



**THE CONTEXT, CONTENT AND PROCESS OF
GREEN INFORMATION SYSTEM INNOVATIONS**

A thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

Mohamad Taha Ijab
Master of Computer Science

School of Business IT and Logistics
College of Business
RMIT University

September 2015

ABSTRACT

This thesis reports an investigation of information system innovations for environmental sustainability. The Information Systems (IS) sub-field concerned with addressing this challenge is known as Green IS and is just beginning to be understood. Green IS is positioned at the interconnection between the economical, social and environmental aspects of sustainable development and it has much to contribute to sustainable outcomes in the face of climate change and other environmental challenges. Green information systems, in addition, refer to specific information system artefacts that organisations create and/or apply to achieve Green goals such as to reduce emissions or to encourage pro-environmental behaviour. On the other hand, Green information system innovation is an integrated and cooperating set of people, processes, software and information technologies to support individual, organisational, or societal goals and serve the purpose of environmental sustainability.

Currently, there is limited research in applying a process perspective to explain the content of Green information system innovation, the factors and forces that affect the innovation process, the intricate process of Green information system creation and application, as well as the outcomes from the use of Green information system innovation. The research therefore poses the following questions: *what is Green information system innovation and why do organisations create and/or apply Green information system innovation, how does the innovation process take place and what are the outcomes from the Green information system innovation?* To address these questions, a literature review covering the domains of organisational innovation, IS innovation and Green IS innovation was conducted. The review led us to adopt the process theory of innovation as well as Pettigrew's (1990) contextualist-processual theory of change with its focus on the "*what, why, and how*" of organisational change as conceptual foundations to facilitate the data collection and analysis, as well as to frame the presentation of the findings.

The investigation was undertaken in a single organisation setting named Telecom Acadia (anonymous), a large telecom operator in the South East Asia region with a focus on four Green information system innovations, namely Energy Informatics, Unified Communications and Collaboration, Sustainable Knowledge Management and Sharing, and Fleet Management Information Systems. An interpretive approach and a qualitative research design were followed to carry out the research. Data was collected through semi-structured interviews with 44 participants, a descriptive survey of 150 participants, and a review of 30 sets of various types of organisational documents. The data was analysed using thematic analysis.

The findings indicate that the four Green information system innovations follow distinct innovation phases and stages through complex and dynamic interactions among the key people that champion and shape the organisation's quest towards environmental sustainability. The research contributes two new Green information system innovation models, namely (1) the Green Information System in Practice Innovation Process Model; and (2) the Green Information System in Spirit Innovation Process Model; and a set of ten testable theoretical propositions for future research. In terms of practical contribution, this research demonstrates the best practices in using information systems for environmental sustainability. Furthermore, this thesis enhances practitioners' understanding by identifying the capabilities and success factors that organisations need to have in order to succeed in Green information system innovation.

Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Mohamad Taha Ijab

21 September 2015

ACKNOWLEDGEMENT

First and foremost, Alhamdulillah. Praise to the Almighty God, I owe my gratitude to Him for the completion of this thesis.

I would like to thank the reader for picking up this thesis. If you find some of it useful, then the whole journey of this thesis research and writing has definitely been made worthwhile.

Many people made it possible for this thesis to exist. They either helped me to discover the particularities of “academic trade”, or to understand my own ways of thinking and feeling.

I must gratefully acknowledge the tremendous help of my senior supervisor, Associate Professor Alemayehu Molla and my associate supervisor, Associate Professor Vanessa Cooper for “holding my hand”, until the very end. For your clear logic, critical thinking and questioning, for your attention to the smallest details, and most of all, for your emotional support. They indeed have gone beyond the call of duty in supporting me throughout my PhD journey. Both of you are amazing supervisors!

The supportive and friendliest of people at the College and School: Prue Lamont, Priyanka and Kalpana. The officers at the SGR: Erin, Belinda, Ellie and Kathy; the past and current HDR Coordinators: Sayyen and Konrad. Without whom, I would be lost in the administrative paperworks and process flows.

I am also grateful to my research participants at Telecom Acadia who provided resources and information useful for my research. Without their input, this thesis will never be possible. To my sponsor, MARA, thank you for the financial assistance and consideration in allowing me to complete my education in Melbourne.

The colleagues and friends from whom I learned a great deal during these years especially my good friends Rodney, Ploy, Hoa, and Ahmed. Not forgetting my ever supportive RMIT brothers and sisters: Sharina, Siti, Kuzah, Umar, Darius, Ming, Ong and Cenie. You all were a great group of colleagues and friends from the first day of my entering the PhD Programme, to the very last days of finalising my thesis. I am grateful for all the assistance, for every piece of advice, and every cup of coffee.

This thesis is also a work of gratitude to the wonderful constellation of my beloved family members and friends:

To Fatehah, who keeps on encouraging me with kind words.

To Dr. Sue Hamid and Naqiu who believe in me, never tirelessly motivate and support me right from the beginning until now. Thanks for all the prayers, God bless you!

To all my brothers, sisters, brothers- and sisters-in-laws, nephews and nieces who provide me with tender support and love.

Finally, I would like to thank my beloved parents: Hj. Ijab and Hjh. Saonah, this thesis is due to both of you.

LIST OF PUBLICATIONS DURING CANDIDATURE

- | Year | Publications |
|------|---|
| 2012 | <ol style="list-style-type: none">1. Ijab, M. T., Molla, A. and Cooper, V. A. (2012). <i>Green Information Systems (Green IS) Practice in Organisations: Tracing its Emergence and Recurrent Use</i>. 18th Americas Conference on Information Systems (AMCIS2012), 9-11 August 2012, Seattle, Washington, USA.2. Molla, A., Ijab, M. T., and Cooper, V. A. (2012). <i>Information Systems Based Energy Management Practices at Telecom Acadia</i>. Green IT Working Papers, Green IT Observatory, RMIT University. |
| 2011 | <ol style="list-style-type: none">3. Ijab, M. T., Molla, A., and Cooper, V. A. (2011). <i>A Theory of Practice-Based Analysis of Green Information Systems (Green IS) Use</i>. Australasian Conference on Information Systems (ACIS2011), 30 Nov – 2 December 2011, Sydney, Australia.4. Ijab, M. T., and Molla, A. (2011). <i>The Study of Green Information Systems Use from the Theory of Practice Perspective</i>. Mediterranean Conference on Information Systems (MCIS2011), 3 – 5 September 2011, Limassol, Cyprus.5. Ijab, M. T. (2011). <i>Studying Green Information Systems as Practice</i>. Proceedings of SIGGreen Workshop. Sprouts: Working Papers on Information Systems, 11(16). |
| 2010 | <ol style="list-style-type: none">6. Ijab, M. T., Molla, A., Kassahun, A. E., and Teoh, S. Y. (2010). <i>Seeking the “Green” in “Green IS”: A Spirit, Practice and Impact Perspective</i>. The 14th Pacific Asia Conference on Information Systems (PACIS2010), 9-12 July 2010, Taipei, Taiwan. |

TABLE OF CONTENTS

ABSTRACT.....	ii
DECLARATION OF ORIGINALITY.....	iv
ACKNOWLEDGEMENT.....	v
LIST OF PUBLICATIONS DURING CANDIDATURE.....	vi
TABLE OF CONTENTS.....	vii
LIST OF FIGURES.....	xi
LIST OF TABLES.....	xiii
CHAPTER 1 : BACKGROUND TO INFORMATION SYSTEMS INNOVATION FOR SUSTAINABILITY	1
1.1 INTRODUCTION.....	1
1.2 BACKGROUND TO THE RESEARCH PROBLEM.....	4
1.3 RESEARCH RATIONALES AND QUESTIONS.....	6
1.4 RESEARCH OBJECTIVES AND SCOPE.....	13
1.5 RESEARCH DESIGN.....	13
1.6 FINDINGS AND CONTRIBUTIONS.....	15
1.7 THESIS ORGANISATION.....	15
CHAPTER 2 : LITERATURE REVIEW	17
2.1 INTRODUCTION.....	17
2.2 THE CONCEPTION OF INNOVATION.....	17
2.3 APPROACHES TO STUDYING THE ORGANISATIONAL INNOVATION PROCESS.....	22
2.3.1 The Diffusion of Innovation (DoI).....	22
2.3.2 Organisational Innovativeness (OI).....	23
2.3.3 The Process Theory of Innovation (PT).....	24
2.4 DRIVERS OF INNOVATION.....	36
2.4.1 Institutional Perspective.....	36
2.4.2 Strategic Choice Perspective.....	38
2.4.3 Technology-Organisation-Environmental (TOE) Perspective.....	38

2.4.4 Contextualist-Processual Perspective.....	39
2.5 OUTCOMES OF INNOVATION.....	41
2.6 RESEARCH IMPLICATIONS.....	43
CHAPTER 3 : A CONCEPTUAL FRAMEWORK FOR INVESTIGATING GREEN IS INNOVATIONS.....	45
3.1 INTRODUCTION.....	45
3.2 UNDERLYING THEORY.....	46
3.3 INITIAL CONCEPTUAL FRAMEWORK.....	47
3.3.1 The Content of Green IS Innovation.....	49
3.3.2 The Context of Green IS Innovation.....	54
3.3.3 The Process of Green IS Innovation.....	58
3.3.4 The Outcome of Green IS Innovation.....	63
3.4 CHAPTER SUMMARY.....	65
CHAPTER 4 : METHODOLOGY.....	66
4.1 INTRODUCTION.....	66
4.2 RESEARCH PHILOSOPHY AND PARADIGM: THE ONTOLOGICAL AND EPISTEMOLOGICAL POSITIONS.....	66
4.3 RESEARCH METHOD.....	73
4.3.1 Case Study.....	74
4.4 DATA COLLECTION.....	76
4.4.1 Study Phases, Participant Selections, and Interview.....	76
4.4.2 Archival Documents.....	81
4.4.3 Survey.....	81
4.5 DATA ANALYSIS.....	82
4.5.1 Data Transcribing.....	82
4.5.2 Data Coding.....	82
4.6 RESEARCH TRUSTWORTHINESS.....	101
4.7 CHAPTER SUMMARY.....	105

CHAPTER 5 : CASE FINDINGS	106
5.1 INTRODUCTION.....	106
5.2 RESEARCH SETTING.....	106
5.2.1 Introduction to Telecom Acadia	106
5.2.2 Vision and Mission of Telecom Acadia	108
5.2.3 Organisation Structure of Telecom Acadia	109
5.2.4 Telecom Acadia’s Environmental Sustainability Journey	111
5.2.5 Details of Research Participants and Organisational Documents.....	113
5.3 CASE 1: ENERGY INFORMATICS.....	120
5.3.1 Introduction to the EI Innovation.....	120
5.3.2 The Context of EI Innovation in Acadia	121
5.3.3 The Content of EI Innovation at Acadia	124
5.3.4 The Process and Mechanisms of EI Innovation at Acadia	133
5.3.5 The Outcomes of EI Innovation for Acadia	145
5.3.6 The EI Innovation Process Model.....	147
5.4 CASE 2: UNIFIED COMMUNICATIONS AND COLLABORATION (UCC).....	149
5.4.1 Introduction to the UCC Innovation	149
5.4.2 The Context of UCC Innovation in Acadia	150
5.4.3 The Content of UCC Innovation at Acadia	154
5.4.4 The Process and Mechanisms of UCC Innovation at Acadia.....	158
5.4.5 The Outcomes of the UCC Innovation for Acadia	174
5.4.6 The UCC Innovation Process Model	176
5.5 CASE 3: SUSTAINABLE KNOWLEDGE MANAGEMENT AND SHARING (SKMS).....	178
5.5.1 Introduction to the SKMS Innovation.....	178
5.5.2 The Context of SKMS Innovation in Acadia	179
5.5.3 The Content of the SKMS Innovation at Acadia	181
5.5.4 The Process and Mechanisms of SKMS Innovation at Acadia	187
5.5.5 The Outcomes of SKMS Innovation for Acadia.....	198
5.5.6 The SKMS Innovation Process Model.....	201
5.6 CASE 4: FLEET MANAGEMENT SYSTEM (FMS).....	203

5.6.1 Introduction to the FMS Innovation.....	203
5.6.2 The Context of the FMS Innovation in Acadia.....	204
5.6.3 The Content of the FMS Innovation at Acadia.....	207
5.6.4 The Process and Mechanisms of FMS Innovation at Acadia.....	211
5.6.5 The Outcomes of the FMS Innovation for Acadia.....	225
5.6.6 The FMS Innovation Process Model.....	227
5.7 CHAPTER SUMMARY.....	229
CHAPTER 6 : CROSS-CASE ANALYSIS AND DISCUSSION.....	230
6.1 INTRODUCTION.....	230
6.2 CROSS-CASE ANALYSIS.....	230
6.3 GREEN IS INNOVATION PROCESS MODELS.....	253
6.3.1 Green IS in Practice Innovation Process Model.....	254
6.3.2 Green IS in Spirit Innovation Process Model.....	263
6.4 CHAPTER SUMMARY.....	270
CHAPTER 7 : CONCLUSION.....	271
7.1 INTRODUCTION.....	271
7.2 OVERVIEW OF THE RESEARCH.....	271
7.3 REVISITING THE RESEARCH QUESTIONS.....	272
7.4 RESEARCH CONTRIBUTIONS.....	277
7.5 RESEARCH LIMITATIONS AND FUTURE STUDIES.....	280
7.6 CONCLUDING REMARKS.....	282
REFERENCES.....	283
APPENDICES.....	307
Appendix 4.1: Ethics Approval.....	307
Appendix 4.2: Plain Language Statement for Data Collection.....	308
Appendix 4.3: Consent Form.....	310
Appendix 4.4: Interview Questions for Phase 1.....	311
Appendix 4.5: Interview Questions for Phase 2.....	317
Appendix 4.6: Survey Questions for Phase 2.....	319
Appendix 5.1: Detailed Description of the Fleet Management System (FMS).....	321

LIST OF FIGURES

Figure 2.1 - Process Framework on antecedent conditions, events, and outcome of Leadership in IS development project.	27
Figure 2.2 - Process of Organisational Change Around CASE Tools	28
Figure 2.3 - Sequence of Events in IS development process	30
Figure 2.4 - Process Model of IS Implementation for CRM.....	31
Figure 2.5- Process Model of IS/IT adoption and evaluation decision making process.	32
Figure 2.6- Process Model of the Attainment and Enactment of Green Leadership	33
Figure 2.7 - Process Model of Effective Improvisation.....	34
Figure 3.1– Proposed Conceptual Framework	48
Figure 5.1– Telecom Acadia’s Organisation Structure.....	110
Figure 5.2 - Acadia’s Electricity Cost in AU\$ Million for 2006 - 2010.....	123
Figure 5.3- BAS and IBMS Architecture.....	127
Figure 5.4 - ES2 Architecture.....	129
Figure 5.5 - Energy Informatics Architecture	132
Figure 5.6 – Building Measurement Capability Phase of Energy Informatics Innovation	134
Figure 5.7– Energy Measurement and Monitoring Phase of Energy Informatics Innovation.....	138
Figure 5.8 – Energy Management Phase of Energy Informatics Innovation	143
Figure 5.9 - Energy Informatics Innovation Process Model	148
Figure 5.10- Sample of Acadia R&D Technology Roadmap	152
Figure 5.11 - Gartner’s UCC Hype Cycle.....	153
Figure 5.12 – UCC Phase of UCC Innovation	159
Figure 5.13– Metastructuring of UCC as SCC Phase of UCC Innovation	166
Figure 5.14– Acadia’s Green IT Framework.	169
Figure 5.15- The inclusion of UCC as one of the Green IT’s End User Computing Solutions.....	170
Figure 5.16 –SCC 2.0 Phase of UCC Innovation	172
Figure 5.17- UCC Innovation Process Model	177

Figure 5.18 - SKMS System Components	184
Figure 5.19 – Document and Application Management Phase of SKMS Innovation ..	188
Figure 5.20 – Environmental Campaign Enablement Phase of SKMS Innovation.....	192
Figure 5.21 - SKMS Innovation Process Model.....	202
Figure 5.22 - Fuel Price Trend from 2000 to 2011	205
Figure 5.23 - Fleet Management System and Relationships Among its Components .	209
Figure 5.24 – Asset and Cost Management Phase of FMS Innovation	213
Figure 5.25 – Behaviour Management Phase of FMS Innovation	217
Figure 5.26 - Use Management Phase of FMS Innovation	222
Figure 5.27 - GHG emissions from company-owned vehicles from fuel purchases (Source: Acadia Sustainability Report 2012).....	226
Figure 5.28- Fleet Management System (FMS) Innovation Process Model.....	228
Figure 6.1- Green IS in Practice Innovation Process Model.....	255
Figure 6.2- Green IS in Spirit Innovation Model	265

LIST OF TABLES

Table 2.1 - Summary of the Conception of Innovation	21
Table 2.2 - Summary of IS Literature Employing Process Theory of Innovation	35
Table 4.1 - Summary of different research philosophical assumptions in IS research (Based on (Pather & Remenyi, 2004)).....	67
Table 4.2 - Application of the interpretivist principles in this research.....	72
Table 4.3 - Research Participants (Interviews) from Phase One.....	78
Table 4.4 - Research Participants (Interviews) from Phase Two	79
Table 4.5– List of the Original Category and Themes for Content of Green IS Innovation from the Conceptual Framework	84
Table 4.6– List of the Generated Thematic Coding for Content of Green IS Innovation	85
Table 4.7 – Sample of Thematic Coding for Content of Green IS Innovation	87
Table 4.8– List of the Original Category and Themes for Context of Green IS Innovation from the Conceptual Framework	88
Table 4.9– List of the Generated Thematic Coding for Context of Green IS Innovation	89
Table 4.10 -Sample of Thematic Coding for Context of Green IS Innovation	91
Table 4.11 - List of the Original Category and Themes for Process of Green IS Innovation from the Conceptual Framework	92
Table 4.12– List of the Generated Thematic Coding for Phase, Stages, and Events Themes of Process of Green IS Innovation.....	96
Table 4.13 – Sample of Thematic Coding for Process of Green IS Innovation.....	97
Table 4.14– List of the Original Category and Themes for Outcome of Green IS Innovation from the Conceptual Framework	98
Table 4.15– List of the Generated Thematic Coding for Event Theme of Outcome of Green IS Innovation.....	100
Table 4.16 - Sample of Thematic Coding for Outcome of Green IS Innovation	101
Table 4.17 - Strategies taken to ensure ‘trustworthiness’ in this research	104
Table 5.1 - Telecom Acadia’s Environmental Performance	112
Table 5.2 – Summary of Research Participants Interviewed for the Research	117

Table 5.3– Summary of Organisational Documents Collected and Used for the Research	119
Table 5.4 - Summary of Acadia’s Energy Informatics	125
Table 5.5 - Energy Informatics Innovation Characteristics	133
Table 5.6 - Outcomes of Energy Informatics at Acadia.....	146
Table 5.7 - Summary of Acadia’s Unified Communications and Collaboration	155
Table 5.8 - Unified Communication and Collaboration Innovation Characteristics	158
Table 5.9 -UCC Diffusion Among Acadia Staff	164
Table 5.10 - Outcomes of Unified Communications and Collaboration at Acadia.....	174
Table 5.11 - Summary of Acadia’s Sustainable Knowledge Management and Sharing	182
Table 5.12 - Sustainable Knowledge Management and Sharing Innovation Characteristics	187
Table 5.13 -SDAM Diffusion Among Acadia Staff.....	196
Table 5.14- MyEarth Portal Diffusion Among Acadia Staff	197
Table 5.15 - Outcomes of Sustainable Knowledge Management and Sharing at Acadia	199
Table 5.16- Summary of Acadia’s Fleet Management Systems	208
Table 5.17- Fleet Management System Characteristics	212
Table 5.18- Outcomes of Fleet Management Systems at Acadia.....	225
Table 6.1- Cross-Case Summary for the Content of Green IS Innovations Category Across the Four Cases.....	234
Table 6.2 - Cross-Case Summary for the External Context of Green IS Innovations Category Across the Four Cases.....	236
Table 6.3 - Cross-Case Summary for the Internal Context of Green IS Innovations Category Across the Four Cases.....	239
Table 6.4 - Cross-Case Summary for Innovation Process Across the Four Green IS Cases	248
Table 6.5 - Cross-Case Summary for Innovation Outcome Across the Four Green IS Cases	252
Table 6.6 - The main characteristics of Green IS in Spirit and Green IS in Practice Innovation Models	253

CHAPTER 1 : BACKGROUND TO INFORMATION SYSTEM INNOVATION FOR SUSTAINABILITY

1.1 INTRODUCTION

In a book entitled “Global Climate Change Impacts in the United States”, Karl, Melillo and Peterson (2009) claim that the global climate is changing, temperature and sea levels are rising, glaciers are retreating, and occurrences of extreme weather events are increasing. It was further argued that the scientifically recognised culprit is human-induced emissions of heat-trapping gases (Karl et al., 2009). In 2009, the U.S. Department of Defence classified global warming as a national security threat due to the prospect of dealing with the effects of violent storms, drought, mass migration, and pandemics (Broder, 2009). Thus, environmental issues are of a growing global concern in all fields of inquiry including the Information System (IS) community. This is further compounded by the research findings of the United Nation’s Intergovernmental Panel on Climate Change (IPCC) who claim that the use of Information and Communication Technology (ICT) consumes energy, and energy production releases Green House Gases (GHG) are a major cause of global warming and potentially damaging climate change (IPCC, 2012). However, IS researchers such as Hilpert, Kranz and Schumann (2014) and Watson, Boudreau and Chen (2010) argue that IS discipline has been slow to acknowledge the problem of global warming and identify the potential of IS to address this environmental challenge. The IS community and IS researchers are therefore suggested to engage in research addressing the ‘grand challenges’ of global warming, climate change and environmental sustainability (Hovorka & Corbett, 2012; Watson, Williamson, Boudreau, Li, & Zeng, 2011).

