WIKI-ENABLED EMERGENT KNOWLEDGE PROCESSES THROUGH ACCELERATION OF STIGMERGIC COLLABORATION

ZHONG YU

MASTER OF PHILOSOPHY

CITY UNIVERSITY OF HONG KONG

DECEMBER 2009

CITY UNIVERSITY OF HONG KONG
香港城市大學

Wiki-enabled Emergent Knowledge Processes through Acceleration of Stigmergic Collaboration
通過促進 “激發工作”式合作進行基于維基的突發式知識管理程序

Submitted to
Department of Information Systems
資訊系統學系
in Partial Fulfillment of the Requirements
for the Degree of Master of Philosophy
哲學碩士學位

by

Zhong Yu
鍾鈺

December 2009
二零零九年十二月

Abstract

As we move further into a knowledge economy, many processes can be labelled as "emergent knowledge processes" (Markus *et al*. 2002; Majchrzak 2006). These processes involve building knowledge in an unstructured and dynamic manner through diverse human participation. Unfortunately, such processes are generally not well supported by existing IT systems, such as executive information systems, expert systems or electronic communication systems (Davenport 2005; McAfee 2006; Wagner 2006). To address the unique requirements of IT systems supporting emergent knowledge processes, this study proposes and evaluates the use of wiki technology and the "wiki way" of collaboration (Leuf and Cunningham 2001; Reinhart 2005). As such, it combines a design theoretic approach (Markus *et al*. 2002) with an empirical evaluation. This research addresses the collaboration in wikis through a new lens by viewing a wiki and its participants as an emergent complex system. Previous work, in contrast, has primarily focused on understanding contributors' activities from a psychological or internal community perspective.

This dissertation draws on the literature of stigmergic collaboration (Grassé 1959; Parunak 2005) which establishes that individuals can collaborate without direct communication if the work product itself represents or contains coordination stimuli. Based on stigmergic theory, the research demonstrates the wiki way as a promising alternative to achieve more effective emergent knowledge processes through the application and acceleration of the mechanism of stigmergy. Stigmergy distinctively relies on the iterative interaction of agent and environment through ongoing and mutual modification or stimulation (Marsh and

Onof 2008). The agents modify the environment through physical manipulation or encode signs directly into or upon it. In turn, the environment plays the role of medium which acts as a cue triggering further actions from agents (Elliott 2007). In such a system, wiki technology and the "wiki way" promise increased efficiency and effectiveness to motivate participants to contribute content collectively. Furthermore, the diversified contributions can be easily integrated into the environment (wiki), thus attracting additional participation. Moreover, on a level above the local interactions of participants and environment, wiki and its participants together can be considered as a stigmergic system. Such a system is often described as "self-organizing" and exhibiting "emergent behaviour" (Parunak 2005; Kelly 1995). In particular, the emergent dynamic is a distinguishing factor of stigmergy. The emergent capacity of stigmergy means that such systems are evolvable, adaptable to the dynamics and able to develop new behaviour.

This dissertation tests the feasibility and effectiveness of the proposed approach through an in-depth investigation of the phenomenon in the context of Wikipedia, one of the most popular and successful wiki applications (Tapscott & Williams 2006). Drawing on the framework of stigmergy, the study systematically identifies significant factors in Wikipedia that harness the principles of stigmergic collaboration based on empirical analysis of longitudinal data from a sample of Wikipedia articles. The "emergent behaviour" in Wikipedia is further evaluated and modelled on the system level based on the data of Wikipedia statistic websites. The statistical results strongly support the research model and expectations. The findings entail significant implications for both research and practice. In terms of research, it provides a better understanding for the underlying mechanism of the wiki way of collaboration by bringing in a stigmergic perspective. It

also identifies critical features in wikis to enable and accelerate stigmergic collaboration. For practice, it offers design guidelines for building up effective wiki collaboration to support emergent knowledge processes.

