'community'
- 2. Participation in the Open Source community is a form of volunteer activity.
- Structural changes in society have changed the way people use their time, which has provided new opportunities for participation.
- 4. Age, gender and life stage impact on the decision to participate in the community and influence the amount of time spent contributing.

To assist with the Rational Choice Theory (RCT) explanation, Core Motives theory, Norms of Reciprocity and Becker's Side Bets theory have been utilised. Furthermore, the structure of the OS community was investigated through Social Network analysis in order to investigate how the organisation of the community may foster participation and commitment. These theories build on Rational Choice Theory, and form the basis of the theoretical framework to test the following research questions.

- 1) Why do people choose to spend time on OS? (The direction of their motivation).
- 2) How much time do people spend on OS? (The intensity of their motivation).
- Why do people continue to stay involved in OS? (The persistence of their motivation).
- 4) Does the OS community have a hierarchical structure based on expertise and participation?

The Open Source community was selected for this research because it is relatively new in comparison with 'traditional' communities. Even though it can be defined as a community (as shown in Chapter 1), it is different from the traditional definition of communities (e.g. members would be unable to recognise each another, even if they were sitting adjacent on a train). Participation in the OS community can be considered a form of volunteering and the volunteering literature is valuable in explaining what attracts people to particular activities and what motivates them to continue. This provided a framework for analysing the OS community that made it possible to see if certain aspects made participation more or less likely. Similar to other types of volunteering activities reviewed in Chapter 2, many participants use work related skills in their volunteer activity which is consistent with the OS community.

The theoretical framework.

In Chapter 4, a theoretical framework was presented for examining the Open Source community. The problem in addressing the research questions has been that previous work in this area has relied on narrow conceptualisations and incomplete models. It is argued in this work that joining and participating in the community is best understood when a combination of theories are used. Rational Choice argues that people generally make

rational decisions to maximise their utility (Goldthorpe, 1998; Simon 1957). People's decisions are based on the information they have at the time and are greatly influenced by their desires, their needs and the opportunities available to them in their present situation. Preference Theory, whilst not used independently in the theoretical explanation, falls under the umbrella of RCT theory and was used to argue that structural changes in society have created an environment that may encourage participation in the OS community (Hakim, 2000). Core Motives theory contends that people have five core motives that influence their decision and was used to explain key areas of motivation that encourage participation under the RCT explanation. Norms of Reciprocity is used to explain the social expectation that people will respond to each other in kind, returning benefits for benefits (Gouldner, 1960), which is observed in the OS community (Hars et al, 2002). Side Bets theory describes OS members' commitment to the community through the investments they make in terms of time spent and contribution (Becker, 1981).

When considered together these theories work together to provide the theoretical basis for examining the OS community. Core motives theory provides the foundation for explaining the underlying motives that can be satisfied by participating in things we believe will help to achieve such goals. Rational Choice Theory provides an explanation for the driving force that can describe how and why we make the choices that we do. Norms of reciprocity explains how the norms in a community develop through reciprocal relationships and Becker's side bets theory describes the investments people make through this participation. These theories combine to examine the motives, right from the decision to join the community through to staying and contributing. This framework provides some precision to what has previously been an imprecise area of research by examining all aspects. The results from the online survey, which provide support for this methodology are discussed first, with the network analysis implication discussed later in the chapter.

The Direction of participants motives, Rational Choice Theory and Core Motives Theory.

People have multiple motives to participate in the OS community.

Rational Choice Theory (RCT) contends that people make decisions based on the information they have at the time and that they are greatly influenced by their desires, needs and the opportunities available to them in their present situation. RCT takes into consideration the constraints and opportunities a person has when making the decision to join and participate in the OS community and it helps to explain the strategic motives for participation. Core Motives Theory is the primary theory in explaining decision making in social situations (Fiske, 2010), and is based on the argument that individuals do not always act selfishly and generally have some regard for the interest of others (Van Vugt, 2009). The literature suggested that people might have multiple motives to participate in the OS community, and Rational choice theory and Core motives theory would suggest that people have differing motives depending on their needs and circumstances. In order to investigate the most commonly reported motives in the current research the results were analysed from the participation in the OS community. The results show that there are three key motives that encourage participation in the OS community

- 1. The opportunity to build human capital,
- 2. The attraction to the community values and the
- 3. The entrepreneurial aspects of the community.