In the last few decades, information system and information technology (e.g., the Web, personal computers, and cell phones), have changed human behaviour greatly and therefore can be seen as having the potential to support the shift to a sustainable society (Esfahani, Nilashi, Abdul Rahman, Ghapanchi, & Zakaria, 2015; Nolan & Varey, 2014;

Watson, Boudreau, & Chen, 2010). As a result, the role and contribution of IS in eco-sustainability have become the concern of many IS researchers. Moreover, the IS community is seen to be increasingly interested in elevating the role of socio-technical systems in reversing the current trajectory of environmental degradation (Melville, 2010).

According to Hasan, Molla and Cooper (2014), Green IS is a specialisation within the field of Information Systems (IS) that encapsulates the responsibility of IS researchers and practitioners towards environmentally sustainable development. Many IS scholars agree that IS can be turned into key enablers for activities that drive the mitigation of, and adaptation and resilience to climate change (Aoun, Vatanasakdakul, & Cecez-Kecmanovic, 2011; Melville, 2010). Boudreau, Chen and Huber (2008) distinguished Green IS from the more widely used term of “Green IT” by claiming that Green IT is seen as a major contributor to Green House Gases (GHG) emissions and takes a negative view of IT as an energy consumer. In contrast, Green IS is described as “the design and implementation of information systems that contribute to sustainability of business processes” tackling a much larger problem in a positive and valuable manner (Boudreau et al, 2008).

As a convention to be applied throughout this thesis, “Green IS” will be used to refer to the field of study within IS, Green IS researchers and scholars, Green IS as a body of knowledge, and Green IS initiative and strategy. On the other hand, “Green information system” will be used as a convention which refers to information system artefacts that organisations create and/or apply to achieve a green goal such as to reduce emission and encourage pro-environmental behaviour. Another important term is “Green information system innovation” which can be defined as “an integrated and cooperating set of people, processes, software, and information technologies to support individual, organisational, or societal goals” (Watson, Boudreau, & Chen, 2010, p. 24) that serve the environmental sustainability purpose. In this thesis, the term **Green information system innovation** will be used to discuss the innovation process of a single or a specific Green information system artefact such as the Energy Informatics innovation. However, when the thesis discusses the innovation process of multiple innovations such as the Energy Informatics, Unified Communications and Collaboration, Sustainable Knowledge Management and Sharing, and Fleet Management Information System, the term **Green information system innovations** will be used.

Green information system innovations present unique challenges to organisations (Malhotra, Melville, & Watson, 2013). As a result, there is a call for IS researchers and practitioners to consider process-related concepts when examining the role of information systems in the transformation towards sustainable organisations (Seidel & Recker, 2012). This allows not only understanding of the transformative power of technological systems in the context of sustainable development, but also the proceeding towards more prescriptive and normative advice to guide the implementation of sustainable IT-enabled business processes (Seidel & Recker, 2012). There is also a need for guidelines to those organisations unsure about how, where, and when they can create and/or apply information systems to improve their environmental sustainability. Nevertheless, according to Hasan et al. (2014, p. 101), there is “a scarcity of work published in the IS literature to date that deal with topics of incorporating Green issues into the design and development of information systems.” This research thesis has therefore taken a process perspective to explain Green information system innovation. This research will investigate Green information system innovation from the context, content, and process perspectives. From the context perspective, both external and internal factors driving or influencing Green information system innovation will be elaborated. From the content perspective, the content of Green information system innovation will be described through the green “spirit” given to the information system by the system developers, its interpretive flexibility and the type of Green information system innovation. Lastly, from the process perspective, the process of Green information system innovation is explained through stages, people, time and critical events. These three overarching perspectives are further elaborated in Section 3.3 of Chapter 3.

In the following sections, the background to the research problem and rationales motivating this research are covered in more detail (Section 1.2 and Section 1.3, respectively). In Section 1.4, research questions were developed based on the research rationales and this is followed by the discussion of the research objectives and scope. Then a brief summary of the research design (Section 1.5) as well as the findings and contributions of the thesis (Section 1.6) are presented and discussed. The chapter concludes with the organisation of the entire thesis in Section 1.7.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

The continuous growth of the world's population and the increasing demand for higher living standards are leading to the exploitation of natural resources and the pollution of the environment on an unprecedented scale (Hart, 1997). While the exploitation of natural resources (e.g., deforestation for farming or commercial logging) is necessary for supporting human and business needs, the ability of future generations to meet their needs remains uncertain (Hart & Milstein, 1999). Nevertheless, the deterioration of natural resources poses not only risks but also opportunities for business organisations (Melville, 2010). In today's business environment, shareholders, regulatory agencies, customers and employees are increasingly demanding that business organisations adopt a systematic approach to the sustainable management of scarce resources and to reduce their impact on the environment while at the same time pursuing their commercial objectives (Ayande, Sabourin, & Moreno, 2015; Chen, Boudreau, & Watson, 2008; Winnard, Adcroft, Lee, & Skipp, 2014). Thus, the increasing awareness about the long-term effects of human and business activities on the natural environment and the pace and magnitude of environmental deterioration have put businesses under increasing pressure to engage in environmentally sustainable practices (Bocken, Farracho, Bosworth, & Kemp, 2014; Hart & Milstein, 1999; Issa, Chang, & Issa, 2010). As a result, eco-sustainability is becoming a strategic imperative in many industries such as manufacturing, oil and gas, logistics, agriculture, forestry and the ICT industry (Hart & Milstein, 1999).

The concept of eco-sustainability has stemmed from sustainable development. The Brundtland Commission defines sustainable development as "development that meets the needs of the present world, without compromising the ability of future generation to meet their own needs," (Brundtland, 1987, p. 8). Sustainability has three dimensions – economic, social and ecological. This research focuses on information system's role on promoting eco-sustainability. Starik and Rands (1995, p. 909) describe eco-sustainability as "the ability of one or more entities, either individually or collectively, to exist and flourish (either unchanged or in evolved forms) for lengthy timeframes, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in isolated systems". Generally, eco-sustainability is concerned with

minimising emissions, waste and water, improving efficiency and minimising the total environmental footprint of a business (Hart, 1995). This means eco-sustainability requires an effective integration and action at multiple levels (individuals and organisations) and various systems (societies, cultures, political and economic) for the benefits of existing and future generations (Chen, Watson, Boudreau, & Karahanna, 2011; Ryan, Mitchell, & Daskou, 2012; Sarkar, 2013).

Technology, both as a source of problem and solution, is increasingly becoming linked to eco-sustainability. On the problem side, although Information and Communication Technologies (ICTs) have made significant contributions to business innovation and wealth generation (Schein, 1989), some opine that ICTs might have had the unintended consequence of accelerating environmental deterioration by facilitating the creation and expansion of pollution generating businesses (Chen, et al., 2008). It is estimated that 2 percent of global CO₂ emissions can be attributed to the ICT industry's (all commercial and governmental IT and telecommunications infrastructure) use of IT artefacts (Mingay, 2007). Thus, technology and technological artefacts need to be designed and used with principles of environmental sustainability (Huang, 2009; Sproedt, Plehn, Schonsleben, & Herrmann, 2015; Zhang, Liu, & Li, 2011). On the solutions side, technological innovations in genomics, nanotechnology, information technology, and renewable energy provide a vast opportunity to promote eco-sustainability (Hart & Milstein, 2003). These technologies are considered to have the potential to reduce the human footprint on the planet. For example, IT can be designed to minimise resource depletion through digitisation of physical products and by developing energy efficient business and social processes and practices (Bibri, 2009; Mingay, 2007). Innovation and technological change are therefore keys to the pursuit of sustainable development. This research will focus on the role (solution) of information systems (IS) and information technology (IT) in eco-sustainability.

Despite claims that information systems can play a significant role in eco-sustainability, there is a dearth of rigorous and empirical research in the area. In particular, there is a need for an investigation of:

1. the proactive strategic approach which may offer opportunities to illustrate the transformative power of information systems to eco-sustainability (Malhotra, Melville, & Watson, 2010, 2013; Watson, Boudreau, & Chen, 2010);
2. the role of IS in sustainability taken from the innovation process dimensions of the sustainability portfolio (pollution prevention, product stewardship, clean technology, and sustainability vision) (Hart, 1997; Hart & Milstein, 2003); and
3. the role of IS in achieving the three eco-sustainability goals: eco-efficiency (DeSimone & Popoff, 1997), eco-equity (Gray & Bebbington, 2000), and eco-effectiveness (McDonough & Braungart, 1998).

This research aims to respond to some, if not all, of these needs and contribute to information systems research in general and to the “Green IS” sub-research in particular.

1.3 RESEARCH RATIONALES AND QUESTIONS

In the intersection between eco-sustainability and IS and IT, two constructs are in common use - “Green IT” and “Green IS”. Some view IT as a polluter and use Green IT to highlight the practices and responsibility of IT professionals and the industry to do something about it (Cooper & Molla, 2014; Mann, Grant, & Mann, 2009; Molla, Abareshi, & Cooper, 2014). Green information system, on the other hand, is commonly used to refer to information systems inducing changes in business processes such as production activities to improve (i.e., by decreasing) their environmental impacts (Boudreau, Chen, & Huber, 2007). Green information system also refers to the use of information systems to encourage individuals and organisations to make more sustainable behavioural choices (York, Watson, Boudreau, & Chen, 2009). On a bigger scale, information system innovations have the transformative power to create an environmentally sustainable society and this capability is called “Green information system” (Seidel, Recker, & vom Brocke, 2012; Watson, Boudreau, & Chen, 2010).

When this research was started in end 2009 and early 2010, research in Green information system was relatively new (Chen, et al., 2011; Melville, 2010; Watson, Boudreau, & Chen, 2010). Due to its relative newness, not much has been understood about Green

information system. Even its definition was widely contested. The rationale for this research was formulated based on research needs identified in early 2010 as described in Sections 1.3.1 – 1.3.3.

1.3.1 Lack of Clarity about Green Information System Innovations

The concept of environmental sustainability has been increasingly addressed in highly recognised information system (IS) journals, e.g. *MIS Quarterly*, *Business & Information Systems Engineering*, *Journal of Strategic Information Systems*, *Communications of the ACM* and the *Harvard Business Review* since 2009 (Chen, et al., 2011; Elliot, 2011; Melville, 2010; Seidel, Recker, & vom Brocke, 2013; vom Brocke, Seidel, & Recker, 2012; Watson, Lind, & Haraldson, 2012). This scientific discourse has led to the creation and recognition of information system innovations that facilitate environmental sustainability within processes, products and services (vom Brocke, et al., 2012). However, researchers such as Grant and Marshburn (2014) claim that Green information system is still in its infancy and has only just begun to be understood and implemented by organisations. It is also highlighted that there are relatively few organisations innovating Green information system (Melville, 2010) and hence, more research needs to be conducted to understand this situation.

Elliot (2011) provides an extensive review of the state of IS-focused environmental sustainability and lobbies for more theory-based research. In a special edition of the *Journal of Strategic Information Systems*, authors provide theory-based research on firms' readiness to undertake Green information system innovations (Bose & Luo, 2011), integrate sustainability (Dao, Langella, & Carbo, 2011), design systems (Zhang, et al., 2011), and innovate (Bengtsson & Agerfalk, 2011). While these studies help explain the subject phenomena, the "content" aspect describing the actual substance and/or the technological artefacts of Green information system innovations and the decision for organisations to implement green initiatives or create and/or apply green systems has not been widely addressed. In the introduction to the *MIS Quarterly* Special Issue on IS & Environmental Sustainability in December 2013, Malhotra, Melville, and Watson (2013) found that only fourteen articles published in leading IS journals between 2008 and 2013 were related to the use of information system for environmental sustainability. The

authors reiterate an urgency for the IS community to address this relevant issue and recommend a “Green team” (Malhotra, et al., 2013, p. 1271) with dedicated special editors to ensure “promoting and publishing impactful green IS research” (Malhotra, et al., 2013, p. 1270).

According to Ijab, Molla, Kassahun, and Teoh (2010), what differentiates the content (i.e., the actual substance and/or the technological artefact) of Green information system from conventional information systems remain unclear at most, and illusive at best. In order to address the lack of understanding on what constitutes the content of Green information system, Ijab et al. (2010) adopted Orlikowski’s (1992) technical point of view about information systems, which considered an information system as an “engineered artefact” expected to do what it is designed for. It was also posited that the content of Green information system is composed of the softer view of information systems seen from the (1) “spirit” which refers to the human values embodied in the structural properties and functional capabilities of a given information system (DeSanctis & Poole, 1994, p. 126); and (2) “interpretive flexibility” which refers to the degree in which users have appropriated a given information system either faithfully (i.e., as intended) or unfaithfully (unintended) (Orlikowski, 1992). There are also other studies such as that by Mines (2011) who identify six types of sustainability software, namely the sustainability performance and project management software, enterprise carbon and energy management software, sustainable product development software, sustainability knowledge and learning management software, collaboration and communications software, and smart infrastructure management software. However, a more thorough investigation of what constitutes the content of Green information system is needed.

Additionally, the use of Green information system innovations can be driven by a different agenda (and associated strategies) compared to conventional information systems (Boudreau, et al., 2007; Olson, 2008). Investment in and use of information systems are generally driven by the business needs and/or economic performance such as the return on investment (ROI), market share, cost, productivity analysis, and profitability (Grover, Purvis, & Coffey, 2005). Other factors driving the use of information systems include the influence of information systems to impact on organisational structure, change, efficiency, responsiveness, increased decision-making quality, coordination, flexibility, productivity, quality of work life, and customer service delivery (Grover, et

al., 2005). Although eco-sustainability has strategic implications in regards to production economics, cost competitiveness, investment decisions and asset valuation (Boudreau, et al., 2007; Enkvist, Naucler, & Rosander, 2007), “Green information system” can be driven by environmental needs beyond economic needs (York et al., 2009; Watson et al., 2010; Melville, 2010; Boudreau et al., 2007). Examples of IS that can be used to meet environmental needs include initiatives like the development of analytical tools that support dynamic routing of vehicles to reduce energy consumption (Boudreau et al., 2007), the use of telematics in the logistics industry (Watson, Boudreau, Li, & Levis, 2010), the implementation of environmental management systems (Wernick, 2002) and the substitution of carbon emitting business practices such as business travels through videoconferencing, teleworking and other online communications and collaboration facilities (Ghose, Hasan, & Spedding, 2008; Hasan, Molla, & Cooper, 2014; Toffel & Horvath, 2004; York, et al., 2009). Based on the abovementioned examples, it is conjectured that the use of “Green information system” as a practice can have both economic (e.g., impact on cost and productivity) and ecological (e.g., impact on the natural environment and future generations) consequences.

However, in the increasing number of literature on “Green IS”, there have been limited studies that clearly explain what (i.e., the content of Green information system innovations) and why organisations embark on Green information system innovations (as the Green information system innovation process unfolds over time). Instead, most studies are investigating factors in Green information system adoptions without explaining how the factors came about for the organisation. As such, a thorough study in explaining the content of Green information system innovations and why organisations create and/or apply Green information system innovations from the factors within the organisation (i.e., the internal motivating factors such as the leadership of top management, the desire to be green, the need to cut operational cost, etc.) as well as factors from outside the organisation (i.e., the external driving factors such as the industry, government, consultants, suppliers, and other stakeholders) is needed. This leads to the first research question:

Research Question 1: *What is Green information system innovation and why do organisations create and/or apply Green information system innovation?*

1.3.2 Lack of Understanding about the Green Information System Innovation Process

Green information system involves innovation but not necessarily invention (a totally new innovation). According to Hasan et al. (2014, p. 101), there is “a scarcity of work published in the IS literature to date that deal with topics of incorporating green issues into the design and development of information systems.” This research hopes to contribute to enriching the IS literature in general, and Green IS literature in particular, regarding how green issues can be incorporated into the design and development of information systems.

For Green information system innovation to be successfully conceived, developed, implemented, adopted and evaluated, it is important to have a clear understanding of what constitutes the Green information system innovation process. This is brought about by clarifying the concept of innovation itself, and how the similar or differing traits of innovation are related to the Green information system innovation process. The desire to innovate is integral to the human condition (Wellstead, 2003). However, what prompts the urge to create, to change, to invent, and what the process of innovating is perceived as is a “black box” (Wellstead, 2003). Thus, this thesis aims to explain the complex process surrounding Green information system innovation.

While the innovation process is widely discussed in organisational innovation (Damanpour, 1991; Pelz, 1985; Wolfe, 1994) and information system innovation (Madon, 1993; Orlikowski, 1993), Green information system innovation processes are still less researched and published. This could be due to the limited actual research done on unearthing how Green information system is created and applied in detail from a process perspective. While there are some Green information system innovation process studies (Pernici, Ardagna, & Cappiello, 2008; Seidel & Recker, 2012; Tan, Pan, & Zuo, 2011), those are focusing on the Green information system business process and Green leadership process. Furthermore, current research on Green IS is largely investigating the factors of Green information system adoption or those that theorise on Green information system phenomenon from either a functional or practice perspective (Babin & Nicholson, 2009; Ijab, 2011; Ijab, Molla, & Cooper, 2012). There exist limited studies that focus on understanding the complex organisational Green information system innovation process

through explanation of the series of actions and steps, as seen from the stages, events, people, and the strategies used in innovating the Green information system. Thus, we pose the following question:

Research Question 2: *How does the Green information system innovation process take place in organisations?*

1.3.3 Limited Understanding of the Benefits or Outcomes of Green Information System Use for Eco-sustainability

The relationship between the use of technology and the broader eco-sustainability goals is not well understood (Berkhout & Hertin, 2004). Many studies focus on the adoption and diffusion of information systems without differentiating their environmental impact (Chen, et al., 2008; Seidel, Szekely, & vom Brocke, 2015). The benefits or outcomes of technological use in the pursuit of eco-sustainability can be framed using the three eco-sustainability goals: (1) eco-efficiency (DeSimone & Popoff, 1997); (2) eco-equity (Gray & Bebbington, 2000); and (3) eco-effectiveness (McDonough & Braungart, 1998).

Eco-efficiency refers to a business's ability to deliver competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts" (DeSimone & Popoff, 1997, p. 47). *Eco-equity* focuses on the equal rights of people for environmental resources and a business's 'social responsibility' for future generations (Gray & Bebbington, 2000). *Eco-effectiveness* generally attempts to stop the contamination and depletion of natural resources by directing individual and organisational attention to the underlying and fundamental factors of environmental problems through a fundamental redesign of the system (McDonough & Braungart, 1998). However, according to Abukhader (2008), the term *eco-effectiveness* is not in common use and is still seen as a metaphor.

There are hypothetical discussions and anecdotal examples on different types of information systems used for achieving eco-sustainability goals. For example, Chen et al. (2008) opine that organisations can achieve eco-efficiency through automation of their

operational and control systems. This will reduce human intervention to a minimum and will significantly enhance information efficiency. Information systems can also help organisations achieve eco-equity goals by informing stakeholders, employees and customers and by giving them adequate information on the ecological impacts of organisational activities (Chen et al., 2008). The Web can be used as one of the mechanisms to distribute such information. Information systems also facilitate the enforcement of regulations and policies via codified knowledge systems and databases such as the computerised ISO 14001 environmental management system (Bibri, 2009; Brown, Dillard, & Marshall, 2005). The creative use of information systems to transform the bike sharing system as an alternative to motorised vehicle use in big cities has been cited as an example of information system innovations that can lead to eco-effectiveness (Bradshaw & Donnellan, 2013).