Table of Contents

CHAPTER 1 1

INTRODUCTION 1

1.1 Research Background 1
1.1.1 Emergent Knowledge Processes 3
1.1.2 Learning from Commons-based Peer Production 6
1.2 Research Questions 13
1.2.1 Collaboration Paradox 15
1.2.2 Sustainability 17
1.3 Dissertation Structure 19

CHAPTER 2 21

STIGMERGIC COLLABORATION 21

2.1 Concept of Stigmergy 21
2.2 Components of Stigmergy 23
2.2.1 Resource-constrained Agents 24
2.2.2 Global Context of Environment 25
2.3 Agent-Environment Interactions 27
2.3.1 Stigmergic Interaction Processes 27
2.3.2 Classes of Stigmergic Interactions 29
2.4 Emergent Intelligence 31

CHAPTER 3 33

THEORETICAL DEVELOPMENT 33

3.1 Principles of Stigmergy Applied in Wikipedia 36
3.1.1 Contribution Activities 36
3.1.2 Marker-based Cue to Contribution Activities 37
3.1.3 Sematectonic Cue to Contribution Activities 44
3.1.4 Moderating Effects 45
3.1.5 Mediating Effects 47
3.2 Sustainability–Emergent Capacity at System Level 50
3.2.1 Growth of Knowledge Asset 52
3.2.2 Overall Quality Improvement 52

CHAPTER 4 54

RESEARCH METHOD 54

4.1 Data Source 54
4.2 Measurement 56
4.2.1. Stigmergic Collaboration in Wikipedia 56
4.2.2. Wiki Site Sustainability 62

CHAPTER 5 64

ANALYSES AND RESULTS 64

5.1 Stigmergic Collaboration in Wikipedia 64
5.1.1 Descriptive Statistics and Correlations of Key Variables 65
5.1.2 Data Analyses 69
5.2 Sustainability 86
5.2.1 Growth in Knowledge Asset 86
5.2.1 Improvement in Quality 89

CHAPTER 6 92

DISCUSSION AND IMPLICATIONS 92

6.1 Discussion of Findings 92
6.1.1 Stigmergic Collaboration in Wikipedia 94
6.1.2 Sustainability 99
6.2 Implications 99
6.2.1 Implications for Theory 99
6.2.2 Implications for Practice 101
6.3 Limitations and Future Study 102

CHAPTER 7 104

CONCLUSION 104

APPENDIX A: Wikiproject Based Quality Assessment Criteria 105

REFERENCES 107

List of Figures

Figure 1. A Design Theory for Systems That Support Emergent Knowledge Processes…….6
Figure 2. Basic Architecture of Stigmergy……..28
Figure 3. Interactions between the Basic Components of Wiki-enabled Stigmergic System…….35
Figure 4. Screenshot of Talk Page Associated with Article ……...39
Figure 5. Screenshot of Wikiproject Banner on Talk Page…….40
Figure 6. Screenshot of Banner Maintenance Template Requiring Citation……...42
Figure 7. Screenshot of Embedded Maintenance Template Requiring Citation…….42
Figure 8. Conceptual Model for Stigmergic Collaboration in Wikipedia……...50
Figure 9. Interaction between Talk Page and Tagged (Dummy variable)……...80
Figure 10. 2SLS Regression Model of Phase II with All Cases…….…….…….....81
Figure 11. Interaction between Talk Page and Volume of Formatting Template…….85
Figure 12. 2SLS Regression Model of Phase II with Tagged Cases……...86
Figure 13. Article Number Growth in GA, A, FA Classes……..90
Figure 14. Proportions of B, GA, A, FA Classes Article Numbers to Total Article Number…....91

List of Tables

Table 1. Comparison among Popular Wikis ….....14
Table 2. Summery of Measurements ……..……..…….…....61
Table 3. Summery of Data Analyses ……..……..……..…….....64
Table 4a. Correlations of Key Variables (Phase I) ……..……..…….....66
Table 4b. Correlations of Key Variables (Phase II) ……...67
Table 5. Multicollinearity Test Results (Phase II) ……..68
Table 6. 2SLS Estimates of Variables Coefficients (Phase I) …….……...……74
Table 7. Single Year 2SLS Estimates of Variables Coefficients (Phase I) ….....75
Table 8. 2SLS Estimates of Variables Coefficients (All Cases in Phase II) …….…….…..…..77
Table 9. Results of Mediation Tests (All Cases in Phase II) ……...……..……...…. 78
Table 10. 2SLS Estimates of Variables Coefficients (Tagged Cases in Phase II) ……..……83
Table 11. Results of Mediation Tests (Tagged Cases in Phase II) ……....……...…….84
Table 12. Regression Results of Wikipedia Growth in Database Size……...……88
Table 13. Comparison for Cubic and Quadratic Models of Wikipedia Growth in Database Size…..88
Table 14. Summery of Hypotheses Testing……....92