This supports Core Motives theory and Rational Choice theories as an explanation of the needs that can be fulfilled through participation in the OS community. The Core motives of Self Enhancement, Belonging and Controlling are each reviewed in turn below.

1) Human Capital

These participants want to strategically improve their human capital, which is consistent with the Core motive for Self Enhancement. Respondents view participation in the OS community as a way of improving their skills, which in turn may lead to improved job and financial prospects. Their decision to participate is more strategic as they are actively looking for something in return from the group. The interesting quality of the OS community is that both its formal and informal processes support all three groups' motives for participation and perhaps contribute to its on-going success, as all three motives are supported within the community structure. The underlying motives (as revealed through the factor analysis) bolster the idea that some participants are making a Rational Choice or calculation to maximise a utility, in this case in terms of job prospects and money. Participation to improve one's skills with the belief that it may lead to improved job prospects and pay was found is consistent with the previous work of Raymond (1999); Lakhani and Von Hippe (2000); Lerner and Tirole (2000); Lancashire (2001) and Hann (2002); Chorng, Gerlach and Young (2006).

2) Community values

Participants' motives for partaking in the OS community were dominated by the values of the group, where a need to use the software drives product creation and improvement, while notions of fairness, or the desire to benefit from the potential and subsequent improvements of others, leads people to contribute their knowledge to the community. Hunter and Suttles (1972) argued that community groups are settings in which people bring their concerns and complaints, and through this shared concern a sense of belonging develops, consistent with the Core motive of Belonging. This can be seen in the OS community where participants derive enjoyment from engaging in creative and challenging programming tasks, working with others and seeing the software improve. This group values the importance of reciprocity in the community and an upholding of the Open Source philosophy. Buss and Potnoy (1967) argue that membership in the community results in a feeling of being invested, and therefore participants feel a sense of belonging. Participants in the OS community contribute their knowledge and skills to the community and generally expect the same in return, and these results reveal that greater participation in the community strengthened member's belief in the OS philosophy. Thus these findings reflect similar results presented by Ghosh, et.al (2002). The results presented in this thesis also show that the social aspects of the community were not *as* important as the more strategic

257

reasons for participation. The community values were strengthened through time spent, and sustained participation. The second most important reason for participation related to the helping nature that exists within the community, and the desire to contribute to this. When participants were asked the principle reason for their on-going participation in the community, the largest percentage reported the OS philosophy, followed by enjoyment of the activity. These results further support the theoretical frame work that utilises Norms of reciprocity, Side Bets theory which are also discussed later in the Chapter under Persistence.

3) Entrepreneurial

Lastly, participants in the OS community primarily undertake tasks that interest them, thus the tasks they choose are not always those for which the project has the greatest need, or for which the most users express an interest. Nevertheless, feedback from users and developers of the code is still a vital component of the system for these developers. Over time, members of this group acquire a greater understanding of larger portions of the software code and enjoy the creative component of designing new software that may be of use to other members. Many of these individuals express a dedication to keeping the design of the software simple and understandable, so that others can continue to improve upon and experiment with the code. This desire to write and maintain an elegant code base is critical to the continued viability of the community and code. Research by Kuan (2000), and by Franke and von Hippel's (2003), supports the motivation of participants to create, customise or improve a product as a significant reason for participation in the community. Additionally, Gabriel and Goldman (2001) found that participating in the community because one finds creating and improving software as enjoyable activity, is also a motivating factor for continued involvement. Furthermore, this entrepreneurial motive links to the core motive of controlling. Being able to design and control your own project is of great interest to many developers and it is found in this general motivation. It is also supported by the results of the Network Analysis that illustrate that the structure of the community supports the gain of recognition and prestige for contributing member.

Time use and participation in Open Source.

An element of the current research was the classification of participation in the OS community as a form of volunteering. This provided a way of empirically analysing the motives for participation. Part of the Rational Choice explanation of participation in the OS community requires that the individuals' demographics be investigated as this will influence and affect the choices that participants make. To examine what motivates people to join the OS community the time use and volunteering literature was used. In terms of examining the direction of participants' choices, my results clearly reveal that there are certain demographic characteristics making participation more likely. The results show that the sample was predominately male, 35 years, highly educated and employed in the IT sector. There were also a large percentage of participants currently engaged in full time study. Similar demographics have been found in previous studies (Ghosh, Glott, Krieger, Robles, 2002), providing evidence that certain traits make participation more or less likely.