Despite the above claims, there is limited study on the realisation of eco-sustainability benefits associated with Green information system use at organisational level. In fact, some studies seem to suggest a number of problems. For example, videoconferencing has existed for many years to facilitate communication (Agius & Angelides, 1997; Beirne, Moore, & Riesenbach, 2007; Davis & Weinstein, 2005). However, its organisational uptake is low (Allan & Thorns, 2008; James & Pamlin, 2009). This is also similar in the arena of teleworking (Bailey & Kurland, 2002; Baruch, 2001). It is found that teleworking initiative in which employees work from home or a satellite office rather than from a central location is gaining acceptance less quickly than it is expected (Allenby & Richards, 1999). Only fairly recently has telework indicated a growing phenomenon especially in developed countries such as the United States and the Netherlands (Kitou & Horvath, 2006; Vermaas & Bongers, 2008). However, relating to the examples outlined above, there is limited research investigating how systems such as videoconferencing and teleworking can benefit organisations in achieving eco-sustainability goals. It is imperative for studies to be conducted in identifying the outcomes, either those intended from the beginning, or unintended outcomes deriving from the use of Green information system and its innovation process. Thus, the following research question is proposed:

Research Question 3: *What are the outcomes from the Green information system innovation process?*

1.4 RESEARCH OBJECTIVES AND SCOPE

The research is aimed at contributing towards explaining how innovation in information systems for sustainability is evolving over time, and the contextual factors driving the innovation process in an organisation.

There are three objectives outlined for this research and they are:

1. To explain the content of Green information system innovation and the context which drives organisations to embark on Green information system innovation.
2. To explain the Green information system innovation process and how it unfolds over time.
3. To explain the outcomes derived from the Green information system innovation process.

This research is conducted as a case study employing primarily the qualitative approach. This is because a quantitative approach with its data collection technique such as a survey will have limited ability to explain and reveal the detailed process of innovation, how the innovation unfolded over time, and to capture the interactions of the people within the context of the innovation. Detailed justification of why a qualitative approach with case study investigation is selected is discussed in Chapter 4.

1.5 RESEARCH DESIGN

The research was designed as a qualitative study and employed semi-structured interviews, a descriptive survey and organisational documents including annual reports, sustainability reports, information systems product information, PowerPoint slides, and meeting minutes. The contextualist-processual theory (Pettigrew, 1990; Pettigrew, Woodman, & Cameron, 2001) provided theoretical lens to delve deeper into the intricate process that is dynamic and commonly unseen without any retrospective investigation or situated study. The empirical data collection was conducted in a large

telecommunications company called Telecom Acadia (anonymous), operating in one of the South East Asian countries.

The research was divided into two phases. Phase 1 involved semi-structured interviews with a total of eighteen (18) staff of Telecom Acadia. The aim was to explore the existence of Green information system innovation and environmental sustainability initiative(s) in the company. The two-month investigation revealed that Telecom Acadia had implemented environmental sustainability practices in terms of technologies and campaigns. However, the study did not go into a detailed process of how the Green information system was created and/or applied or the main contextual factors leading towards the innovation of Green information system. The first phase was also intended to identify the relevant people who could provide more information pertaining to Green information system innovation in the subsequent phase of the research. Relevant organisational and information system product documents such as annual reports, brochures, and presentation slides were collected to assist further understanding of Telecom Acadia's environmental sustainability initiatives. In Phase 2, a total of twenty six (26) people were interviewed. The overall total of research participants from both phases of data collection is forty four (44). A survey was also conducted and it received 150 responses from Acadia staff on their use of Green information system innovations and their general view on environmental sustainability. Four types of information system innovations were studied in detail and they are the information system for energy informatics, information system for sustainable communications and collaboration, information system for knowledge management and sharing, and information system for carbon management.

The data collection process was conducted after successfully gaining ethical clearance from RMIT University. The data was analysed using thematic analysis (Boyatzis, 1998; Braun & Clarke, 2006) as discussed in Chapter 4.

1.6 FINDINGS AND CONTRIBUTIONS

This research is significant as it provides explanations defining innovation in general, and in information systems created and/or applied for environmental sustainability in particular (Chapter 5). Based on existing theories of contextualist-processual approach (Pettigrew, 1990; Pettigrew, et al., 2001), concepts related to environmental sustainability, the information system innovation process and case findings of the project, this research developed two new Green information system innovation models, namely the Green Information System in Practice Model and Green Information System in Spirit Model along with a set of theoretical propositions (Chapter 6).

1.7 THESIS ORGANISATION

This thesis is organised into seven chapters.

Chapter Two provides a review of extant literature pertaining to the conception of innovation, approaches to study organisational innovation from the perspectives of the diffusion of innovation, organisational innovativeness, and the process theory of innovation. The chapter also reviews the drivers of innovation from the institutional, strategic choice, technology-organisation-environment and contextual-processual perspectives. A discussion of the outcomes of innovation is provided and the chapter concludes by highlighting the research implications.

Chapter Three introduces the conceptual framework for the research. A review of theories and concepts, particularly the contextualist-processual approach, is discussed. The chapter then proposes and discusses in detail the proposed conceptual framework by offering insights into the content, context, process, and outcome of Green information system innovations.

Chapter Four describes the research design of the research. Discussion revolves around the research paradigm and its epistemological assumptions. The reasoning for selection of the interpretive research paradigm is discussed. The data analysis using thematic coding

is elaborated on and the steps taken to ensure research trustworthiness or rigour are also covered in addition to the ethical clearance from the university.

Chapter Five describes the research setting where the data collection took place. An overview of the organisation's environmental sustainability initiatives is presented. This is followed by the four Green information system innovation cases, namely the Energy Informatics, Unified Communications and Collaboration, Sustainable Knowledge Management System, and Fleet Management System. The Green information system innovation cases are presented according to context, content, innovation process and outcomes perspectives.

Chapter Six discusses the findings by cross-analysing the four Green information system innovation cases against the larger context of environmental sustainability in Telecom Acadia, and the internal and external environment where Telecom Acadia is operating. This chapter recaps the research questions and ponders upon the findings based on the objectives of this research in extrapolating the explanation for the Green information system innovation process. Based on the analysis of the data, two innovation process models are presented and a number of propositions are proposed.

Chapter Seven provides the conclusion for this research. The chapter recaps the findings and shows how they are novel as well as contributing to both theory and practice. The chapter acknowledges the limitations of this research. Finally, the chapter concludes with some suggestions for future research work which could be conducted in this area.

CHAPTER 2 : LITERATURE REVIEW

2.1 INTRODUCTION

This research draws from four innovation research domains: organisational innovation (Daft, 1978; Damanpour, 1991; Rogers, 1983; van de Ven, 1986), environmental innovation (Hart, 1995; Sharma & Vredenburg, 1998; Shrivastava, 1995b), IS innovation (King, et al., 1994; Orlikowski & Robey, 1991; Swanson & Ramiller, 2004) and Green IS (Melville, 2010; van Osch & Avital, 2010; Watson, Boudreau, & Chen, 2010). This chapter presents the review of these literature.

The chapter is structured in five sub-sections addressing the conception of innovation (Section 2.2), the approaches to studying the organisational innovation process (Section 2.3), the drivers of innovation (Section 2.4), and the outcomes of innovation (Section 2.5). The chapter is concluded with the research implications (Section 2.6).

2.2 THE CONCEPTION OF INNOVATION

According to Thirtle and Ruttan (1986), for analytical purposes, it is useful to use the term *innovation* instead of *invention* to designate any "new thing" in the area of science or technology and to reserve the term *invention* to refer to that subset of technical innovations that are patentable. Furthermore, invention generally refers to the initial discovery of something new while innovation is more of an activity (Lubrano, 2013). Lubrano (2013) continues that innovation introduces invention into the social structure, whether it be a new method or performing a task, a new custom, or a new product/device/service. Therefore, for the purpose of this research, innovation will be used throughout the thesis.

Different researchers define innovation differently. One of the earliest definitions of innovation is given by Schumpeter (1934, p. 66) cited from Hagedoorn (1996) as “*the*

introduction of a new product or a new quality of a product, a new method of production, a new market, a new source of supply of raw material or half-manufactured goods, and finally implementing the new organisation of any industry.” This definition captures four dimensions of an innovation, namely (i) the stage; (ii) the nature; (iii) the type; and (iv) the entity of innovation. The stages of innovation derived from Schumpeter’s definition consist of “introduction” and “implementation”. The nature of an innovation is considered as “new” and the types of innovation include that of “product, method of production, market and source of supply.” The entity or context of innovation is an organisation, within any industry.

In the 1960’s, at least three definitions appeared and were added to Schumpeter’s (1934) definition. In particular, the definition by Thompson (1965) added “generation” and “acceptance” to the stage of innovation, and included “ideas, processes and services” as the new constructs of the type of innovation. Another two definitions from the 1960s added the construct of “use” (Becker & Whisler, 1967) and “adoption” (Knight, 1967). Knight (1967) added the construct of “environment” to the context of innovation and “change” in his definition, implying that change may occur during the process of adopting an innovation.

All these earlier definitions maintained that innovation is “new” to the adopter. However, the consideration of “new” is subjective. The subjectivity of “new” is embedded in the innovation definition by Zaltman, Duncan, and Holbeck (1973) which considered innovation as something new or “perceived” new. The newness perception can be seen from at least six aspects: new to the world, new to the industry, new to the scientific community, new to the market(place), new to the firm, and new to the customer (Garcia & Calantone, 2002). Zaltman et al. (1973) also expanded the types of innovation to include practice and material artefacts and the context of innovation as “the unit of adoption” where innovation is taking place. Daft’s (1978) definition of innovation introduced “behaviour” as one of the types of innovation while Rogers (1983, p. 11) introduced new “object” when he defined innovation as *“an idea, practice, or object that is perceived as new by an individual or other unit of adoption”*. As research conducted by Rogers (1983) revolved around innovation diffusion, the notions of innovation context which he included are “individual” and “other unit of adoption”.

Two broader typologies of innovation were introduced by Damanpour and Evan (1984): technical innovation and administrative innovation. For example, technical innovation includes new products, processes or services while an administrative innovation refers to the policies, resource allocation, structuring of tasks or administrative systems, authority, and reward (Damanpour & Evan, 1984). Van de Ven (1986) also added an important consideration to the definition of innovation by capturing the dynamics of the innovation process involving “... *people who over time engage in transactions with others within an institutional order*” (van de Ven, 1986, p. 590).

Definitions from the 1990s further expanded the earlier definitions. From types of innovation dimension, the inclusion included “device”, “system”, and “policy” (Damanpour, 1991), “procedures” (West & Anderson, 1996) and “structure” (Nohria & Gulati, 1996). Also, Damanpour (1991) mentioned the origin of innovation, of either being generated internally or purchased from outside. From the stage of innovation, an example of a new addition was West and Anderson’s (1996) “application”. Another extension was in the context of innovation and the people involved in the innovation process, which was captured by Nohria and Gulati (1996) as “innovating unit” and the “manager” who manages the innovation process. Furthermore, Nohria and Gulati (1996) reiterated that the newness in innovation is a matter of perception instead of being objectively new. An important contribution from the innovation definitions of the 1990s is the inclusion of “outcome” in the dimension of innovation. West and Anderson (1996) included “benefits” as the outcomes of innovation. The benefit is seen from the perspectives of the beneficiaries of the innovation, such as “group, individual, or wider society” (West & Anderson, 1996). Crossan and Apaydin’s (2010) definition also added to the dimension of the outcomes of innovation when they stated that “outcomes” is one of the elements in any innovation.

In one of the more recent definitions, Damanpour and Aravind (2012) reiterated that innovation in nature is new, but the “newness” is subjective. In their parlance, this is argued as “... at least new to an organisational population” (Damanpour & Aravind, 2012, p. 425). In addition, “technology” is featured in Damanpour and Aravind’s (2012) work as one type of innovation.

In summary, a review on the definitions of innovation published over the past fifty years or so is summarised in Table 2.1. The underlined construct indicates the first time the construct appears in the definition timeline and the dash (-) indicates that the author did not mention anything pertaining to that particular dimension of innovation.

Hence, based on the analysis of the reviewed literature, innovation is an idea (Thompson, 1965), product (Rogers, 1983; Damanpour & Aravind, 2012), service, process, device, system, policy and procedure (Damanpour, 1991), technique and method (Crossan & Apaydin, 2010), behaviour (Daft, 1978) that is either new (Schumpeter, 1934) or perceived as new (Rogers, 1983) or that has value-added novelty (Damanpour & Aravind, 2012) by an individual or other units of adoption.

From an IS perspective, information system innovation is defined as “*innovation in the organisational application of digital computer and communication technologies*” (Swanson, 1994, p. 1072). On the other hand, Green IS researchers defined Green information system innovation as “*the use of information systems for the purposes of re-designing and implementing environmentally sustainable changes to business processes*” (Seidel & Recker, 2012, p. 1).

Author(s)	Innovation Dimension			
	(1) Stage of Innovation	(2) Nature of Innovation	(3) Type of Innovation	(4) Entity of Innovation
Schumpeter, 1934	<u>Introduction, implementation</u>	<u>New</u>	<u>Product, method of production, market, source of supply</u>	<u>Organisation, Industry</u>
Thompson, 1965	<u>Generation, acceptance, implementation</u>	New	<u>Ideas, processes, products, services</u>	-
Becker & Whisler, 1967	<u>Use</u>	New	Idea	Organisation
Knight, 1967	<u>Adoption</u>	New	<u>Change</u>	Organisation, <u>Environment</u>
Zaltman et al, 1973	-	<u>Perceived new</u>	<u>Idea, practice, material artefact</u>	<u>Unit of adoption</u>
Daft, 1978	Adoption	New	<u>Idea, behaviour</u>	Organisation
Rogers, 1983	-	Perceived new	<u>Idea, practice, object</u>	<u>Individual, other unit of adoption</u>
Damanpour & Evan, 1984	Implementation	New	<u>Technical idea, administrative idea</u>	-
Van de Ven, 1986	<u>Development, implementation</u>	New	Ideas	-
Damanpour, 1991	Adoption, generation	New	<u>Device, system, policy program, process, product, service</u>	Adopting organisation
West & Anderson, 1996	Introduction, <u>application Benefit</u>	New	<u>Processes, products, procedures</u>	Relevant unit of adoption, <u>Group, organisation, wider society</u>
Nohria & Gulati, 1996	-	Perceived new	Policy, <u>structure</u> , method, process, product	<u>Manager, Innovating unit</u>
(Goswami & Mathew, 2005)	Adopting	New	Ideas, Change	<u>Market, People</u>
(Damanpour & Wischnevesky, 2006)	Invention Development, application	-	Idea	-
Crossan & Apaydin, 2010	<u>Production, adoption, assimilation, exploitation</u> <u>Outcomes</u>	<u>Value-added novelty</u> , New	Products, services, markets, <u>methods of production, management systems</u>	-
Damanpour & Aravind, 2012	Generation (development), adoption (use) Outcomes	New; perceived new	<u>Ideas, behaviours, product, service, technology, practice</u>	Organisational population

Table 2.1 - Summary of the Conception of Innovation

2.3 APPROACHES TO STUDYING THE ORGANISATIONAL INNOVATION PROCESS

There are three research approaches in relation to the studies of organisational innovation (Orlikowski & Baroudi, 1991; Shrivastava, 1995a; Wolfe, 1994). They are: diffusion of innovation (focuses on addressing the diffusion of an innovation over time and/or space) (Foster & Heeks, 2013a; Rogers, 1983), organisational innovativeness (focuses on the determinants of the innovativeness of organisations) (Damanpour, 1991; Horbach, 2008) and the process theory of innovation (focuses on the processes that organisations go through in implementing innovations) (Avgerou, 2001; Walsham & Waema, 1994). The following subsections discuss these three approaches.

2.3.1 Diffusion of Innovation (DoI)

Diffusion of innovation (DoI) refers to the spread of an innovation through a population of potential adopters (Rogers, 1983). The unit of analysis is therefore the innovation. The objective of DoI research is to explain or predict rates and patterns of innovation adoption over time and/or space. DoI research analysis focuses upon the fit of hypothesised innovation diffusion models with actual diffusion histories (Fischer & Carroll, 1986; Tolbert & Zucker, 1983). Diffusion rates and explanatory variable information for DoI studies have been collected by survey questionnaires (Attewell, 1992; Teece, 1980), expert judgments (Souder & Quaddus, 1982), and archival (Fischer & Carroll, 1986; Tolbert & Zucker, 1983) data collection.

Factors that influence diffusion include: (1) adopter characteristics; (2) the social network to which the adopters belong; (3) innovation attributes; (4) environmental characteristics; (5) the process by which an innovation is communicated; and (6) the characteristics of those who are promoting an innovation (Rogers, 1983). An outcome of DoI research has been the identification of innovation attributes which influence diffusion (e.g., relative advantage, compatibility, complexity, trialability, and observability) and the classification of adopters which is presumed to have different characteristics and tendencies to adopt (i.e., innovators, early adopters, early majority, late majority, and laggards) (Rogers, 1995; Tornatzky & Fleischer, 1990).

IS researchers have criticised the diffusion of innovation theory. One of the criticisms of the theory is that it ignores the social context of IS adoption in organisations (Lyytinen & Damsgaard, 2001). It is also regarded as being too simplistic to address issues of social context in which the adoption and diffusion of information system take place (Lyytinen & Damsgaard, 2001). The limitation of this theory is the failure to understand the human environment and organisational context (Du Plooy, 1998). In order for information system adoption to be successful, there is a need for social and environmental perspectives to complement technical perspectives. Information system adoption processes need to be based on social-technical adoption models instead of a technological linear phenomenon (Jokonya, Kroeze, & van de Poll, 2012; Weilbach & Byrne, 2010).

2.3.2 Organisational Innovativeness (OI)

According to Wolfe (1994), the objective of organisational innovativeness (OI) research is to discover the determinants of an organisation's propensity to innovate. The unit of analysis is thus the organisation. Zaltman et al. (1973) and Hurley and Hult (1998) conceptualise innovativeness as an organisation's 'cultural readiness' to innovate or to adopt new ways of doing things. Berthon, Hulbert, and Pitt (1999) describe innovativeness as "open-mindedness", "enterprising", "willingness to change", "ability to innovate" or to be creative. Blake, Neuendorf, and Valdiserri (2003) regard innovativeness as a "generalised readiness" to follow new ways and be creative. Kundu and Katz (2003) relate innovativeness to the organisation's "intention to be innovative". For Hult, Hurley, and Knight (2004), innovativeness is a firm's capacity to introduce new processes, products, or ideas in the organisation. Menguc and Auch (2006, p. 66) relate innovativeness as a "firm's proclivity, receptivity, and inclination to adopt ideas that depart from the usual way of approaching business". Thus, organisational innovativeness, the dependent variable, has generally been operationalised as a composite score based on the number of innovations adopted by an organisation (Baunsgaard & Clegg, 2015; Daft, 1978; Kimberly & Evanisko, 1981).

While researchers have investigated the influence of individual, organisational, and environmental variables in OI studies, this stream has tended to focus on the influence of

organisational structure because it has been argued that structural variables are the primary determinants of organisational innovation (Damanpour, 1988; Kim, 1980; Kimberly & Evanisko, 1981). However, no definitive characteristics which differentiates more from less innovative organisations have emerged (Rogers, 1983; Tornatzky, et al., 1983). This has resulted in a number of important criticisms about OI research and in strategies being suggested for its improvement (Baunsgaard & Clegg, 2015; Lynch, Walsh, & Harrington, 2010; van de Ven & Rogers, 1988).

Recommendations for improving OI research have included: (a) switching from the organisation to the “innovation-in-an-organisation” as the unit of analysis, thus treating organisation specific innovation attributes as such rather than as innovation inherent attributes (Downs & Mohr, 1979); (b) moving away from the adoption decision being the dependent variable towards conceptualising it as an extent of innovation implementation (Downs & Mohr, 1979; Kimberly & Evanisko, 1981; Tornatzky & Klein, 1982), and (c) moving away from a static, over determined perspective towards investigations of the nature of, and the factors which influence, innovation processes (Mohr, 1987; Rogers, 1983; Tornatzky, et al., 1983; van de Ven, 1986; van de Ven & Poole, 1989). These suggestions have contributed to more interest in the process research.