RCT theory research argues that people have goals which they would like to reach and they will take action to reach their goals in ways they perceive will maximise their utility (George, 1998). It was contended that participants have instrumental motives to participate in the OS community and to volunteer in certain activities, which increase their skill base and therefore improve their employment prospects. Gidron (1978) argues that younger volunteers are more likely to emphasise the importance of gaining work experience, whilst older volunteers tend to value social interaction. This supports Rational Choice theory, which posits that participants desire to participate is driven by self-interest (Goldthorpe, 1998). The results support the hypothesis that many people participate in the community to fulfil a need (building human capital or in many cases a need for better software). People aged 35–44 reported the highest levels of volunteering (ABS cat 4441.0). Similar results were found in the current OS survey, with the average age of participants being 35.5 years.

I tested to see if similar results were found with the participant's age influencing the motive of skill enhancement.

The following hypotheses were tested

Younger participants will value skill enhancement as a reason to be involved in the OS community more than older participants.

A RCT explanation was supported, as the motives are influenced by a person's individual circumstance, which in turn directs the behaviour (in this case to join the OS community). My results show that the younger age groups (20 to 39) place more value on participating in the community in order to improve their job opportunities and skill base when compared to the older participants. This is in line with previous empirical work by Lerner and Tirole (2002). Analysis was also conducted to see if older participants placed more value on social interaction than the younger as proposed by Gidron (1978) and Clary and Snyder (1999). Support for these finding was not found, as older participants were just as likely to value the contributing and the helping nature as well as the development aspects of the community as compared to their younger counterparts.

This dissertation argues that the reasons for joining the community are different from those that keep participants involved. The literature reveals that many participants join the OS community as they are seeking something (Raymond 1999 and Kuan, 2000), such as advice or a program. However, there are many other motives that exist within the community such as enjoyment and reciprocity (Gabriel and Goldman, 2001) and it was of interest to the current research to examine if the motives of the participants change over the course of their involvement in the OS community. To begin with the following hypothesis was tested with the ongoing motives for participation investigated later in the chapter. Participants were asked to respond in their own words as to what initially attracted them to participate in the OS community. The below hypothesis were tested.

Hypothesis

Initially, people are more likely to become involved with the OS community to gain equipment or advice, rather than the social aspects

The results show that the largest proportion of respondents were initially attracted to the OS community, as they perceived it to have better software than the alternative proprietary products. Similar results were found by Ghosh, Glott, Krieger and Robles (2002), who found this to be one of the major motives for joining the community. Raymond (1999), Kuan (2000), and Franke and Von Hippel (2003) also demonstrate that the need for a product is a significant influence for joining the OS community, and this is also supported by Fang and Neufeld (2009), who also found that the motives for sustained participation were different to what initially attracted participants to the OS community. These results support a Rational Choice Theory explanation of why people join the OS community. These needs vary according to the individual and their circumstances but range from wanting assistance with a problem, requiring a new piece of software, improving their skills or just for the sheer enjoyment of participating. The individual makes a rational choice based on their unique circumstances and particular needs to join the OS community.

Intensity (how much time and effort do they put in once they join (Preference theory/time use).

Preference theory and the time use data have been used to argue that structural changes in conjunction with more varied working hours have created more opportunities for individuals, and more choices in how they use their available time (Wooden, 2000; Hakim 2000). Preference Theory can be used to explain the dominance of males in the OS community, as it can be argued that societal changes have occurred that provide the majority of people with the opportunity to choose the career path of their choice (Hakim,

2000). The majority of people employed in the IT industry are male (U.S. Department of Labor, 2004). Preference theory suggests that the type of work appeals to more men than women and thus assists in explaining why more males than females are involved in the OS community. Both this current research and previous works by Ghosh et.al (2002), have found a high saturation of males who are employed in the IT industry participate in the OS community. The results provide support for similar findings in the volunteering literature, that suggest that if a participant enjoys their paid work then they will be more likely to volunteer in a comparable role (Herzog and Morgan, 1993). Additionally, people are also more likely to volunteer in activities that are an extension of the skills used in the participants paid employment (ABS cat 4441.0).

The time use literature was reviewed because it suggested a likely source of explanation for engagement in OS. In particular, average working hours were examined, to see whether more time in paid work would reduce the amount of free time participants would spend contributing to the OS community. It was established that between 1985 and 2005, the average weekly hours worked by the Australian workforce declined from 35.8 hours to 34.7 (ABS. cat 4102.0). This thesis tested to see if hours of work influence participant's time spent contributing to the OS community.

The following hypothesis was analysed:

Hours of employment will influence available time, and therefore time spent in the Open Source community. Longer hours of employment will result in less time spent participating in the OS community.

The survey data provided support for this hypothesis, although there were some unexpected findings. The data confirmed that working hours influence the amount of time participants spent contributing to OS, but not necessarily as predicted. The results reveal that many participants work on OS as part of their paid employment. Therefore, in this case, the more hours spent at work increased the hours spent on OS activities. To account for this finding, additional analysis was carried out on the data and it was determined that people 262 who work longer hours in paid employment tend to spend less of their 'free time' contributing to OS. Having said this, the results indicated that the majority of participants would spend the same or more time on OS, the same or more time with family and friends, the same or less on housework, the same or less time in a paid job, and the same or more on leisure and relaxing. So despite an environment with potentially more flexible schedules and changes in time use, and although many participants say they would like to work less (as discussed in Chapter 6), the respondents in this survey display something of a time squeeze, where they express wanting to generally have less contracted and committed time and more free time. In terms of Preference Theory and time use, the results do not provide unequivocal support.

Preference Theory argues that societal changes have occurred that provide increased flexibility in the way women and men choose to work and spend their time (Hakim, 2000). However, the results reveal that the structural changes in society may not have provided the desired flexibility or a choice with how one uses their time. This is not in line with previous work by Hakim (2000) but has support from research conducted by Wooden and Loundes (2001) who argue that there are an increasing number of workers in full time employment working longer than the standard 40-hour week. This might be a contributing factor to the time squeeze reported by participants.

The time use data reveal that there are many factors that influence the amount of free time that people have, (age, gender, occupation and marital status). It was therefore important to understand how these factors influence the time people have, in order to analyse the environmental conditions that may provide the opportunity for people to participate in the OS community. The time use data revealed that males, those that live alone, the childless and people in the younger and older age groups also tended to have more free time (ABS cat 4153.0). The following hypotheses were tested to see if this was consistent in the OS community and a possible influence to hours spent contributing to the community.

The following hypotheses were tested.

Single and non-cohabitating participants will spend more time on OS participation than those that are cohabitating.

Younger (< than 30) and older participants (> than 50) will spend more time on OS projects.

The literature revealed that single people tended to have more free time than those that were cohabitating (ABS cat 4153.0). The results provided support for the hypothesis that 'cohabitating' status impacts on the time participants dedicate to OS, with those cohabitating spending less time contributing to the OS community. The age of the participant did not influence time spent contributing. This was despite the fact that prior research has found that the older and younger age groups tend to have more free time (ABS cat 4153.0).

Overall the findings reveal that more free time results in more time spent on OS. However, the amount of free time is dependent on individual circumstances, with age and life stage impacting. More time spent contributing to the OS community also builds more commitment to the community, which is discussed next.

Persistence (why do they stay involved) Side Bets, Norms of Reciprocity and Core Motives.

Becker's (1981) Side Bets theory was used to explain the collateral investment which participation creates, that can sustain involvement in the OS community. Becker (1960) argues that commitments come into being when a person, by making a side bet, links extraneous interest with an existing activity. Norms of Reciprocity help to explain the desire to stay involved in the Open Source community. Reciprocity leads to the development of group norms, which then foster commitment in the community. Essentially, when people take something from the community, be it a piece of software or advice, they generally feel obliged to give back. Norms of Reciprocity is powerful in motivating, sustaining and regulating the cooperative behaviour required for social organisations, such as the OS community (Seinen and Schram, 2001). A number of questions were posed to investigate the theoretic framework provided by the theories of Side bets and Norms or reciprocity.