2.3.3 The Process Theory of Innovation (PT)

Process theory (PT) research of organisational innovation investigates the nature of the innovation process, including how and why innovations emerge, develop, grow, and terminate (Wolfe, 1994). Arguably, PT research is focusing on the conception, development, implementation, and evaluation stages of an innovation. According to van de Ven, Polley, Garud, and Venkatraman (1999), who also study the process theory of innovation, innovation processes develop in a messy, complex progression of events. As such, innovation is an unpredictable, uncontrollable, emergent process wherein people have to explore, experiment, and play with possibilities without knowing where their queries will lead or how their actions will unfold (van de Ven et al., 1999). Besides that, Mumford, Scott, Gaddis, and Strange (2002) posit that plans in any innovation process may not unfold as intended, and people create novel responses without a pre-scripted plan or certainty of outcomes, resulting in them defining and redefining goals and paths to goal

attainment vis-à-vis the work and the needs of the organisation.

The unit of analysis of PT research is the innovation process itself. In contrast to Diffusion of Innovation (DoI) and Organisational Innovativeness (OI) research, PT research typically investigates the temporal sequence of activities (i.e., the critical events) in the development and implementation of innovations (Perks & Roberts, 2013; van de Ven & Poole, 1990). By decomposing organisational innovation into time phases and focusing on the sequential nature of precursor events and on their determinants, PT research takes advantage of relative stability and simplicity at each process stage (Isabella, 1990; Perks & Roberts, 2013; Wolfe, 1994). Process research, thus, counters the instability of OI research caused by the large number of innovation determinants and the significant interaction among them (Downs, 1978). Data gathering methods in PT research tend to be less removed and the data is more qualitative than in variance research (Rogers, 1983; van de Ven & Angle, 1989).

In general, PT of innovation is divided into two - Process A-Stage and Process B-Process (Wolfe, 1994). Process A-Stage (also called the Stage Model) focuses on the stages organisations go through in implementing innovation (either organisational innovation, environmental innovation, or information system innovation) from the adoption through implementation of an innovation (Damanpour & Schneider, 2006; Pelz, 1983). On the other hand, Process B-Process (also called the Process Model) focuses on the forces that explain the chain of events which results in innovation adoption through to implementation (Kim & Pan, 2006; Schroeder, van de Ven, Scuder, & Polley, 1989). As this research is interested in understanding the stages as well as the chain of events of Green information system innovation, the combination of Process A-Stage and Process B-Process would be used.

Regarding the innovation process, Poole, van de Ven, Dooley and Holmes (2000) distinguish between three meanings of process with each definition associated with a particular type of process research. The first type is a variance approach to process in which “process” is considered to be the logic by which independent variables are taken to be contributing factors in a certain outcome or dependent variable. The process as such is not part of the research but is simply taken to be there to account for assumed cause and effect relationships. The second type uses “process” as a category of concepts represented

by some process variables that are inserted into a cause and effect model. In this case, the process effects are part of the research but it still resembles a variance approach. In a way, this is a static representation of a process and does little to account for the changeable nature and transiency of the research object. The third type, which is the interest of this research, sees “process” as a developmental event sequence (Langley, 1999; Miles & Huberman, 1984; Poole, et al., 2000). In contrast to variance approach, this third approach to process does not work with variables (such as variables found in any quantitative investigation) that provide explanations in terms of relationships between dependent and independent variables but works instead in terms of events that lead to an outcome. Events somehow contribute to the continuity and change of the object under study and are at the core of any process explanation (Peterson, 1998).

In the following sub-sections, we review a sample of eight prominent studies in the IS field which utilised the process model approach in explaining about the innovation process. The reviewed studies are relevant to this current research as they provide insights into the type of process theory being adopted (i.e., either stage approach, process approach, or the combination of stage and process), type of innovation, the innovation being studied and the research outcomes, as summarised in a table at the end of this section. Additionally, pertinent concepts of the innovation process such as events, time, and key people involved in the innovation process are also covered in the articles reviewed below.

2.3.3.1 Newman and Robey (1992)

Newman and Robey’s (1992) process framework (see Figure 2.1) provide a structure for explaining the leadership of a system development project. The complex and dynamic information system development process is said to be punctuated by events such as encounters between the information system and its users that result in the acceptance, equivocation, or rejection of the initial leadership condition. The outcome in the information system development process is the leadership style under which the project is completed. As the information system development process entails complex activities, there is no clear and predictable outcome of the information system development as the path from start to finish can deviate at any point based on the social interactions between users and the information system itself. The stages or sequence of events indicated in this

research include leadership, encounter, episode, repetition or cycles of encounter-episode sequence, and end with leadership patterns.

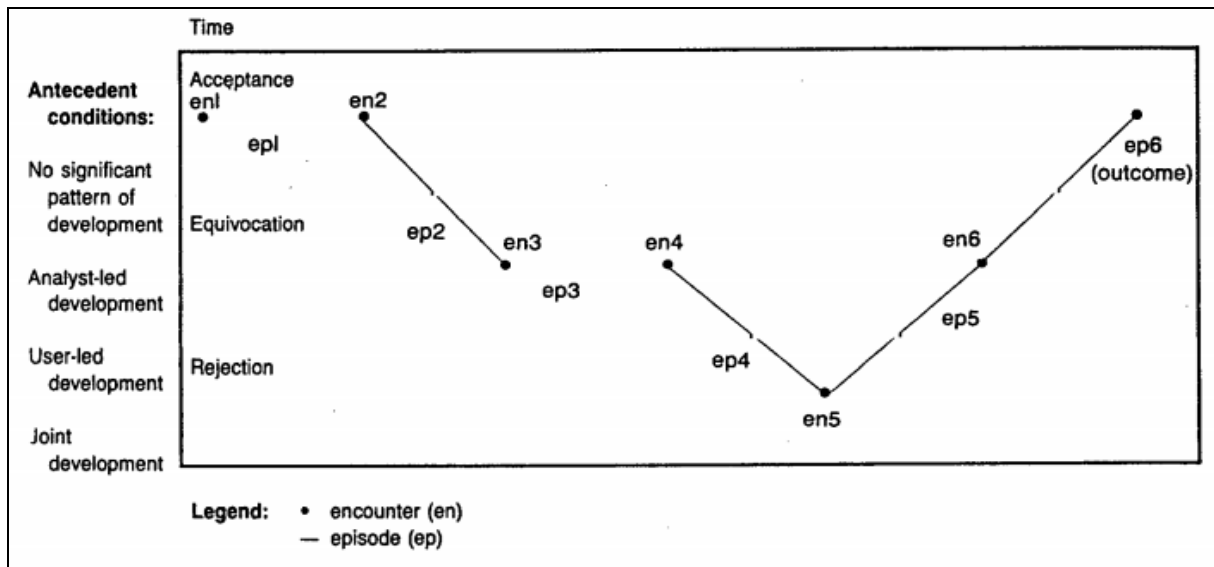


Figure 2.1 - Process Framework on antecedent conditions, events, and outcome of Leadership in Information System development project.

(Source: Newman & Robey, 1992)

2.3.3.2 Orlikowski (1993)

For Orlikowski (1993), the process model (see Figure 2.2) is used to explain how and why the consequences of Computer-Aided Software Engineering (CASE) tools usage emerge from CASE adoption. The precursor events include articulating the information system problems and formulating the expected benefits of CASE. However, the existence of these events does not ensure that the intermediate events will occur, thus demonstrating the unpredictable nature in the information system process model. Nonetheless, using the sequential approach, the events associated with CASE adoption and use are followed by the final outcomes of the model which include reactions from the key people involved in the CASE innovation (i.e., system developers, IS managers and clients). Thus, the stages of CASE innovation include the precursor conditions for adopting and using CASE tools, adopting and using CASE tools, and consequences (or outcomes) of adopting and using CASE tools. The contextual factors of the environment,

organisation and information system are also used to explain the influencing forces towards the adoption and use of the CASE tools.

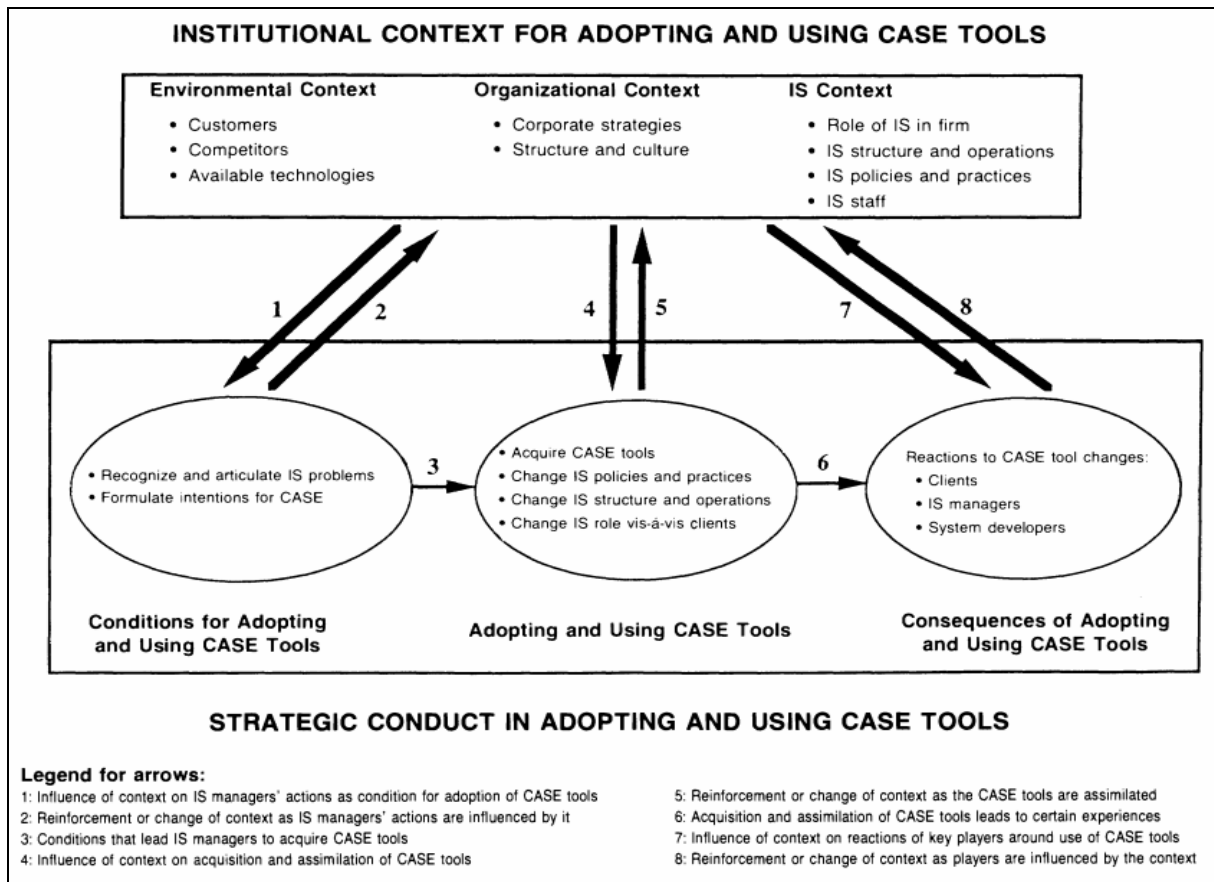


Figure 2.2 - Process of Organisational Change around CASE Tools
(Source: Orlikowski, 1993)

2.3.3.3 Orlikowski (1996)

Orlikowski (1996) uses a process theory approach to study emergent and situated change in an organisation called Zeta Corporation which was implementing a new technical support technology for its Customer Service Department (CSD). The model describes five metamorphic phases in the evolution of work within that customer service department. Each phase consists of deliberate and emergent changes in the work of managers and customer service specialists, as well as unintended outcomes. The model tells a rich and detailed story about the changes taking place within Zeta Corporation's CSD.

Each of the CSD's five metamorphoses are characterised by: (i) an analysis of the practices which enacted the changes, including the organisational properties which influenced and which were influenced by those changes; (ii) the specific technological features which were appropriated for use by the users at Zeta Corporation; and (iii) the unanticipated outcomes which resulted from the changes and which influenced further changes.

The process model posits a recursive relationship between the everyday actions of human agents (i.e., the key people in the CSD project) and the social structures which are both the medium and outcome of those actions. The process model depicts the social structures or the organisational properties of Zeta Corporation and the CSD, namely the authority relations, division of labour, strategies, incentive systems, evaluation criteria, policies, and work culture, which represented the institutionalised aspects of the Zeta and CSD social systems (Orlikowski, 1996). These constrained and enabled the production of ongoing practices by members of the CSD project, while also being changed over time by those practices. While the developed technology itself (i.e., the content of the information system innovation) is not specifically depicted in the model, somehow it played a critical role in mediating the changes in practices and structures of the CSD innovation project (Orlikowski, 1996). Accordingly, this IT in the CSD plays a role similar to that of organisational properties - shaping the production of situated practices, and being shaped by those practices in turn.

2.3.3.4 Robey and Newman (1996)

Robey and Newman (1996) develop a process model (see Figure 2.3) explaining an IS project in a firm. The model begins with the role of the key people (i.e., an analyst-led IS development approach) and ends with a joint-led approach. The process is also composed of social encounters which lead to acceptance, rejection or equivocation episodes (i.e., making a statement that is not literally false but that cleverly avoids an unpleasant truth). Each encounter is an event that leads to a subsequent episode. The path from one encounter to the next is unpredictable because of the social processes and organisational dynamics leading to each encounter. Some of the events in the sequence include a

proposal to begin, acceptance, appointment of project director, equivocation, organisation of users, sign-off on systems requirements, and acceptance.

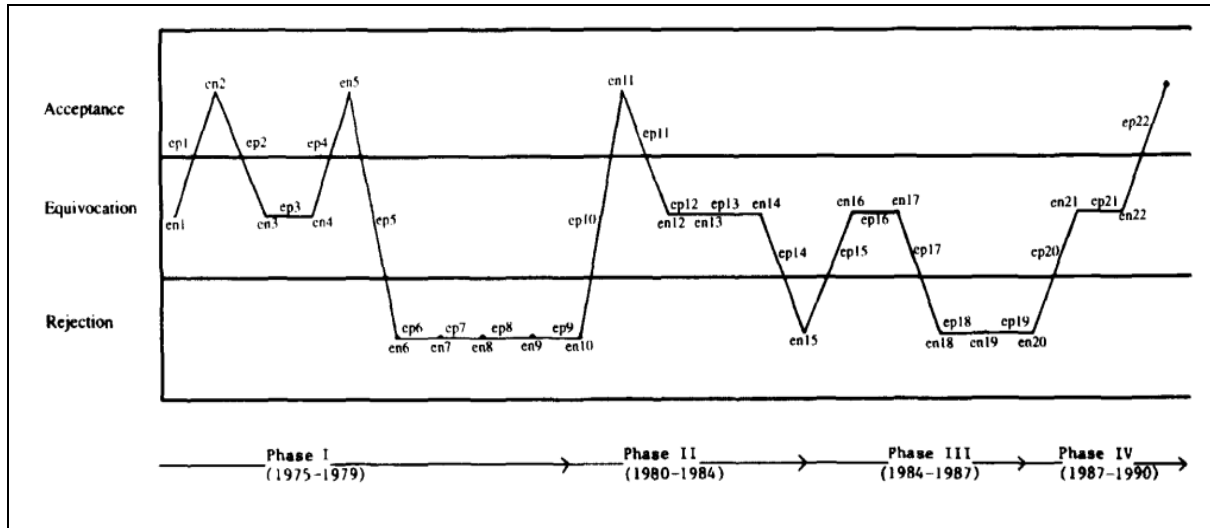


Figure 2.3 - Sequence of Events in IS development process

(Source: Robey & Newman, 1996)

2.3.3.5 Kim and Pan (2006)

Kim and Pan (2006) examine the process of information system implementation (i.e., Customer Relationship Management, CRM) by explaining how factors of information system implementation influence each other and how interactions among them produce results. Based on the empirical study of one successful case and two unsuccessful cases, the process model below is proposed (refer Figure 2.4). The model is able to explain the process of information system implementation and the dynamics of information system success. The model also facilitates an understanding of how repeating patterns of information system failure can be reversed. In general, the proposed process model captures the precursor antecedents such as organisational and key people commitment (i.e., champion continuity, management support, user participation, and resource investment) which leads to the events (i.e., project management, technology management), and process (i.e., CRM process); as well as the consequences or outcomes from the CRM implementation.

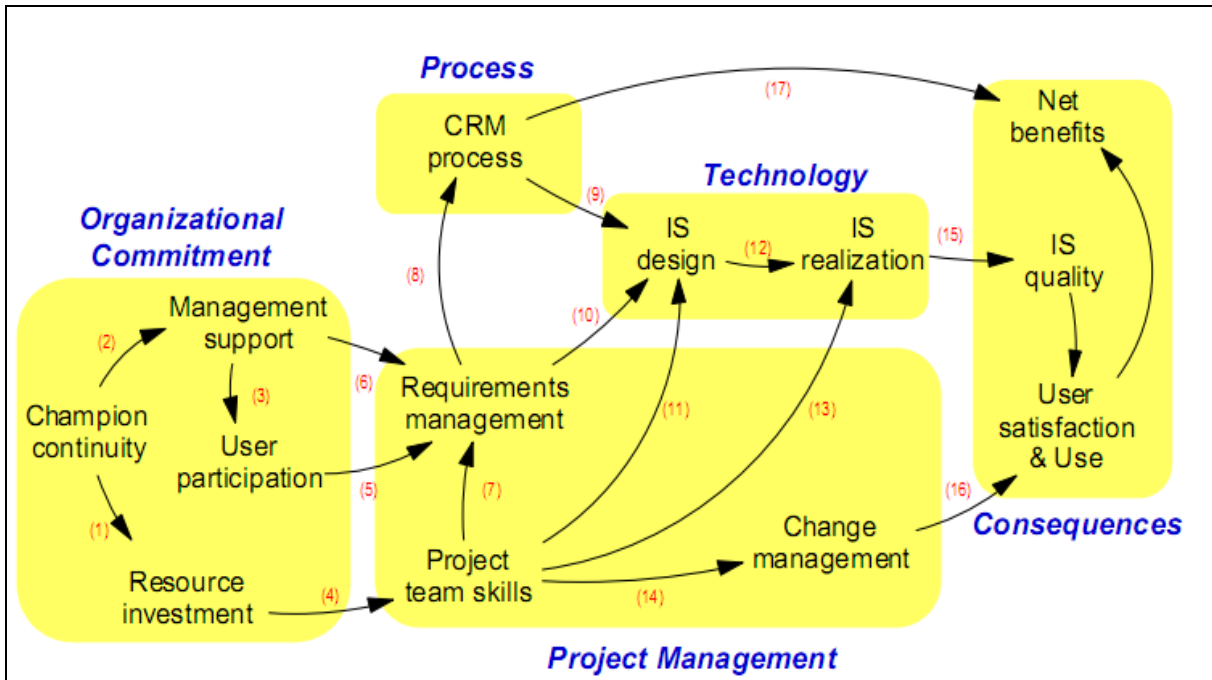


Figure 2.4 - Process Model of IS Implementation for CRM

(Source: Kim & Pan, 2006)

2.3.3.6 Kaewkitipong and Brown (2008)

Kaewkitipong and Brown's (2008) process model (refer Figure 2.5) depicts an understanding of the use of e-business technologies to reach and serve customers and facilitate a firm's back-end processes. The model captures the dynamic changes that occur throughout the adoption and evaluation adopted by small-and-medium Thai tourism enterprises in their use of information systems. The information system innovation is framed around the micro-and-macro contexts, and evolves over a period of time in stages (i.e., pre-adoption, adoption and use, until evaluation). The model shows the nature of processes and how they are shaped by a firm's specific contextual factors as well as external factors.