The following Hypotheses were proposed:

- The longer a person has been involved in OS, the more they will contribute to projects;
- The more projects participants have contributed, the more likely they are to value gaining a reputation in the community to; and
- The more projects a participant is involved in the greater the desire to give back to the OS community

The survey results show that Becker's side bets theory and Norms of reciprocity are supported as an explanation for the on-going participation of OS members. Through their contribution, participants became more invested in the OS community. The length of a person's involvement in the OS community shows a probability to commit to further projects. The more projects a member becomes involved with, the more likely they are to value gaining a reputation in the community. Most significantly, the longer a person had 265

been a member of the OS Community, the larger the percentage of their free time is spent contributing to the community. The results provide support for Side Bets theory, as the more time participants spend in the community, the greater their contribution tends to be, and the more committed they become. The more projects the participant contributed to the more they had a desire to give back to the community. This provides support for Norms of Reciprocity. These links between the norms that develop and the collateral investments that are made in the community through contribution have not been explicitly made in previous research. Similar motives for participation have been found by previous researcher Rheingold (1993), Gabriel and Goldman (2001) who have found that motives such as affiliation, identity and values ideology are important factors to contribute to the community.

The results reveal that many people originally join the Open Source community because they are in need of something, be it advice, assistance, or a specific piece of software. After the participant has received what they require, there is no obligation to continue to be involved in the community. However, as the literature review in Chapter 1 contended, many members stay involved and in fact build their investment in terms of time and contribution. The survey asked participants what initially attracted them to participate in the OS community and it was found that the largest percentage of participants joined because they required software. Participants were further asked the reasons for their continued involvement in the OS community and the largest percentage of participants responded that they believed the OS philosophy to be a major reason for continuing their participation. The OS philosophy is not only founded on the idea of an 'Open Source code' but on the values of sharing and participating in the community (Sonali, 2003). The survey results provided support for this idea, as many participants reported that the helping and contributing nature of the community, as well as the desire to give back when they have received something from the community, to be a motivating factor for their continued participation. The results found that the more participants spent on OS in their free time, the greater their belief in the importance of the OS philosophy. A commonly stated reason

for participants continuing involvement in the OS community was the enjoyment they gained from participation. A further explanation is that the majority of respondents report they enjoy their paid work (the majority work in IT) and would like to spend a bit more time on OS. This is consistent since OS development is very like paid work, and they enjoy their paid work, so it is reasonable to assume that they would then enjoy OS. The majority of members also believe that as a member, they should help to develop free software, have a job that is useful to society and that allows them to help people. These results provide support to the argument presented in the literature review, as well as the theoretical framework that norms develop in the community based on the reciprocal benefits received and that this encourages sustained participation. Thus both Becker's Side bets and Norms of reciprocity are supported as an explanation for continued participation. The motives for joining are different to what sustains participation. The community structure also provides an environment in that the evolving motives of participants can be satisfied.

To further analyse participant motives for continued involvement participants were asked about the most important reason for their continued involvement in the OS community, as it is argued in the current research that the motives for involvement may change over time. The results revealed that the largest percentage of members identified OS philosophy to be a major reason for their continued participation. In order for a community to function, members must have a common understanding of the environment in which it operates (Fiske, 2004). Conveying a shared belief is a key to belonging and people are motivated to belong generally encourages members to conform to group norms (Fiske and Von Hendy, 1992). It was found that the more time members spent on OS in their free time, the more they tended to believe the OS philosophy to be an important aspect. The Open Source community bases itself on the ability of developers and users to make changes to the source code and therefore alter the performance of a program. This shared belief is the key characteristic of community. As stated previously, the need for affiliation as a source of motivation is consistent with previous research (Haring, 2002). Respondents reported that 'the helping and contributing nature of the community' was a key factor in their on-going participation and provide support for Norms of reciprocity in explaining the behaviours in the community. The belief in the OS philosophy also forms the basis of trust that is evident in the community. Members design and contribute to software online, trusting that others follow the guidelines of OS philosophy and keep the source code open. If members did not uphold the general principles of OS development, including the process of online collaboration, members would not be as likely to contribute their skills. At a basic level the need for control is expressed by the desire to experience some contingency between an individual's own actions and the responses of others (Van Vugt, 2009). People who exhibit effectiveness and competence last longer in groups than people who experience social interaction arbitrarily or out of control (Van Vugt, 2009). The Network Analysis results (which are discussed later) reveal that the most experienced members were the ones that tend to lead the discussions and projects.