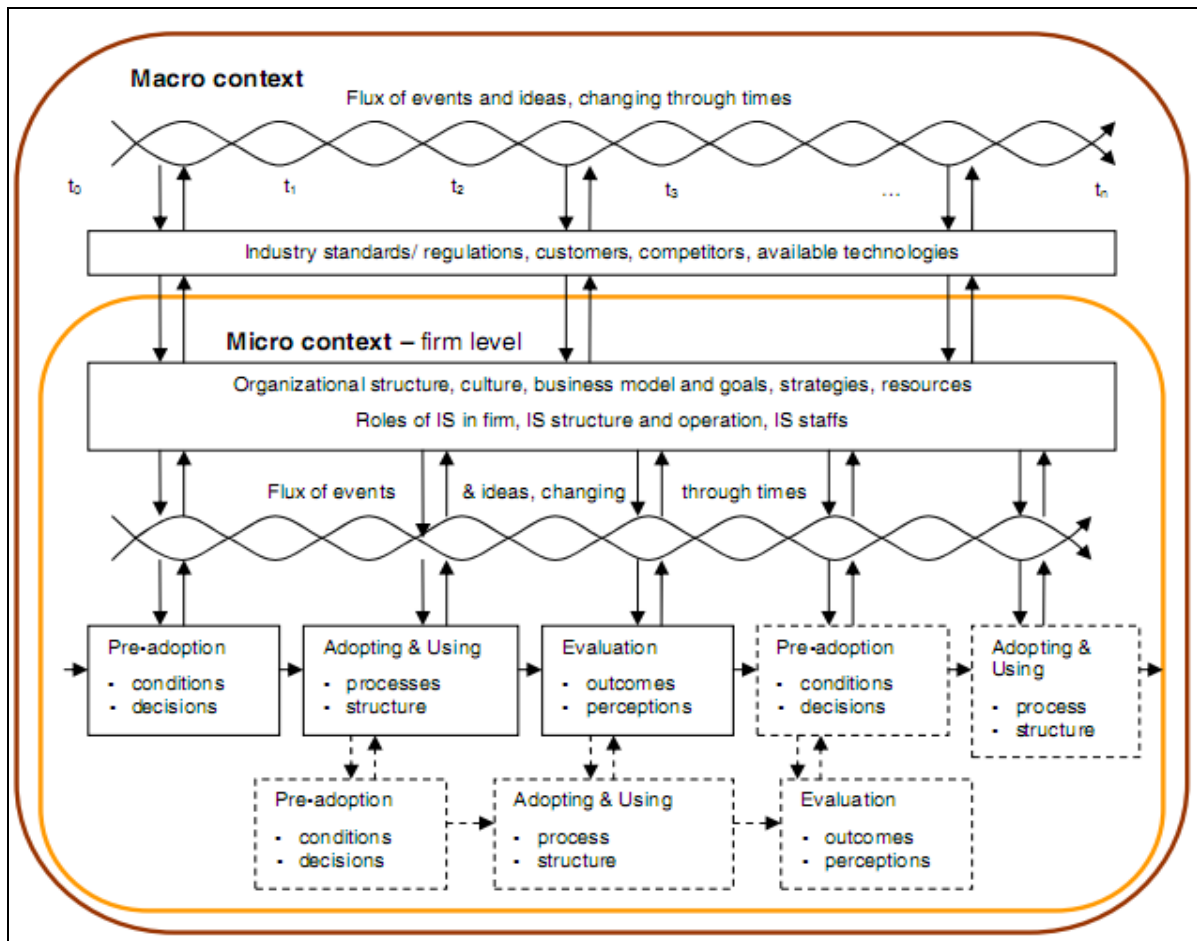


Figure 2.5 - Process Model of IS/IT adoption and evaluation decision making process
(Source: Kaewkitipong & Brown, 2008)

2.3.3.7 Tan et al. (2011)

Tan et al. (2011) explain the “green leadership” of a large telecommunications firm in China. The model (see Figure 2.6) provides insights into the underlying processes through which green leadership can be achieved, facilitated by internal and external conditions, and going through a number of events and phases over a period of time. The process of attaining and enacting green leadership unfolded in three distinct phases, namely Phase 1: Establishing a Green Vision (2007-2008); Enacting Internally, Promoting Externally (2008-2009); and Acting in Concert (2009-present). In each of these phases, the explanation of the existing situation, activities undertaken and implications from the activities were discussed. These three phases are called as Phase 1 – Strategizing; Phase 2 – Mobilizing, and Phase 3 – Collectivizing.

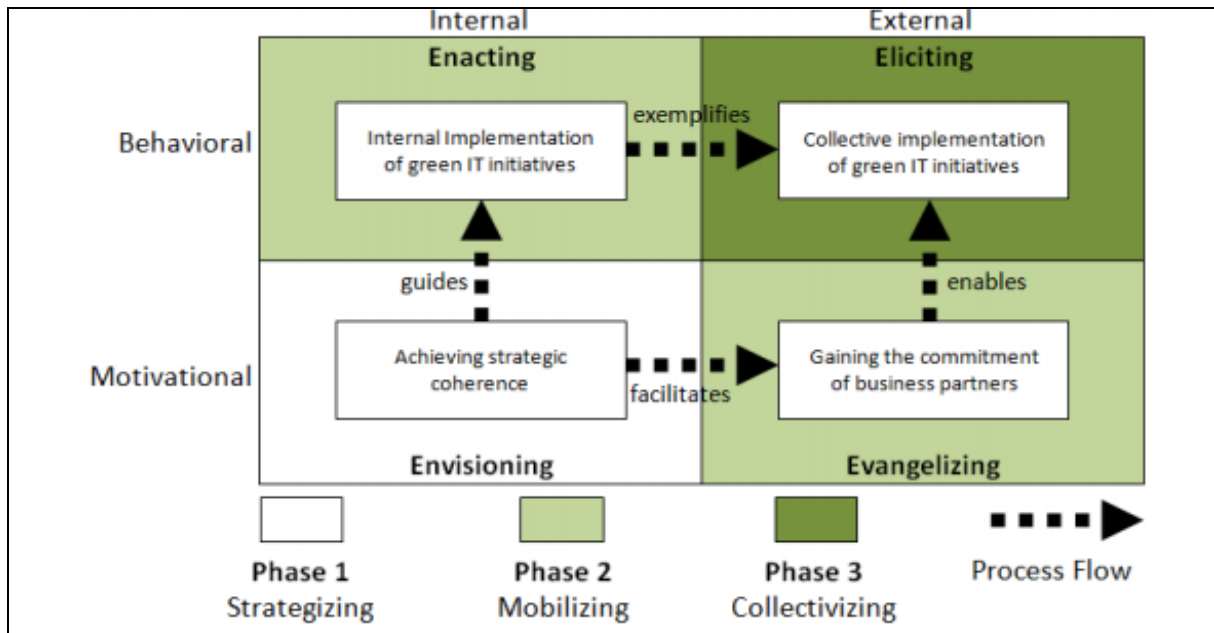


Figure 2.6 -Process Model of the Attainment and Enactment of Green Leadership
(Source: Tan et al., 2011)

2.3.3.8 Du, Pan, and Liu (2015)

Du, Pan, and Liu (2015) claim that the process of effective improvisation remains unknown and the lack of knowledge in this area may account for the difficulties faced by many IS practitioners in engaging in effective improvisation. Based on a case study on Tencent's software product development, the authors derive a four-phase process model of effective improvisation (see Figure 2.7), consisting of simultaneous grounded observation, situated reflection, grounded design, and situated execution. The process model proposed delineates how effective improvisation takes place, explicates its internal dynamics, and presents a new view that consists of both improvisational search and build.

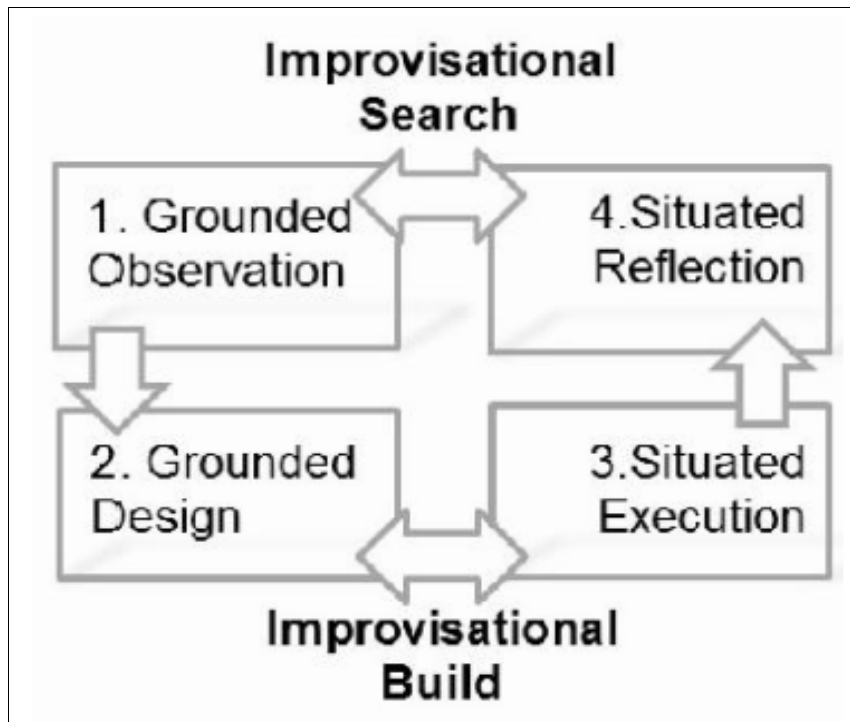


Figure 2.7 - Process Model of Effective Improvisation

(Source: Du et al., 2015)

A summary of the reviewed IS literature employing the process theory of innovation is shown in Table 2.2.

Authors	Type of Process Theory	Type of Innovation	Innovation Studied	Research Method	Research Outcome
Newman & Robey (1992)	Process A-Stage	Administrative idea	Leadership of a system development project	Qualitative method (Case study)	A sequence of episodes and social encounters between systems analysts and users lead to eventual outcomes in the system development project.
Orlikowski (1993)	Process A-Stage; Process B-Process	Adoption process	Computer-Aided Software Engineering (CASE) tools use and adoption	Qualitative method (Case study)	The contextual factors of the environment, organisation and information systems are used to explain the influencing forces towards adoption and use of the CASE tools.
Orlikowski (1996)	Process A-Stage	Organisational change	Implementation of a new technical support technology	Qualitative method (Case study)	Organisational change can be captured and described using metamorphic phases in the evolution of work. Each phase consists of deliberate and emergent changes in the work of the key people and produce intended and unintended outcomes.
Robey & Newman (1996)	Process A-Stage	Development and implementation process	Information system development project	Qualitative method (Case study)	Usefulness of social process model to make sense of complex social processes such as IS development projects that are unpredictable and dynamic.
Kim & Pan (2006)	Process A-Stage; Process B-Process	Implementation process	Customer Relationship Management (CRM) implementation	Qualitative method (Case study)	The process of information system implementation can be explained by examining how factors of IS implementation influence each other and how interactions among them produce results or outcomes.
Kaewkitipong & Brown (2008)	Process A-Stage; Process B-Process	Adoption and evaluation process	e-Business technologies	Qualitative method (Case study)	The process model shows the nature of adoption and evaluation processes is shaped by the firm's specific contextual factors as well as external factors.
Tan, Pan, and Zuo (2011)	Process A-Stage; Process B-Process	Administrative idea	Green leadership in Green IT initiative	Qualitative method (Case study)	The process model of green leadership provides insights into the underlying processes through which green leadership can be achieved, facilitated by internal and external conditions, and going through a number of events and phases over a period of time.
Du, Pan, & Liu (2015)	Process A-Stage	Improvisation process	Software product development	Qualitative method (Case study)	The process model of improvisation process in a software product development delineates how effective improvisation takes place, explicates its internal dynamics, and a continuous iteration between the improvisational acts of search and build.

Table 2.2 - Summary of IS Literature Employing Process Theory of Innovation

It can be seen from the brief review of information system innovation process models and the summary table above, deploying a process approach enabled the researchers to provide a rich description of a series of sequentially interconnected events and interactions that unfold over time. This essentially illustrates that the story of that particular organisation yields valuable insight that would be difficult if not impossible to capture in a variance model. Furthermore, Shaw and Jarvenpaa (1997) posited that processes are more practical because they are easier to visualise than variance relationships. Thus, via a process model, the resulting ‘pictures of the processes’ reveal a detailed story about the changes taking place within a target situation by explaining how objects interact, how they collectively lead to future courses of action, and the perceived constraints on their collective action are unlikely to be achieved using the variance model.

2.4 DRIVERS OF INNOVATION

The review of the literature shows that the drivers for innovation can fall under four perspectives, namely institutional (Butler, 2011; DiMaggio & Powell, 1983; King, et al., 1994), strategic choice (Orsato, 2006; Porter & van der Linde, 1995), Technology-Organisation-Environment (TOE) (Bose & Luo, 2011; Tornatzky & Fleischer, 1990), and contextual-processual (Madon, 1993; Orlikowski, 1996; Walsham, 1993).

2.4.1 Institutional Perspective

According to DiMaggio and Powell (1983), organisations are typically viewed as specialised arenas in an institutional field that are comprised of coercive, normative, and mimetic elements. Institutional theory as proposed by DiMaggio and Powell (1983) has been used to describe how individual entities in an institutional field, in the context of their environment, face pressures to conform to shared behaviour and norms, and how that shapes their decisions over time, leading to a certain isomorphism in behaviour and structure.

Coercive isomorphism is when firms conform to external pressures exerted upon them by other organisations upon which they are dependent, such as the government, industry associations, professional networks, consultants, and powerful clients and suppliers. Normative isomorphism arises through professionalisation (such as the professional associations of engineers, doctors, lawyers, architects, accountants, etc.) that leads to members of those professions holding a common set of norms, values, and cognitive models (DiMaggio & Powell, 1983). Mimetic isomorphism is when firms mimic other organisations in order to cope with uncertainty and save on search and other learning costs. It is often associated with the bandwagon effect (Staw & Epstein, 2000).

In recent times, the focus of institutional theory has expanded beyond understanding factors that lead to isomorphism and homogeneity to institutional forces that drive change. Change in institutional fields, particularly that which is initiated at the field level, has been studied by Hinings, Greenwood, Reay, and Suddaby (2004). Institutional theory, with its focus on the environment of the organisation, provides an understanding of a theory on how members of an institutional field could be playing a role in the adoption and usage of new technologies (Bose & Luo, 2011; Butler, 2011; Chen, et al., 2011). For Green information system innovation, institutional theory and the external forces of organisations are discussed in Chen et al. (2008), Melville (2010), Watson et al. (2010), Elliot (2011), and Butler (2011). For example, Melville (2010) classifies the Green information system context from macro forces (i.e., society and organisations) as well as micro forces. It is claimed that the external forces for Green information system innovation include policies and regulations, and economics (Watson et al., 2010). Furthermore, the instances of external forces include consumers, suppliers, and government (Watson et al., 2010), which can be then categorised into different levels, namely national, regional, global and industrial levels (Elliot, 2011; Watson et al., 2010). In addition, Chen et al. (2008) and Butler (2011), informed by the works of DiMaggio and Powell (1983) and Scott (1994), posit that coercive, normative, and mimetic forces from institutional environments are shaping the organisational field of environmental sustainability.

In the larger IS field, researchers such as Bughin and Chui (2010) describe the emergence of networked enterprises through the use of social media technologies. According to them, the most prominent uses of these technologies were linked to establishing new

channels of communication and commerce between a firm and its business partners, such as customers and suppliers. The important role of entities external to the firm such as business partners, consultants and vendors in the assimilation process has also been observed (Hirt & Swanson, 2001; Somers & Nelson, 2004).

2.4.2 Strategic Choice Perspective

Strategic choice refers to the decision made by organisations which are strategic in nature for pursuing innovation (Orsato, 2006). There is some research which demonstrates the organisation's decision to create and/or apply Green information system innovation or environmental sustainability based on the strategic decision-making of the organisation. For example, Orsato (2006) highlights four types of strategic choices: eco-efficiency, beyond compliance leadership, environmental cost leadership, and eco-branding. In some instances, organisations pursue Green information system innovation and environmental sustainability because of the desire to become a leader in the context of environmental sustainability (Tan et al., 2011).

The strategic choice perspective can be linked to the resource-based view (RBV) of the firm (Barney, 1991). This is due to the fact that the RBV of the firm holds that firm-internal characteristics such as strategy, structure, and core capabilities are important determinants of innovation (Fagerberg, Mowery, & Nelson, 2005) and important to competitive advantage. All these three characteristics form the "strategic choice" for innovation. Resources are classified into tangible (e.g., financial resources), intangible (e.g., reputation of the firm), and personnel-based (e.g., culture, training) resources. The consideration and benefits of intangible properties are particularly emphasised. Organisational capabilities to "assemble, integrate, and manage" these resources play an important role (Russo & Fouts, 1997, p. 537). Also, building on RBV, Hart (1995) links competitive advantage to a firm's relationship with the natural environment and hence, driving organisations into innovating in environmentally friendly innovations.

2.4.3 Technology-Organisation-Environmental (TOE) Perspective

Realising the importance of technology adoption, Tornatzky and Fleischer (1990)

developed the technology-organisation-environment (TOE) framework to evaluate technology adoption. The TOE framework is consistent with the Rogers' (1983) diffusion of innovation (DOI) theory as both focuses on the internal and external characteristics of the organisation as well as technological characteristics in the study of drivers for new innovation diffusion (Ghobakhloo, Arias-Aranda, & Benitez-Alamo, 2010).

The TOE posits that the technological (internal and external technologies), organisational (firm size, scope, centralisation, complexity, slack resources) and environmental (regulatory, industry and competitors) contexts of a firm can either facilitate or inhibit the acceptance and use of a given technological innovation (Tornatzky & Fleischer, 1990). The TOE has been used to study both complex and emerging technologies such as object-oriented technology (Ihlsoon & Young-Gul, 2001), e-business (Zhu, Kraemer, & Xu, 2006), ERP (Kouki et al., 2010), Green IT via virtualisation (Bose & Luo, 2011), and the greening of data centres (Alarafi, Molla, & Deng, 2011). Nevertheless, the majority of TOE based-research has identified a number of factors that are specific to their research setting. As such, the TOE has a generic nature that makes it suitable to study different types of technology innovation.

Although the TOE framework has been successful in classifying adoption factors in their respective contexts, it has been criticised for failing to provide a model for describing the factors that influence IS adoption decision-making in organisations (Bose & Luo, 2011). The technology-organisation-environment theory's main contribution has been to encourage researchers to broaden the context of IS adoption in organisations (Jokonya, et al., 2012).

2.4.4 Contextualist-Processual Perspective

The contextualist-processual perspective refers to the “*what, why and how*” of change such as information system innovation and evaluation (Stockdale & Standing, 2006). Based on the contextualist-processual perspective, the information system innovation process is typically seen as processes unfolding through time in a dynamic manner. For example, Madon (1993) explains the process of introducing a new IS innovation called computerised rural information systems project (CRISP) for the management of a rural

development programme in the context of India's local administration districts. The research explains the reasons for poor integration between the process of technology adoption and the context within which the technology is implemented and how this has changed over the years with the more effective implementation of CRISP. While explaining the CRISP innovation process, it was broken down into three stages and each stage represents natural breaks in the course of events over time (Madon, 1993, p. 40). The first phase was the pre-CRISP phase taking place before 1987; Phase 2 from 1987 to 1990; and Phase 3 from 1990 onward. In the discussion, contexts such as bureaucratic inflexibility and power struggles between centre and state were explained. The role of a project champion such as the system designer and intervention by some government administrators and cadres show the importance of social interactions in overcoming issues in all information system innovation process life cycles. Some of the issues managed and addressed by the key persons in the CRISP project include resolving the unfaithful use of CRISP by producing manual reports which can be modified for personal purpose and tackling non-participative styles of bureaucracy. The use of CRISP to achieve the outcomes (i.e., the set governmental targets in improving the delivery of government services to the rural populations) was also mentioned.

Walsham (1993) argues how an information system emerged from a dynamic and interactive relationship between the technology, its social and organisational context, and the negotiated actions of various individuals and groups. Using the concept of the contextualist-processual perspective, information system innovation was depicted as interrelated with and inseparable from contextual settings. Accordingly, Walsham (1993, p. 53) posits that contextual perspective avoids understanding information system projects "as episodes divorced from the historical, organisational or economic circumstances from which they emerge." Explaining the information system innovation process from the contextual-processual perspective enables the narration of how a new or perceived new information system is developed, the forms or configurations for the information system, and the intended (and unintended) consequences of its implementation and use. The information system innovation process depends on an institutional and cultural context of complex social relations and actions, the infrastructure that supports its development and use, and the organisational history of social arrangements and commitments that accompany any instance of information system development and use (Walsham, 1993). The information system innovation

process also entails “social process of communication, learning and negotiation within and between individuals and stakeholder groups” (Walsham, 1993, p. 236) and further demonstrates the situated and sociotechnical nature of the information system innovation process.

2.5 OUTCOMES OF INNOVATION

Most IS researchers studying information system innovation from the process approach also highlight the importance of measuring the outcomes of the innovation process (Kaewkitipong & Brown, 2008; Kim & Pan, 2006; Seidel, et al., 2013; Sorgenfrei, Katharina, Stefan, & Murray, 2014). From the perspective of information system innovation, the outcomes of the information system innovation process include acceptance, equivocation, or rejection (Newman & Robey, 1992) and leadership styles (Newman & Robey, 1992). In Orlikowski (1993), the outcomes of information system innovation itself are seen from the perspective of IS users’ reactions to the new information system. From Madon (1993), one of the stated outcomes of CRISP is the achievement of the set governmental targets in improving the delivery of governmental services to the rural populations. The outcomes from successful CRM implementation, based on the study by Kim and Pan (2006), were measured based on the information system’s quality, user satisfaction and use of the information system, which impact the overall net benefits of the information system on the organisation.

The Green information system innovation process is also described through outcomes (Melville & Whisnant, 2012; Tan, et al., 2011). With regards to the benefits or outcomes from Green information system innovation, the literature identifies that eco-sustainability goals can be framed using (1) eco-efficiency (DeSimone & Popoff, 1997); (2) eco-equity (Gray & Bebbington, 2000); and (3) eco-effectiveness (McDonough & Braungart, 1998). *Eco-efficiency* refers to “a business’s ability to deliver competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts” (DeSimone & Popoff, 1997, p. 47). *Eco-equity* focuses on the equal rights of people for environmental resources and a business’s ‘social responsibility’ for future generations (Gray & Bebbington, 2000). *Eco-effectiveness* generally attempts to

stop the contamination and depletion of natural resources by directing individual and organisational attention to the underlying and fundamental factors of environmental problems through a fundamental redesign of the system (McDonough & Braungart, 1998). According to Abukhader (2008), the term *eco-effectiveness* is not in common use and is still seen as a metaphor.

There are hypothetical discussions and anecdotal examples on different types of information systems used for achieving environmental sustainability goals. For example, Chen et al. (2008) opine that organisations can achieve eco-efficiency through automation of their operational and control systems. This will reduce human intervention to a minimum and will significantly enhance information efficiency. Information systems can also help organisations achieve eco-equity goals by informing stakeholders, employees and customers and by giving them adequate information on ecological impacts of organisational activities (Chen, et al., 2008). The Web can be used as one of the mechanisms to distribute such information. Information systems also facilitate the enforcement of regulations and policies via codified knowledge systems and databases (e.g., computerised ISO 14001 environmental management system (Bibri, 2009; Brown, et al., 2005)). The practice of using collaboration tools and telepresence which can completely eliminate paper-based workflows and reporting (Chen, et al., 2008) and conducting business transactions through e-commerce (Abukhader, 2008; Boudreau, et al., 2007) can lead to eco-effectiveness. In another example, in Watson et al. (2010), the outcomes of efficient and effective energy informatics include the attainment of all three eco-goals of eco-efficiency, eco-effectiveness, and eco-equity. Furthermore, Melville and Whisnant (2012) argue that the outcomes from Environmental ERP initiated by belief formation and action taking may include annual sustainability reports as the direct output; the Environmental ERP itself, and other outcomes such as energy reduction initiatives and employee engagement programmes. On the other hand, Tan et al. (2011) view the outcome from the greening initiative as “Green Leadership”.

2.6 RESEARCH IMPLICATIONS

Based on the literature analysis discussed above, the followings are the salient points that can be taken as key takeaways to further this research.

1. From the conception of innovation, while the definitions and types of organisational and information system innovations are clear, however, the clarity of Green information system innovation conception is still not clearly defined due to the field's relative newness. Moreover, Green information system is considered still in its infancy stage by IS researchers as compared to the larger IS discipline. Hence, more research to provide clarity on the conception of Green information system innovation is warranted. This is particularly for process-based Green information system research which investigates the stages, nature, types, and adopting entities of Green information system innovation.
2. There are three lenses to study Green information system innovation such as the diffusion of innovation (DoI), organisational innovativeness (OI) and process theory of innovation (PT). Of the three, the process theory (PT) lens of innovation is more suited to explain Green information system innovation because the PT enabled the explanation of rich description of a series of sequentially interconnected events and interactions that unfold over time in any Green information system innovation process and undertaking.
3. From the drivers of innovation discussion point of view, each of the perspectives of innovation drivers such as institutional, strategic choice, the TOE framework and contextual-processual is able to provide a general understanding towards the decision for organisations to create and/or apply Green information system innovation. However, the contextual-processual perspective provides an investigation tool that is more thorough in explaining the drivers of Green information system innovation as it provides the mechanisms to examine the interactions between the contextual factors (internal and external) with the unfolding innovation process as its progress over innovation stages.
4. The outcomes of innovation are various. Innovations often result in direct products or techniques used to produce better productivity, increase efficiency and effectiveness. For Green information system innovation, the most common benefits are framed

using the eco-efficiency, eco-equity and eco-effectiveness perspective. However, in the context of the organisation, the outcomes of Green information system innovation, particularly from the environmental, economic, operational, or social, are less captured in the literature. In some instances, some Green information system innovations are producing negative benefits such as creating more e-waste than intended. Hence, this research is imperative in achieving better understanding about the outcomes from Green information system innovation.

CHAPTER 3 : A CONCEPTUAL FRAMEWORK FOR INVESTIGATING GREEN INFORMATION SYSTEM INNOVATIONS

3.1 INTRODUCTION

This chapter discusses the conceptual framework developed for this research. Drawing from the insights of the contextualist-processual approach and the process theory of innovation discussed in Chapter 2, the conceptual framework for the research is proposed in this chapter. Gregor (2006) posits that theories are useful as they provide a lens for viewing and explaining the world and identified four primary roles of theory. The first role of the theory is called analysis and description whereby the theory is used to analyse and describe the research phenomenon. The second role it provides is for explaining and the focus of this theory is to explain why, how, what and when things happen within the phenomenon under study. Predication, that is, the use of the theory to predict what will happen in the future if certain conditions are maintained is the third role of the theory. Finally, there are prescriptive theories to predict as well as to describe the method or structure of the development of an artefact (Gregor, 2006). In the current research, the second role of the theory (i.e., to explain) is chosen as the research questions were about the *what*, *why*, *how*, and *when* pertaining to Green information system innovation in an organisation. The conceptual framework therefore provided a theoretical tool for the researcher to approach the data collection and analysis and to frame the presentation of the findings.

The chapter is structured as follows. Section 3.2 provides the underlying theory to the conceptual framework. In Section 3.3, the initial conceptual framework is proposed and discussed along with the related concepts to help facilitate the framework building. The concepts include content, context, process, and outcome of the Green information system innovation. The chapter concludes by offering the chapter summary in Section 3.4.

3.2 UNDERLYING THEORY

As this research is focused on Green information system innovation process, and seeking to understand both the stages as well as the chain of events (Wolfe, 1994) of Green information system innovation process, Pettigrew's (1990) contextualist-processual theory of organisation change was considered as a relevant theoretical foundation. Pettigrew's (1990) contextualist and processual theory of organisation change is relevant for analysing innovation process in organisations as it provides the tools to focus on the "what, why and how" of change such as information system innovation and evaluation (Stockdale & Standing, 2006).

In analysing the change process including an innovation process, there are four basic elements to a contextualist analysis. They are: the content component, the context component, the process component, and the outcome component of the process under investigation. Pettigrew (1987, 1990) defines **content** as the area subjected to transformation that could include a new **technology**, the personnel of a firm, or a new product launch. In this thesis, the **content** of Green information system innovation refers to the **new or existing technology**, in which the substance of the Green information system artefacts can be seen from the spirit, interpretive flexibility, and the types of Green information system. The context refers to the environment in which organisations and stakeholders operate, and is further delineated as outer and inner context. The outer context describes the environment that the firm operates in, including social, competitive, economic, and political factors. The inner context incorporates the culture of the firm, including social norms, firm objectives, and management structure. Pettigrew (1997) posits that context is not a static state from which to base the study of a particular phenomenon; rather there is a constant interaction between the content and context, and outcomes are constrained and shaped by the context. The process refers to the specifications and interactions between stakeholders as they attempt to modify organisational practices. Processes are studied from two dimensions, the vertical and the horizontal. According to Pettigrew (1987, 1990), the vertical processes refer to the interdependencies between higher and lower units of analysis through time, while the horizontal analysis provides a temporal view of the transformation or to the sequential

interconnectedness between phenomena in historical, present, and future time. The outcome component is used to understand the benefits from the innovation.

A proper exploration of these elements requires the study of the relationship and interplay between the content, the context and the process of managing the change. In terms of concretely applying the contextualist-processual approach, there are six key issues, according to Pettigrew et al. (2001, p. 607) researchers need to pay attention to: “(1) The examination of multiple contexts and levels of analysis in studying organisational change, (2) the inclusion of time, history, process, and action, (3) the link between change processes and organisational performance outcomes, (4) the investigation of international and cross-cultural comparisons in research on organisational change, (5) the study of receptivity, customisation, sequencing, pace, and episodic versus continuous change processes, and (6) the partnership between scholars and practitioners in studying organisational change”. As discussed in Chapter 2 (refer Section 2.4.4 for details), the contextualist approach has been used in several IS research studies which saw the process of IS implementation taking shape in an interplay with social and cultural aspects of both the organisational and the broader national environment.

3.3 INITIAL CONCEPTUAL FRAMEWORK

The application of the contextualist-processual theory to explain Green information system innovation implies that the ‘*what*’ of Green information system innovation can be explained by looking at the content of Green information system. The ‘*why*’ of Green information system innovation can be understood through the analysis of the internal and external contexts of Green information system innovation to explain the motivation and drivers of the innovation as well as the outcome of Green information system. The ‘*how*’ of Green information system innovation provides the detail and complex process of innovation unfolding through the analysis of sequence of events.

This current research is framed within an organisation which operates within its own contexts (i.e., internal context such as leadership, business needs, sustainability culture, and innovativeness; as well as the external pressures exerted by the government, industry,

consultants, suppliers, vendors, partners, stakeholders, customers, and competitors through coercive, normative and mimetic pressures). Both of the internal and external contexts interact with the innovation process occurring within the organisation over time. This interaction is taking place in both directions whereby the context would drive the innovation process while the innovation process would in turn also influence the internal context where applicable. The interactions of the factors, either from the internal and/or external contexts influence how the innovation phases proceed from one stage to another. . This, in return will also affect the outcomes of the innovation process as there is no predetermined outcome could be guaranteed to be achieved despite the intended benefits from using the Green information system innovation. Figure 3.1 demonstrates a pictorial representation of the conceptual framework which is followed by a discussion of each of the underlying concepts.

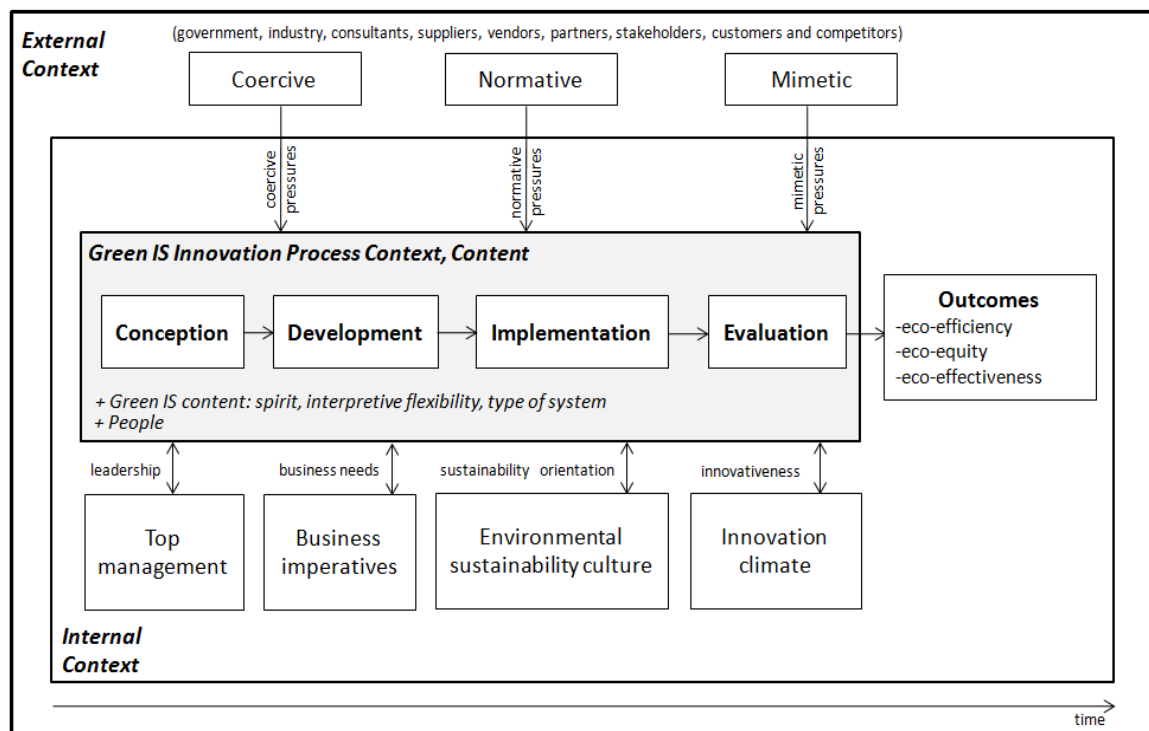


Figure 3.1– Proposed Conceptual Framework

3.3.1 The Content of Green Information System Innovation

The content of Green information system innovation can be described in three themes. First is in the **spirit** of the system, second is in the **interpretive flexibility** of the system, and third is in the **type of the system**.

3.3.1.1 The spirit of Green Information System

To understand about the **spirit** of the system, it is important to refer to the softer conceptualisation of information systems that goes beyond the objective and touchable artefacts which incorporates a subjective construct. This perspective of information systems is closely related to Orlikowski's (1992, p. 400) view where she argues that, "technology is not an external object but a product of on-going action, design and appropriation". Thus, an information system as a product of human agents will include, and at the same time reflect the "structures", that is, the rules of behaviour of the social system that designs it. This embodied structure of information systems is known as "spirit" and defined as "the general intent with regard to values and goals underlying a given set of structural features" (DeSanctis & Poole, 1994, p. 126). In essence, the spirit is related to the human values embodied in the structural properties and functional capabilities (i.e., the technical features or affordances) of a given information system. In fact, DeSanctis and Poole emphasise that "...when considering spirit, we are more concerned with questions like, 'What kind of goals are being promoted by the technology?' or 'What kind of values are being supported?'" (DeSanctis & Poole, 1994, p. 127). According to Markus and Silver (2008), values must be considered when analysing IS effects because system developers usually try to promote their own values of efficiency, aesthetics, democracy or control.

This conception of information systems implies that the contents of the new technology and new products (Simula, Lehtimaki, & Salo, 2009) that aim to improve the sustainability of the natural environment, that is, for pollution prevention, product stewardship, clean technology and supporting sustainability vision (Hart, 1995, 1997; Hart & Milstein, 2003) can emerge in the structural feature of the technology or product. Ijab, Molla, Kassahun, and Teoh (2010) propose that when the information systems are

developed with an intentional inscription of the values of eco-sustainability into their technical features or affordances during design and development, then, they become Green information system innovation. Hence, the way designers view their tasks, in particular when designing and developing information system for today's organisations and their orientation of designing environmentally sustainable systems is one way of identifying the spirit of the system (Watson et al, 2010). Melville (2010) and Molla et al (2014) also posit that the extent to which systems developers understand and implement the design of information system for energy monitoring, energy optimisation systems and model the demand for future energy requirements are other ways of inscribing greenness in information system. Further, following on York et al (2009) and Melville (2010) observation, to what extent the information system design community is developing and using innovative information systems that change user behaviour is one reflection of the content of Green information system. Such innovative information systems, developed with the Green "spirit" are not only for organisational use (i.e., environmental management systems) but also for general environmental information and action-inducing systems.

3.3.1.2 The interpretive flexibility of systems

In the parlance of Orlikowski (1992, p. 406), "technology is physically constructed by actors working in a given social context but also technology is socially constructed by actors through the different meanings they attach". Thus, an information system as a product of human agents will include, and at the same time reflect, not only the "structures", that is the rules of behaviour of the social system that designs it but also the **interpretations** of the social system that it is going to serve (Rose & Scheepers, 2001; Walsham, 2002). "**Interpretive flexibility**" therefore refers to the degree to which users have appropriated a given information system either faithfully (that is as intended) or unfaithfully (unintended) (Orlikowski, 1992).

As a result of the time and space gap between the construction of an information system and its implementation, different users are likely to appropriate and use the same information system differently. This also means that the same technology is likely to have different meanings and effects for different users (Rose & Scheepers, 2001). Identifying this "time-space discontinuity" between the design and the use of the technology is very

crucial in understanding the difference between technology in design (with its spirit and embedded structure) and technology in practice (with its emergent structure). The practice lens of technology argues that users interact with the technology recursively in their day-to-day practices (Orlikowski, 2000). Through “regularised engagement with a particular technology (and some or all of its inscribed properties) in particular ways, in particular conditions, users repeatedly enact a set of rules and resources which structures their on-going interactions with that technology” (Orlikowski, 2000, p. 407). Over time, people constitute and reconstitute a structure of technology use, that is, they enact a distinctive technology-in-practice. As technology-in-practice is recurrently enacted, it becomes firmly fixed in mind (forms a cognitive structure) that shapes subsequent behaviours. Consequently, the action becomes routine and a taken for granted matter.

The above argument implies that the content of Green information system can emerge at the time of use as users interact with and interpret a given information system that may or may not have a Green spirit. To illustrate this, we take two examples. Most organisations can substitute the traditional, face-to-face business meetings that require travelling by video conferencing. Video conferencing was originally developed and used to facilitate communication instead of eco-sustainability. By adopting video conferencing practices, organisations reduce not only their needs for business travels and its ancillary expenses (hotel, foods, time wasted on the road) but also can reduce traffic congestion as well as carbon footprints associated with the travel (Dwyer & Hasan, 2012; Hasan, et al., 2014; Toffel & Horvath, 2004). Another example is the use of word processor. While the use of word processor was never developed with Green spirit and not consciously appropriated to enact Greenness in-practice, the use of word processor would likely consume fewer natural resources and would create less waste, in addition to increasing productivity (Huang, 2009). Thus in defining the content of Green information system, in addition to the spirit of the system, we need to look into the practice of using the systems and the goals achieved by the system: that is the interpretation of the system by the users.

3.3.1.3 Types of Green Information System

Another dimension to explain the content of Green information system innovation can be drawn from Mines’ (2011) work. Mines (2011) provides a typology of software for environmental sustainability that most organisations need and classified them into six

types of Green information system, namely (i) software for sustainability performance, (ii) software for carbon and energy management; (iii) sustainability product development software, (iv) sustainability knowledge and learning management system, (v) sustainable collaboration and communications systems, and (vi) smart infrastructure management software.

Software for sustainability performance. This kind of software helps organisations to manage their corporate sustainability performance and track progress of sustainability projects. In particular, the software is able to distill complex sustainability data into powerful insights through the automation, informing up and down, and transforming of IT/IS resources for sustainability purposes. The software also integrates and streamlines environmental processes such as emission analyses, water and energy management, and waste reduction. Through the integration, the software provides visibility into risk of incidents including oil spills, chemical leaks, or improper disposal of toxic substances while strengthening compliance with environmental regulations and standards. This type of software, in summary, enables organisations to analyse the environmental impact through powerful dashboarding system that provides a comprehensive view of environmental activities, incidents, and trends, facilitating continuous improvements (Butler, 2011; Mines, 2011; The Climate Group, 2008).

Software for carbon and energy management. This kind of software helps organisations to measure, monitor, manage, and report corporate carbon footprint and resource consumption. The software is usually specific to the carbon and energy management that tracks organisational data, allowing organisations to comply to the Greenhouse Gas (GHG) reporting either on mandatory or voluntary basis. Using the system, it provides a centralised, online data repository across the entire organisation, providing relevant, consistent, transparent and accurate GHG data. The software also enables standardised GHG emissions accounting and quantification methodologies that facilitate accurate and verifiable emissions inventory across the entire organisation, therefore, it provides the platform for meeting the demanding challenges of GHG management. The carbon and energy management software can be available on the web or on the cloud, to give organisations an accessible view of their GHG and carbon inventory (Butler, 2011; Mines, 2011; The Climate Group, 2008; Watson, Boudreau, & Chen, 2010).

Sustainability product development software. This type of software is used for helping organisations, particularly in R&D and product management roles to improve the design and the development of greener products. The examples of the software include software to design high performance building which can simulate and analyse lighting, energy, and airflow through all stages of the design process; software that enable rapid energy modeling for existing buildings in order to retrofit quickly and efficiently; software that provide materials life cycle assessments to quantify the embodied impacts of building materials, components, or assemblies with high-quality environmental data; or software to design vehicles efficiency by optimising aerodynamics and simulate composite part substitution for light-weight, and fuel efficient vehicles (Butler, 2011; Mines, 2011).