The motive of self-enhancement is the desire to maintain and possibly improve self-esteem. The OS Community offers many incentives for self-enhancement (further supported by RCT). Results demonstrate that skill development is of particular importance to younger members, and is in fact a significant motivator for participants in general overall (Ghosh, et.al, 2002; Lancashire, 2001; Hann, 2002). However, the results also revealed that the more projects that a person contributes, the more likely they are to place value on gaining a reputation in the community, which is consistent with previous research (Raymond, 1993; Gabriel and Goldman, 2001). The community provides an environment that offers these individuals the motive of self-enhancement. However, there was one interesting contradiction reported by the respondents illustrated by **Figure 11** On the one hand OS participants think that software should be free but they also, think that they should make money from OS projects. This is quite a contradiction and is worthy of further study.

The Structure of the community.

The hierarchical nature of the community was investigated through the use of discussion posts from OS online boards, which were analysed using network analysis techniques. The results are presented in Chapter 6. The results uphold the idea presented in the literature review, namely that a hierarchal structure exists in the community, with the members who contribute the most having the control over projects. These findings are consistent with Rheingold (1993) and Raymond (1999), who found participation in order to maintain or build a reputation within the community an important motivator for some members. The structure of the community may be one of the most critical factors that contribute to its success. These communities have no paid staff or management and are geographically dispersed yet they provide participants with a social context and the resources to create useful products that have on occasion displaced, or significantly improved upon commercially produced products (Sonali, 2003). The OS community represents a very different type of organisational structure for innovation that adds to its value as a community worthy of substantial investigation. It also provides an example of a community in which hierarchy is predominately based on the skill and expertise of members, rather than other traits (Gabriel and Goldman, 2000). Further support was found through the online survey, the results of which revealed that the more projects a participant had contributed to, the more likely they were to value gaining a reputation in the community. The OS philosophy is based on the ability of developers and users to make changes to the source code, and therefore alter the performance of a program. The values of the community are founded on three main issues, freedom, anti corporate ideology and software development. Freedom is based on the right to make copies of the program, distribute it, access to the software's source code, and the right to make improvements to the program (Perens, 2008). The anti-corporate ideology consists of a group of negative attitudes towards proprietary companies that produce and profit from software that has a closed source code, thus preventing the software from being altered (Gabriel and Goldman, 2000). Lastly the software development is at the heart of the community, with the belief

269

being that by having the source code open it produces superior software to proprietary (Franke and Von Hippel, 2003).

The structure of the community and the way it operates encourages members to continue with their participation in the community. The norms that develop are based on reciprocity and the building investments that members make to the community. As well as the opportunity for individual's to gain status and prestige in the community. The structure also encourages continuing participation as it provides individuals with the opportunities to fulfil their on-going needs including the Core motives of Understanding, Belonging, Controlling, Trust and Self Enhancement.

Important findings.

The research conducted for this thesis provides an in-depth review of the OS community that far exceeds the hypotheses analysed. The links between stage of life, gender, age, education level and occupation and the influence this has on how individuals utilise their free time are valuable, as the relationship between these factors and OS participation has not previously been studied. Furthermore, it was found that hours of work influenced the amount of time members participated in the community, with hours spent contributing in the community decreasing with longer paid working hours. The results showed that many members in the OS community work on OS as part of their paid employment. Living arrangements proved significant, with cohabitating participants spending less time on Open Source than their non-cohabitating counterparts.

The results reveal there are three main motives for participation in the community. A belief in the Open Source community values, the incentives to be able to design and create software, and the strategic motive for human capital improvement. Interestingly, age alone did not appear to influence time spent in the community. This was surprising, as the literature presented in Chapter 3 revealed that younger and older participants have more 270 free time (ABS cat 4153.0), and it was assumed that more free time would lead to more time spent contributing to the OS community. Why age does not influence time spent in the community could be of interest for further research. The motives for participants varied according to age, with younger participants more interested in human capital improvements than older participants, this is consistent with the volunteering literature. Members working on numerous projects are more likely to value gaining a reputation in the community. The network analysis results support the hypothesis that there is a hierarchical structure in the community, based on contribution and expertise. This structure would therefore encourage and support participants to search for the prestige they desire and no doubt help to maintain the quality of the software produced.

Significantly, the *direction* of participants' motivation in joining the OS community tends to be as a result of fulfilling a particular need, which is guided by core motives and rational choice. The *intensity* of their choice is dependent on many factors, namely occupation, working hours and life stage which impacts on available time. *Persistence* tends to be due to the continual reciprocal benefits received and a strengthening in the beliefs of the OS philosophy and community values and the structure of the community where they gain status and prestige

Conclusion.

This research has found that OS participation is a type of volunteering and the members form a community. The results reveal that participation in the community is influenced by the individual's current needs and that the Open source community provides an environment that continues to support participants evolving requirements through their ongoing participation. The motives to join the community are not necessarily the same as those that lead to maintaining commitment. The motives for participation are influenced by many factors including, age and life stage. The benefits that individuals receive and the way the community fosters participation and commitment through the prestige gained by its contributing members, helps to strengthen the communities structure.

Do the findings support the theoretical explanations for participating in the Open Source Community?

The results overwhelmingly support a Rational Choice explanation of OS participation. The results reveal that when people join the community they generally have a requirement that they believe the OS community can provide. Essentially, they have a need and the OS community provides an avenue to satisfy that need. These requirements are influenced by certain aspects of the participant's life, such as gender, age and occupation, which all affect the reasons why people choose to participate and this was consistent with the volunteering literature. This line of research has not previously been attempted. Whilst motives to participate in the OS community have been investigated overall (Hars and Ou, 2002 and Lakhani and von Hippel, 2003), the influence of the actual participant's life factors, or how the participant's motives may evolve overtime, has not been considered by previous research. By examining the community this way, a much greater understanding of the community can be determined and this provides the avenue to further investigate participant's motives and influences. In terms of Preference Theory and time use, the results do not provide explicit support. The structural changes argument, that people have more flexibility or choices with how one uses their time, was not found as many participants reported a time squeeze with how they want to use their time. Time spent participating in the OS community was very dependent on hours of work, age and living arrangements.

Core Motives theory is supported by the current results, with elements of each of the core motives found. It is not surprising that for a community as successful as the Open Source community these motives would exist. It can be assumed that the core motives would be influenced by the participant's needs and their circumstances, similar to RCT. Certain motives would be more important to some participants than others, and for each participant, the motives importance may change during the course of their involvement. The significance of Core motives theory in the current research is that it helps to explain the fundamental elements that help sustain the source community. These five essential overriding motives can be satisfied through participation in the OS community and were found in the respondent's survey responses. The findings also support both the Side Bets and Norms of Reciprocity theories. It found there was a 'building investment' that comes through participation that strengthens one's commitment. Additionally, the social norms that guide human behaviour in groups is explained by Norms of reciprocity. When you are given or take something, you generally feel obliged to give back. This norm helps to sustain the online community. These two theories also further strengthen the RCT argument, with results revealing that motives in the community change over time. Frequently the motives begin as wanting to satisfy an instrumental need before then evolving to more altruistic motives for participation, increasing the community viability.

In concluding, it is clear that Rational Choice Theory explains the drive to join the community, to satisfy an instrumental need. Core motives theory explains the emotive needs of the individual that can be satisfied through participation. Side Bets explains the investments that are made that lead to increased participation and Norms of Reciprocity explains the behavioural norms that exist that support the community to function. This thesis significantly extends our knowledge of the OS community by explaining who these people are, how their motives for participation differ and the factors that influence these variances. This research clearly demonstrates that you cannot possibly examine the motives of the OS community without firstly investigating the background of the participants', as there is a relationship between the two. In short, this thesis explains what directs the behaviour, what factors affect the intensity/time spent and what contributes to their persistence/on-going participation through the theory framework described.