Sustainability knowledge and learning management system. The instances of the sustainability knowledge and learning management systems are Intranet portal and knowledge repositories. Academics perceive the role of Intranet in encouraging green behavior and shaping environmental orientation with respect to environmental cognition, attitudes and behaviors, at both employee and organisational levels (Jenkin, Webster, & McShane, 2011; York, et al., 2009). Additionally, Hasan et al (2014) identify “knowledge repositories” as one example of knowledge and learning management system used for creating, managing and using sustainability related information. When implemented in organisations, sustainable knowledge and learning management system could support staff engagement and education on environmental sustainability education (Boudreau, et al., 2007; Cooper & Molla, 2012; Hasan, et al., 2014; Mines, 2011).

Sustainable communications and collaboration systems. This kind of software, according to Bullock and Davis (2011) help organisations to improve their employee’s productivity, and reduce the delays and costs associated with sharing of the business knowledge. IS researchers also claim that the use of sustainable communications and collaboration system enable organisations particularly knowledge workers to reduce the needs for business travels and improve work efficiency (Boudreau, et al., 2007; Hasan, et al., 2014; Mines, 2011). Chen et al (2008) argue that the adoption of eco-friendly technologies and practices such as video conferencing system or telepresence is the first step towards ecological sustainability. The Climate Group (2008) posit that software such

as communications and collaboration systems facilitate the altering of user behaviour towards sustainable practices as well as enable the adoption of low carbon solutions.

Smart infrastructure management software. This kind of software is used to help in managing smart infrastructure and in improving utilisation of hard assets such as buildings and facilities, as well as fleets of vehicles (Boudreau, et al., 2007; Mines, 2011; Watson, Howells, & Boudreau, 2012). The software provides asset owners (building or vehicles) with information including asset condition and status, asset management, and asset maintenance decision support tool which operate in real-time basis. Performance data are captured using sensitised objects (Watson et al, 2010) such as smart meters, embedded sensors, RFID tags, or global positioning systems (GPS) module to ease the tracking, measuring, analysing, and reporting for management and strategic purposes (Mines, 2011).

3.3.2 The Context of Green Information System Innovation

As highlighted in Section 3.2 and based on the Chapter 2 (Section 2.4) literature review, both themes of **external** and **internal** factors and forces define the context of Green information system innovation (Watson et al, 2010; Elliot, 2011; Butler, 2011).

3.3.2.1 External factors

To understand the external factors, we draw from the institutional theory (DiMaggio & Powell, 1983) and focus on the **coercive, normative, and mimetic pressures** exerted by government, industry, consultants, suppliers, vendors, partners, stakeholders, customers and competitors.

According to Butler (2011), the purpose of **coercive** influences is to coerce a uniform response across organisational fields in order to induce organisational isomorphism in terms of environmental compliance (Chen, et al., 2008; Chen, Boudreau, Watson, & Karahanna, 2009; Scott, 1994). The key institutional pressure to comply with environmental regulations is the government agencies such as the Department of Environment (DoE) which implements the environmental laws and acts. The other

examples of coercive influences include those of regulatory and legal compliance and imperatives that may involve national, regional and international regulations. This may include compliance to certain environmental laws, eco-labels or greener practices advocated by bodies/agencies such as the Restriction of Hazardous Substance (RoHS) Directive, the European Union's Waste Electrical and the Electronic Equipment (WEEE) Directive (Butler, 2011). Further, the regulatory push to reduce carbon footprints exerted by the external forces has forced corporate agendas to include more sustainable practices, and information systems is seen as one of the potential solutions in implementing these practices (Bose & Luo, 2011; Butler, 2011; Molla, 2013). Chen et al (2009) conjecture that coercive pressures are often associated with powerful actors such as the regulators. For example, relentless punishment such as steep fines and/or suspension of operation licenses for dumping toxic or electronic waste carries financial implications and poor corporate image for organisations that violate the mandate. Therefore, based on this example, coercive influences can generally define the context of Green information system innovation from the development until the disposal stage.

The **normative** influences are also shaping organisational responses and this is clearly seen when most of the large corporations are now addressing the triple-bottom line (TBL) and giving greater focus on improving their environmental performance (Chen et al, 2008; Butler, 2011). For instance, ISO14001 - Environmental Management Systems (EMS) has become normative in its adoption allowing companies to comply with rigorous environmental performance indicators. In addition, other normative signals include compliance to the Environmental Protection Authority's (EPA) Energy Star program that looks into energy consumption of the products in use by corporations. The use of the Electronic Product Environmental Assessment Tool (EPEAT) is also seen as a normative influence which enables companies to promote compliance to greener product selection for internal procurement and deployment. Other examples of normative influence that shape organisations' Green information system innovation is the formation of industry associations such as the Climate Savers Computing Initiative, Global eSustainability Initiative (GeSI), and The Climate Group, which according to Butler (2011), advocated for greater eco-sustainability awareness from organisations.

Mimetic influences include the voluntary disclosure made by organisations of their CO₂ emissions and climate change avoidance strategies as advocated by the Carbon Disclosure

Project (Melville, 2010; Butler, 2011). The disclosure of environmental performance indicates the signal sent from organisations to their investors, customers, vendors, suppliers, regulators and competitors that they are indeed taking actions in greening their business operations. Butler (2011) also mentioned that the mimetic influences (*or cultural-cognitive influences, as Butler termed it*) exerted by the non-government organisations (NGOs) such as Greenpeace, the World Wildlife Fund (WWF) and Friends of the Earth, pressured organisations into adopting greener business practices and thus, shaped organisational Green IS field.

3.3.2.2 Internal factors

In addition to these external pressures that set the outer context for Green information system innovation, **internal** factors from within the organisations also shape the organisation's sustainability orientation and desire to go green. Based on the literature review in Section 2.4 (Chapter 2) and Pettigrew (1997) notion of inner context (see Section 3.2 in this chapter), the most important internal factors include ***top management, environmental sustainability culture, innovation climate, and business imperatives***.

Researchers such as Chen et al (2008), Nedbal, Wetzlinger, Auinger, and Wagner (2011), Bose and Luo (2011), and Abdul Rahim and Abdul Rahman (2013) argue that **top management** support is a significant internal factor offering the *leadership* to drive Green information system innovation in organisations. Powerful members of an organisation are more likely to accept changes in organisational operations and strategies if they fit with their values (Andersson & Bateman, 2000; Chen, et al., 2008). As organisational leaders, the top management shape and direct their organisations' managerial attitudes towards such environmental sustainability initiatives facilitated by IS/IT. Further, Nedbal et al (2011), Abdul Rahim and Abdul Rahman (2013), and Gholami, Sulaiman, Ramayah, and Molla (2013) suggest that top managerial support is important to orchestrate the organisational adaptations in technology, strategy, and business processes. The implementation or acceptance of Green information system innovation requires the leadership and commitment of the top management to recognise the usefulness of Green information system initiatives to the organisation and allocate resources for innovation throughout its development and implementation (Bose & Luo, 2011). Additionally, Bose and Luo (2011), Nedbal et al (2011), and Lei and Ngai (2014)

find that champion support can facilitate the adoption of a new technology such as the Green information system innovation by providing the necessary drive and effort to initiate the adoption.

Environmental sustainability culture can be defined as the environmental attitudes at the employee level and organisational level which represent feelings of favourableness or unfavourableness toward a behaviour (Jenkin, et al., 2011). It is another internal factor that facilitates organisations to create and/or apply Green information system. For environmental sustainability culture to develop, staff members need to value the environment and are committed to sustainability and support environmental innovations, thus forming a positive *sustainability orientation* which could influence adoption of Green information system innovation and change work practices towards more sustainable ones (Baumgartner, 2009; Jenkin, et al., 2011; Melville & Whisnant, 2012). The environmental sustainability culture also force IT departments and managers to clean up their environmental acts through initiatives such as Green IS, Green IT or sustainable computing (Babin & Nicholson, 2009; Mithas, Khuntia, & Roy, 2010).

According to Maughan (2012), establishing an **innovation climate** requires appropriate policies and practices with respect to people and work. For innovation climate to happen, the *innovativeness* of the organisation is the important criteria (Benitez-Alamo, Perez-Arostegui, & Javier, 2010). Innovativeness is the organisation's predisposition to innovate and that encourages employees to be innovative in pursuing the development of new products or processes (Benitez-Alamo, et al., 2010; Santos-Vijande & Alvarez-Gonzales, 2007). Innovativeness also entails organisational capability to support initiatives developed by employees such as new ways of doing things, productivity and quality improvement, elimination of wasteful and inefficient work practices, new product ideas, new procedures, or new/perceived new innovations (Benitez-Alamo, et al., 2010). A related term to innovativeness was coined from the perspective of Green IT, called "eco-innovativeness". According to Molla (2013), "eco-innovativeness" is a firm's ability to take advantage of the opportunities associated with climate change, to cultivate eco-sustainability mindset and vision for product and service for innovation, and create a pool of talent and other resources to realise the vision. Organisations that encourage eco-innovativeness climate can also spur IS/IT innovations among the employees in supporting the organisations' environmental sustainability goals and initiatives.

Another driving factor from the internal is the **business imperatives**. The **business imperative** refers to organisations' motivation to implement sustainable practices and information system innovations that could lead to revenue generations and/or costs reductions (Seidel, Recker, Pimmer, & vom Brocke, 2010). Researchers such as Alaraifi, Molla and Deng (2011); Melville and Whisnant (2012); and Roessler, Schlieter and Esswein (2014) argue that more and more organisations are innovating in sustainable practices and information system due to the *business needs* in reducing energy costs, optimising the resources, enhancing the performance, and increasing productivity. Furthermore, Mithas et al (2010) claim that innovations in and prudent use of IS/IT innovations had become a top priority for organisations as it has the potential of saving up to 25 percent of total energy costs for the adopting organisations.

3.3.3 The Process of Green Information System Innovation

The contextualist-processual view of process implies that the process of Green information system innovation has to be explained through a temporal view of the transformation across higher and lower units of analysis, Pettigrew (1987, 1990). To achieve this, and based on the insight drawn from the literature on the process theory of innovation (Section 2.3.3 in Chapter 2), we need to look at four themes: **stages, critical events, people, and time**.

3.3.3.1 Stages and critical events

The **stages of innovation** (inclusive of the **critical events** inside it) can be described based on the four main stages, listed below:

- *Conception stage*: At the conception stage, an opportunity for Green information system innovation is conceived and recognised by organisations or the adopting entities (Huang, 2009; Ijab et al, 2010). According to Huang (2009, p. 117), “environmental concerns need to be an integral part of the development process from the beginning, not an afterthought”. There are many possible sources of Green information system innovative ideas as innovations can be internally

generated, borrowed from outside the organisation, or copied from other organisations within the same industry (Chen, et al., 2011; Jenkin, et al., 2011; Malhotra, et al., 2010). Typically, the conception stage involves **critical events** such as problem recognition and definition, requirement gathering (Shenoy & Eeratta, 2011), including green functional requirements (Huang, 2009; Ijab, et al., 2010; Zhang, et al., 2011), and project definition and scoping (Huang, 2009).

- *Development stage*: After detecting an opportunity for innovation, organisations as the innovation adopting entities must realised the opportunity into an innovation, transforming by designing and developing the initial idea into a new thing (or perceived new thing), or a new way of doing things (Capra, Francalanci, & Slaughter, 2012; Huang, 2009; Sobotta, Sobotta, & Gotze, 2010; Zhang, et al., 2011). Among the **critical events** carried out in this stage include designing the “carbon-aware” software process management (Ghose, Hoesch-Klohe, Hinsche, & Le, 2009), evaluating and deciding sourcing, defining functional and customer requirements (Zhang et al, 2011), specifying hardware requirements, deciding development environment for the information system, as well as developing the information system innovation itself.
- *Implementation stage*: This third stage represents the culmination of the innovative activities or events such as defining the implementation environment, system testing, system migration, awareness creation, and development of users’ capacity via trainings (Huang, 2009; Ijab, et al., 2012; Ijab, et al., 2010; Shenoy & Eeratta, 2011). During this stage too, new (or perceived new) products or processes are commercialised or implemented (i.e., diffused across the organisation) (Bengtsson & Agerfalk, 2011; Pitt, Parent, Junglas, Chan, & Spyropoulou, 2011; Vaia, Carmel, DeLone, Trautsch, & Menichetti, 2012). **Critical events** related to implementation or use stage include the appropriation of the information system according to the original intent, acceptance or rejection of the information system, cultivation of practice, monitoring the practice and its diffusion, defining performance indicator or measure, as well as producing reports over the effectiveness of the information system innovation in use (Bose & Luo, 2011; Huang, 2009; Ijab, et al., 2010).
- *Evaluation stage*: This last stage involves the evaluation activities whereby the innovation and action made based on the sustainable practice is measured in terms

of its outcomes or impacts to the organisations (Huang, 2009; Ijab, et al., 2010; Melville, 2010; Vaia, et al., 2012). **Critical events** include decision making in which decision will be made, either the innovation will continue to be used (use extension), expand the functional affordance or features, replaced or discontinued (Ijab, et al., 2010; Molla, Cooper, & Pittayachawan, 2011; Shenoy & Eeratta, 2011). At this stage too, information system innovation can be metastructured, which is defined as ‘deliberate, on-going, and organisationally-sanctioned intervention within the context of use that helps to adapt new communication technology to that context, modifies the context as appropriate to accommodate use of the technology, and facilitates the on-going effectiveness of that technology over time’ (Orlikowski, Yates, Okamura, & Fujimoto, 1995, p. 424).

3.3.3.2 Key people

As discussed in Section 2.3.3 The Process Theory of Innovation, the **key people** involved in any information system innovation process should include the top management, system developers, IS managers and clients. In the narrower context of Green information system innovation, the key people are generally similar; however their roles are more towards championing the sustainability cause through IT/IS.

Green IS researchers claim that the **top management** uses their “positional” power to instruct the development of sustainable systems (Abdul Rahim & Abdul Rahman, 2013; Ijab, Molla, & Cooper, 2011; Nedbal, et al., 2011). This is because the top management as leaders in organisations has the ability and capability to give commitment, make decisions, allocate resources and set norms (Bose & Luo, 2011; Abdul Rahim & Abdul Rahman, 2013). Therefore, they have a critical role in influencing the adoption decision of sustainable practices including Green information system innovation. In the case of China Mobile’s Green IT initiatives, Tan, Pan, and Zuo (2011) demonstrate the attainment and enactment of green leadership in the organisation was attributed to leaders who have the traits, dispositions, function, behaviour, power, vision, and intelligence that are sustainability-conscious and environmentally friendly. Other IS researchers such as Bose and Luo (2011) also posit that the implementation or acceptance of Green IT initiatives requires support from the organisation’s top management who recognises the usefulness of an idea to the organisation and leads authority and resources for innovation

throughout its development and implementation. The examples above illustrate the major role played by the top management in driving and influencing the entire Green information system innovation process.

Melville (2010), Zhang et al (2011), and Otrell-Cass (2015) highlight that those who are directly involved in ICT development are potentially in a prime position to shape people's ideas about the environment because the products of their development can support sustainability practices by focusing on environmental and economic performance. In this regard, **system owners** and **system developers** are the key people with those responsibility to inscribe the environmental sustainability values into the IS innovations at the time of its conception and development (Ijab et al, 2010; Zhang et al, 2011). Furthermore, Zhang et al (2011, p. 80) claim that “specifically for IT system, the **system owner's** design decision is of great importance to the system's overall environmental impact”. **System developers** can rely on several models while designing and developing environmental-friendly information system innovations. These models include Huang's (2009) Sustainable System Development Life Cycle (SSDLC), Zhang et al's (2011) Goal-Oriented Requirements Language (GRL) Model, Naumann, Dick, Kem, and Johann's (2011) The GREENSOFT Model, Shenoy and Eeratta's (2011) The Green Software Development Life Cycle Model, and Mahmoud and Ahmad's (2013) Green Model for Sustainable Software Engineering.

The role of **IS managers and professionals** are also important in shaping the direction of sustainable information system innovations (Dedrick, 2010; Ijab, et al., 2011; Molla, et al., 2008; Seidel, Recker, Pimmer, & vom Brocke, 2014). According to them, IS managers and professionals are more focused on reducing the direct environmental impacts of IT, for example, by making data centres and personal computing more energy efficient. For instance, Molla et al (2008) discover that IT professionals in Australia were most concerned about climate change and they also practice simple behaviours to support eco-sustainability. Further, Ijab et al (2011), Gholami et al (2013), and Cooper and Molla (2014) also discover that IS professionals and managers are more exposed to the latest trends in the ICT industry pertaining to environmentally-friendly practices and initiatives such as Green IT and Green IS. The exposure were received through engagements with **technology consultants**, interactions with other industry players including **vendors and partners**, **clients** and **competitors**, and participations in industry seminars and trade

exhibitions provide them with the sufficient and actionable sustainability knowledge. Thus, these consolidated knowledge on sustainable practices would make them suitable environmental sustainability **change agents** or **environmental champions** in organisations (Ijab & Molla, 2011; Ijab, et al., 2011; Taylor, Cocklin, & Brown, 2012; Visser & Crane, 2010). Ideally, Seidel et al (2014) claim that environmental champions (or sustainability champions in their parlance), should have the role of multipliers and front runners that communicate and facilitate the implementation of the sustainability strategy, and dedicate 10% of their working time to sustainability-related issues (Seidel et al, 2014).

3.3.3.3 Time

In the literature review chapter (refer Section 2.4.4, Chapter 2), it was posited that based on the contextualist-processual perspective, information system innovation process is seen as processes unfolding through **time** in relation to layers of context of the organisational setting and the external environment. Time is a form of temporal dynamism (Rivoli & Waddock, 2011). Thus, Green information system innovation process cannot be examined in a static context because during the innovation process, time dynamic actually correspond to the dynamics in the external and internal contexts (see Section 3.3.2), the progression in the Green information system innovation stages and the unfolding of critical events (see Section 3.3.3.1), and as they are shaped and directed by the key people (see Section 3.3.3.2).

In the Green IS/IT literature, there are several Green information system case studies that can be explained from the perspective of time (Melville & Whisnant, 2012; Tan, et al., 2011; Watson, Boudreau, Li, et al., 2010). Watson et al (2010) highlight the UPS' telematics project. The case study revealed UPS's use of package flow technology in 2003 with the purpose of determining efficient route for drivers, resulting in 11.4million litres of fuel saved in 2008. In order to increase efficiency (i.e., to further reduce mileage, fuel consumption, and replacement parts), in 2007, UPS piloted telematics project with 300 delivery trucks and in 2009, the project was expanded to 10,000 delivery trucks. The main environmental benefits from the telematics project was claimed to be significant reduction in fuel consumption for UPS. Another case in point is the examination of China Mobile's success in attaining and enacting Green Leadership over a period of time (Tan et

al, 2011). The time dynamics was divided into three distinct phases, namely Establishing a Green Vision Phase (2007-2008), Enacting Internally, Promoting Externally Phase (2008-2009), and Acting in Concert Phase (2009-Present). The phases entail several major processes including strategising, mobilising, and collectivising. These critical events were then divided into sub-processes such as envisioning (for strategising process), enacting and evangelising (for mobilising process), and eliciting (for collectivising process). The last case example, Melville and Whisnant (2012) illustrate the key events related to environmental sustainability and environmental ERP (e-ERP) at SunGard from pre-2008 to 2011. The key events associated include: grassroots sustainability efforts (pre-2008); formal sustainability commitment (2008); Generation 1 e-ERP (2009); Generation 2 e-ERP: Vendor Vetting (2010); and Generation 2 e-ERP: Implementation (2011). In the case study, the role played by the senior management who embraced the importance of corporate environmental sustainability was highlighted. This is added with the involvement of the external and internal stakeholders including the employees.

Based on the above discussion, time is indeed a crucial element towards understanding and explaining Green information system innovation process. The dynamics and effects of time, according to Pettigrew et al (2001, p. 697) is “an essential part of investigations of change if processes are to be uncovered”. Therefore, based on the adopted contextualist approach, the inclusion of time in researching Green information system innovation process is useful as it is interconnected with the study of contexts, content, process, and outcome of change.

3.3.4 The Outcome of Green Information System Innovation

The outcome of Green information system innovation can be framed around the three themes of eco-sustainability goals: (1) **eco-efficiency** (DeSimone & Popoff, 1997), (2) **eco-equity** (Gray & Bebbington, 2000) and, (3) **eco-effectiveness** (McDonough & Braungart, 1998) as defined and discussed in Section 2.5 (Chapter 2). In this section, more details on the three outcomes of Green information system innovation are discussed. In general, Chen et al (2008) and Hasan et al (2014) argue that information system can be leveraged to achieve eco-efficiency through automating, eco-equity through information flows, and eco-effectiveness through organisational transformations.