Overall the results have shown that people have multiple motives and that these depend on their individual circumstance. This thesis provides strong support for Rational Choice Theory and Core motives. Mixed support was found for Preference theory and environmental 273 change as contributing factors for ongoing participation. Preference theory helps to explain the dominance of males in OS, and how the environment has supported this. However, respondents reported wanting less committed and contracted time and a desire for more free time, which contradicts the prior research. Furthermore, the reasons for joining the OS community are different to what sustains participations with motives evolving from more egocentric needs to more community-focused aspects. There was strong support for both Norms of reciprocity and Becker's Side-bets theory with the collateral investments and the desire to contribute being key factors for ongoing participation. This was further supported by the Network analysis, which illustrated how the structure of the community enhances participation through status and reputation building and the ability of the community to satisfy individual's motives as they continue to contribute to the community. Individuals make a rational choice not only when joining the community but also in their ongoing participation, as it provides an environment to satisfy their evolving motives and needs.

The research has revealed a lot about who the OS participants are, and what they want. This research has found that these motives are strongly influenced by the individual's circumstances. The community is predominately male, well-educated and employed in the IT industry. They would generally like to work less and spend more time contributing to the OS. It was also found that motives in the community generally evolve overtime from more egocentric needs to altruistic motives. The Social Network Analysis (SNA) explains the relations in the community, the interactions that foster that 'community'. In a sense, the SNA gives some insight into the long-term viability of the community. Participants get 'hooked' because of the norms, side bets and the community structure.

A limitation of the current research is that it may not be a representative sample of the OS community, despite the considerable response rate for the survey. A systematic random sample is not possible since it is difficult to find populations to define and locate. The survey was opt-in, so the results can only be based on the sample that was captured. Due to the lack of understanding of the population and the relationship amongst the variables (a lack of 274

previous work in the area) this analysis was necessarily descriptive and investigatory, which is why exploratory techniques were used. Structural equation modelling is a confirmatory method (Hair, 1998), and so is not appropriate for this work. Future research building on this work should look to use confirmatory techniques.

Additionally, the social network analysis is limited considerably by the software, which prevents very large numbers of items to be analysed in a significant and measurable way. Further research may wish to explore the contradictory finding that participants think that software should be free whilst believing that they should make money from OS projects. Additionally, it might be valuable to investigate in more detail why so few women are participants in the OS community. Likewise, since the conception of this thesis, there has been major growth in OS - namely the creation of the Android Operating System utilised in mobile phones. In a short period this has become the largest selling smart phone platform in the world. Licensed under the Free and Open Source Software licence since 2008, this has created new and exciting opportunities for Open Source developers to create and modify the software used in mobile phones. This may significantly influence the motivations of Open Source developers, and may be worthy of future research.

Lastly, this thesis offers some precision in the vague and imprecise area of what motivates people to participate in the Open Source community. It provides a theoretical framework that brings together many themes from a wide literature, which increases our ability to investigate such communities.

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APPENDIX 1 DEAKIN UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE

PLAIN LANGUAGE STATEMENT

Open Source Participation Survey

Thank you for taking the time to be part of this study. The questionnaire should take less than fifteen minutes to complete. The results from this survey will help us better understand what motivates people to participate in the Open Source Community **and will contribute to my Doctor of Philosophy thesis.**

The survey covers topics like years of involvement with the Open Source Community and the amount of time you spend contributing to Open Source projects. If you wish you can click 'proceed' and look through the questions before you decide whether or not to participate? If you decide not to participate, just close the browser window.

Should you wish to withdraw your participation at any time during the questionnaire you will need to close the browser without selecting to submit your responses? This will ensure your responses are not collected.

If you would like to obtain a copy of the results or contact the researcher involved please see below.

Ms Lara Thynne BSocSc(Hons) Deakin University 221 Burwood Highway BURWOOD VIC 3125 +61 3 92446365 e-mail larat@deakin.edu.au

To begin the survey please write your e-mail address* and click to proceed.

*We ask for email addresses to make sure people do not complete the questionnaire multiple times. Your e-mail address will never be linked to your answers and will be deleted from our records at the end of the survey.

Should you have any concerns about the conduct of this research project, please contact the Secretary, Ethics Committee, Research Services, Deakin University, 221 Burwood Highway, BURWOOD VIC 3125. Tel (03) 9251 7123 (International +61 3 9251 7123).