In achieving **eco-efficiency** outcome, Green information system innovation can enable efficient use of natural and firm resources in order to reduce negative environmental impacts (Hasan, et al., 2014; Jenkin, et al., 2011). Careful use of Green information system can reduce energy cost, might induce organisations to focus on recycling of waste and other waste management measures that may lead to reduce power consumption (Gholami et al, 2013). Organisations may use collaboration tools, telecommuting, and video conferencing tools to reduce costs due to travel needs reductions. Hasan et al (2014) claim that virtual meetings have been possible for several decades but were hampered by either cheap but low quality video conferencing systems, or expensive but with high quality video conferencing systems. Thus, towards achieving and understanding the eco-efficiency outcome enabled by Green information system innovations, Green IS scholars are encouraged to conduct more research in this area of investigations.

In terms of **eco-equity** outcome, Jenkin et al (2011) posit that Green information system innovation can be used in focusing the equal rights of people to environmental resources and a business' social responsibility for future generations. The implementation of an information system and associated technology can capture environmental data during product distribution, use and maintenance for product design improvements (Jenkin, et al., 2011; Yang, Moore, Wong, Pu, & Chong, 2007). Information system innovation can also contribute to the development of eco-equity through informing the users and through increasing the certainty, transparency, and emotivity of the salience of ecological issues (Chen, et al., 2008; Elliot, 2011). Elliot (2011) claims that information system contribute to eco-equity by informing downwards to build environmental awareness in organisations and community, such that eco-equity oriented practices can gain popularity among the staff members or the society. Additionally, information system can also contribute to eco-equity by informing upwards to facilitate enforcement of environmental regulations (Elliot, 2011).

As regards to the **eco-effectiveness** outcome of Green information system, Jenkin et al (2011) posit that Green information system can be used in infusing environmental sustainability considerations throughout all of an organisation's activities and interactions with the goal of stopping environmental degradation altogether. Hasan et al (2014) argue that eco-effectiveness outcome is less researched and hence, little is published in the IS

literature pertaining to eco-effectiveness outcome. However, one exemplar case that can be used to explain eco-effectiveness is from Bradshaw & Donnellan (2013). Bradshaw and Donnellan (2013, p. 6) in their works on the use of Energy Informatics Framework in enhancing the design of bikeshare schemes claim that “the concept of bikeshare is consistent with the goal of eco-effectiveness”. This is because the central concept of bikeshare is to provide an affordable alternative to motorised transportations and enable transformation in the forms of reducing urban traffic congestion, noise, and pollution. In the study, three bikeshare schemes in Ireland, the United States, and Denmark as well as their associated information system (i.e., the RFID tags as the sensitised objects, the GPS technology for sensor network, and the kiosk-based central information systems and web application for the information system part) were investigated and explained. The transformative power of information system (i.e., the bikeshare scheme systems) demonstrates the eco-effectiveness outcome resulting from Green information system innovation, and hence is captured in the conceptual framework of this study.

3.4 CHAPTER SUMMARY

This chapter discussed the underlying theories and concepts used in guiding the development of the conceptual framework for this research work. The discussion was made on the contextualist-processual approach pinned around the works of Pettigrew (1987, 1990, 1997) and Pettigrew et al (2001) along with the research implications reviewed in Chapter 2. The proposed conceptual framework provides the necessary mechanisms towards understanding the intricate Green information system innovation process from the content, context, process, and outcome perspectives. Additionally, the conceptual framework is developed as to facilitate the data collection, data analysis and as well as presentation of findings and the overall thesis discussion. The following chapter provides detail on the research methodology adopted during the conduct of this research.

CHAPTER 4 : METHODOLOGY

4.1 INTRODUCTION

This chapter describes the research methodology employed in conducting this study. The chapter begins by providing a brief overview of the available research philosophies and the interpretivism research paradigm selected for this study (Section 4.2). The chapter then outlines the research method which details the strategy taken in implementing the study (Section 4.3) and in particular, the data collection techniques adopted (Section 4.4), and the use of thematic coding for data analysis (Section 4.5). The chapter then provides a discussion on the topic of research trustworthiness (Section 4.6) before concluded it with a chapter summary (Section 4.7).

4.2 RESEARCH PHILOSOPHY AND PARADIGM: THE ONTOLOGICAL AND EPISTEMOLOGICAL POSITIONS

The philosophical assumptions of academic research undertaken in the IS field are commonly discussed under different beliefs about the nature of social reality (ontology) and the competing visions about the ways humans create their knowledge about the social world (epistemology) (Myers, 1997). A research philosophy provides the researcher with the foundation for the methods or strategies by which the phenomenon can be investigated (Crotty, 1998). In IS research, there are three major philosophical assumptions (or research paradigms): positivism, interpretivism and critical research (Myers, 1997; Orlikowski & Baroudi, 1991). A summary of these research approaches is depicted in Table 4.1.

Epistemology	Positivism	Interpretivism	Critical	
			Critical research	Relational realism
Ontology	Reality is 'real' and apprehensible.	Reality is socially constructed rather than objectively determined.	View social reality as materialist and structuralist in nature, with reality existing independently from the observer.	Reality is relationally constructed, embedded in time and constituted in relationships.
Characteristics	Emphasis on quantification of constructs; the use of variables have a central role.	Argues that the development, use and implementation of IS intimately concern people, and that the social world presents a better stage to study IS than the material world of technology.	Accept the truths of both positivism and interpretivism. Also accept the need for both causal theories based on objective observation and interpretive descriptions.	Basic units of analysis to be neither individual entities (agent, actor, firm) nor structural wholes (society, order, social structure) but relational processes of interaction between and among identities.
Purpose	Theory testing	Sense-making, Theory building	Uncover myths and hidden meaning.	Uncover relational processes of interaction supporting a more relational and historical view of theory.
Method	Quantitative - survey, experiment, case study, simulation	Qualitative - case study, ethnography, grounded theory, action research	Mixed method - combining both quantitative and qualitative methods	Mixed method - combining both qualitative and quantitative methods.
References	(Galliers, 1992; Mingers, 2003; Orlikowski & Baroudi, 1991)	(Andrade, 2009; Klein & Myers, 1999; Lee, 1991; Roode, 2003)	(Dobson, 2001; Mingers, 2003)	(Bouwens, 1998; Emirbayer & Johnson, 2004; Swartz, 1997)

Table 4.1 - Summary of different research philosophical assumptions in IS research (Based on (Pather & Remenyi, 2004))

This research adopted interpretivism epistemology. Ontologically, interpretivism claims that reality is socially constructed rather than objectively determined (Klein & Myers, 1999). Interpretivism argues that the development, use and implementation of information system intimately concern people, and that the social world presents a better stage to study IS than the material world of technology (Andrade, 2009; Klein & Myers, 1999; Lee, 1991; Roode, 2003). As this research explains Green information system innovation process, ultimately, the study is about researching people and their social world in the context of an organisation as they are embarking along the Green information system innovation journey.

In applying the interpretivism epistemology in this research, the researcher adopted Klein and Myers' (1999) Seven Principles of Interpretivist Research. Towards applying the **fundamental principle of hermeneutic circle**, the researcher immersed himself with the participants in the divisions and individual staff members in order to understand about the Green information system innovation process in Acadia. The researcher also collected and read internal publications such as reports related to the company's environmental sustainability initiatives towards making sense of the various environmental initiatives undertaken in the organisation where the study took place.

In applying the **principle of contextualisation**, the researcher critically investigated the data on Acadia's environmental sustainability based on the company's Annual Reports 2000-2011 and through the interview data. This was carried out to gauge the social context (from external and internal) and historical understanding of the company's initiatives on environmental sustainability. Conducting this Green information system innovation process research from the contextualist approach and interpretive lens allowed the researcher to draw the richness, complexity and the identification of institutional and organisational issues demanded by the contextualist principle.

In adopting the **principle of interaction**, the researcher continuously asked for clarifications, or asked for supporting documents from the research participants in order to understand the Green information system innovation cases being investigated. Since the data collected were voluminous, some information can be considered as abstracts and subjective in nature. These data need to be generalised and sorted according to categories or themes. Using the principle of abstraction and generalisation, the researcher abstracted

to generalise the findings based on the interpretation of the data. Based on the collected data, a detail and thick description was found to explain Acadia's complex innovation process. Thus, based on the discussions with the research supervisors on the research conceptual framework, the innovation process was categorised into phases, stages, events and people.

In applying the **principle of dialogical reasoning**, the researcher and the research supervisors were engaged in critical dialogues toward reasoning certain contradictions found in the data. Clarifications from the research participants or support documents were sought as well. For example, some of the findings on process "events" were similar to the "mechanisms" in the context discussion. Critical discussions with the supervisors were able to clarify the contradictions and confusions encountered by the researcher.

Under the **principle of multiple interpretations**, the researcher collected and compiled the data based on multiple narratives or stories of the same sequence of events under study from many research participants. Thus, the researcher was aware that there will be various interpretations or descriptions over the same issue. For example, the terms used by the participants sometimes are different but they are referring to the same thing. This reconsideration of different interpretation within the same context of all data sources enable the researcher to recognise of where and why views diverge in order to gain a valid finding.

Lastly, by applying the **principle of suspicion**, the researcher was sensitive to the possible "biases" and systematic "distortions" in the narratives collected from the participants. Therefore, in the event of suspicion, the researcher would refer to other participant or the organisational document for verification of the information.

Table 4.2 summarises the application of the interpretivist principles in this research as recommended by Stockdale and Standing (2006) and Klein and Myers(1999).

Interpretivist Principle	Explanation	Application in this Research
1. The Fundamental Principle of the Hermeneutic Circle	This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.	In order to understand the unfolding Green information system innovation process, the researcher immersed himself with the participants in the divisions, and individual staff members, gaining their insights on Green information system innovation in Acadia. At the same time, the researcher read internal publications, and reports related to the company's environmental sustainability initiatives as to contrast the organisational view (the whole) with the individual/group view (the part) in order to make sense out of the confusion, incomplete or contradictory meanings from the voluminous of data. The application of this principle is related to the data collection as covered in Section 4.4.
2. The Principle of Contextualisation	Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.	The researcher critically investigated the data on Acadia's environmental sustainability based on the company's Annual Reports 2000-2011 and through interviews as to gauge the social and historical understanding of the company's initiative on sustainability. Conducting this Green information system innovation process research from the contextualist approach and interpretive lens allowed the researcher to draw the richness, complexity and the identification of social and organisational issues demanded by the contextualist principle. See Section 5.2 in Chapter 5 for the discussion on research setting which provides the contextualisation of the research.
3. The Principle of Interaction Between the Researchers and	Requires critical reflection on how the research materials (or "data") were socially constructed through	The researcher asked for clarification, or asked for supporting documents and gained multiple participants' views in order to understand the Green information system innovation being investigated. In particular, the researcher was in constant

Interpretivist Principle	Explanation	Application in this Research
the Subjects	the interaction between the researcher and participants.	communications and interactions with IT Manager 01 who generally understood much better of Acadia's IT systems and environmental sustainability initiatives, thus she was able to provide the necessary answers. See Section 5.2.5 on the detail of research participants and the types of supporting documents collected, and Sections 5.3 - 5.6 on the details of the Green information system innovations.
4. The Principle of Abstraction and Generalisation	Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.	The researcher abstracted and attempted to generalise the findings based on the interpretation of the data. For example, findings on the complex innovation process in Acadia, which later the supervisor suggested to be further categorised into stages, events and people. This was done together with the research supervisors who provided second opinions and strong theoretical understanding of the Green IS domain. See Sections 5.3 - 5.6 on how the abstraction and generalisation principle was applied to the Green information system innovations process findings.
5. The Principle of Dialogical Reasoning	Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.	The researcher and the research supervisors engaged in critical dialogue in reasoning certain contradictions found in the data and to seek clarifications from the research participants or support documents where needed. For example, some of the findings on process' "events" were similar to the "mechanisms" in the context discussion. Critical discussions with the supervisors were able to clarify the contradictions and confusions encountered by the researcher. See Sections 5.3 - 5.6 on how the dialogical reasoning principle was applied to the Green information system innovations process findings and Chapter 6 on the cross-case analysis and discussion.

Interpretivist Principle	Explanation	Application in this Research
6. The Principle of Multiple Interpretations	Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.	The researcher is open to multiple interpretations of the research participants on the Green information system innovations. The terms used by the participants sometimes are different but they are referring to the same thing. This reconsideration of different interpretation within the same context of all data sources enable the researcher to recognise of where and why views diverge in order to gain a valid finding. See Section 4.5 on the detail of data analysis process towards interpreting the different view points from the research participants.
7. The Principle of Suspicion	Requires sensitivity to possible “biases” and systematic “distortions” in the narratives collected from the participants.	The reflexivity and consciousness (i.e., the subjective ontology of interpretivism study) allow the researcher to be sensitive to the biasness or to avoid from being distorted by the participants. In the event of suspicion, the researcher would refer to other participant or the organisational document for verification of the information. The application of this principle can be seen from the data collection process covered in Section 4.4 and Section 5.2.5 on the detail of research participants and the types of supporting documents collected.

Table 4.2 - Application of the interpretivist principles in this research.

(Adapted from: (Stockdale & Standing, 2006) and (Klein & Myers, 1999))

4.3 RESEARCH METHOD

The first principle of the interpretivist research is the fundamental principle of hermeneutic circle. It deals with understanding a complex phenomenon by considering and combining the interdependent meaning of parts and the whole surrounding the phenomenon being studied (Klein & Myers, 1999). Therefore, in order to understand the meaning of the Green information system innovation process phenomenon, data need to be collected and analysed. There are three types of research methods typically used IS research for collecting and analysing data - quantitative, qualitative and mixed method (Creswell, 2009). The quantitative method places considerable reliance in numbers that represent opinions or concepts (Amaratunga, Baldry, Sarshar, & Newton, 2002). On the other hand, the qualitative method is typically conducted through an intense and/or prolonged contact with a “field” or prolonged time spent in the case organisation (Amaratunga, et al., 2002; Orlikowski & Baroudi, 1991). This method also concentrates on words and observations in its data collection to express reality and attempts to describe people in natural settings (Amaratunga, et al., 2002). The mixed method tends to be based on a pragmatic ground by collecting and analysing both quantitative and qualitative data in a single study (Creswell, 2009).

According to Yin (1994), research strategy should be chosen as a function of the research situation. This is because each research strategy has its own specific approach to collect and analyse empirical data. In choosing the research strategy, (Yin, 1994) lists several conditions which should provide the grounds for strategy choice, including the degree of focus on historical or contemporary events. As this research focuses on a contemporary event, Yin (1994) and Harvey and Myers (1995) suggest that IS research practices need to be viewed in the light of their historical context. This historical or temporal dimension can be used to study both individual and collective behaviours in the organisation’s Green information system innovation process.

4.3.1 Case Study

This study is based on a single organisation setting with the multiple Green information system innovation cases. A case study is appropriate in exploring contemporary phenomena with empirical research typically associated with answering “how” and “why” questions (Yin, 2003). It also focuses on understanding the dynamics present in a management situation (Eisenhardt, 1989). Using case studies, a researcher is able to gather a rich depiction of the social context of the studied phenomena, resulting in rich and insightful information (Yin, 1994).

Case studies can be either single or multiple-case designs. A single case design is used to confirm or challenge a theory, or to represent a unique or extreme case (Yin 1994, pp. 33-40). A single case study is also ideal for revelatory cases where an observer may have access to a phenomenon that was previously inaccessible to scientific investigation. Benbasat, Goldstein & Mead (1987) argue that current topics in the IS field are amenable to the case study approach. For example, the use of expert system which was just beginning to be introduced in organisations in the middle of 1980’s was considered as “revelatory” case study since such a system would provide valuable insights (Benbasat et al, 1987). In two recent works, Sarkar and Young (2011) and Melville and Whisnant (2012) adopted in-depth single case study approach that they considered as revelatory. Sarkar and Young’s (2011) who studied an Australian tertiary institute’s use of cloud technology claimed that their investigation provide them the opportunity to analyse the institute’s motivation and decision for moving a portion of its IT services to a “cloud”. On the other hand, Melville and Whisnant (2012, p. 9) chose a revelatory case study in their investigation of environmental ERP implementation in a leading global software and technology services company because the case study enabled them “to explore phenomena previously inaccessible to researchers and extract insights that lay a foundation for future theory development and potentially advance management practice”. Further, according to Yin (1994), single-case designs require careful investigation to avoid misrepresentation and to maximise the investigator's access to the evidence. These studies can be holistic or embedded, and the latter occurring when the same case study involves more than one unit of analysis (Yin, 1994).

Multiple case studies, on the other hand, are desirable when the intent of the research is description, theory building or theory testing (Benbasat, Goldstein & Mead, 1987). Multiple case studies make it possible to develop a cross-case analysis to extend theory. Each individual case study consists of a 'whole' study, in which facts are gathered from various sources and conclusions drawn on those facts. Multiple case study designs allow cross-case analysis and comparisons, and the investigation of a particular phenomenon in diverse settings (Darke, Shanks, & Broadbent, 1998). Multiple case studies may also be selected to predict similar results (literal replication) or to produce contrasting results for predictable reasons (theoretical replication) (Yin 1994, p. 46). A multiple case study approach can increase the generalisability of findings, and yield more compelling and robust results than a single case study can (Benbasat, Goldstein & Mead, 1987; Yin, 1994).

The multiple cases approach has been suggested to increase the methodological rigour of the study through 'strengthening the precision, the validity and stability of the findings' (Miles & Huberman, 1984). Contrary to the common misconception that case studies provide little basis for scientific generalisation, case studies are generalisable to theoretical propositions, even though not to populations or universes (statistical generalisation) (Lee, 1989; Yin, 1994). Multiple case study designs should allow cross-case analysis and comparisons, and the investigation of a particular phenomenon in diverse settings (Darke et al, 1998).

Given the aforementioned advantages, this research opted for a multiple case study design. By selecting four Green information system innovations as the case studies, the researcher was able to examine the factors driving Green information system innovation, the Green information system innovation process, and the outcome of the Green information system innovation in a cross-case analytical perspective.

The main reasons for selecting the single organisational setting with multiple Green information system case studies are as follows: First, access and convenience. As the researcher was previously an employee of the company, was readily able to contact some of the potential participants. Second, the Green information system is an emerging phenomenon in the organisation and the company has shown interest in using technology for achieving environmental sustainability. Thus, the organisation offered revelatory

Green information system cases to offer insights into the study of the Green information system innovation process. Third, a single organisational setting study is useful for exploration at the beginning of theory generation (Iacono, Brown, & Holtham, 2011). Since there has been little research on Green information system innovation process, researching a single organisation could be a starting point to explore this area. By conducting the data collection in the same organisation, the researcher had some control over some external factors that could affect information system process innovation adoption (Mustonen-Ollila & Lyytinen, 2003). For example, economic fluctuations and market changes affected all studied cases equally as their shared vision and resources were similar. Fourth, the interaction and process of innovation in Green information system involves a lot of complex and complicated processes among the stakeholders. In this perspective, studying more than one organisation would be time consuming and become infeasible.

4.4 DATA COLLECTION

Data were collected after an ethics application was approved by the Human Research Ethics Committee (HREC) in the College of Business of RMIT University (Ref: Ethics Appl. 1000234 (refer Appendix 4.1)). Prior to lodging the ethics application, letters of support from Telecom Acadia were obtained, providing formal approval to access the organisation. Three data collection techniques were employed in the study: interviews and reviews of relevant organisational documents which were carried out in two phases, and a survey was conducted in the second phase of the study.

4.4.1 Study Phases, Participant Selections, and Interview

In Phase One, the study was conducted for two (2) months with the aim of identifying and exploring the existence and the extent of Green information system practice in Acadia. The participants were selected with the assistance of a “gatekeeper”. The gatekeeper (i.e., one of the IT Managers in Acadia’s IT Department, who was also interviewed during Phase One) was contacted when the researcher inquired about the opportunity of conducting empirical data collection in Acadia pertaining to the company’s

environmental sustainability initiatives and the use of information systems for supporting those initiatives. The IT Manager then assisted in identifying relevant persons, while contacts and arrangement to conduct the interview with the interviewees were made by the researcher himself. The research participants were selected due to their knowledge and experience relevant to the research question and objectives of the research (Mack, Woodson, MacQueen, Guest, & Namey, 2005). In this research, as the topic is about Green information system innovation process, the participants need to be the people directly involved in the Green information system innovations process. These include system owners, system developers, and system users who hold various job positions ranging from Assistant General Managers down to technicians. The participants were attached to different divisions and departments within the company being studied. In some instances, information were also collected from indirect sources such as people who were not directly involved in the Green information system innovations, but have relevant information to share pertaining to the general environmental sustainability initiatives implemented in the company.

The sampling technique described above is called the “purposive sampling”. According to Jackson and Verberg (2006), the goal of purposive sampling is not generalisation of findings but rich descriptions of phenomenon by those who have experienced it, and therefore, it was suitable for this research. A snowballing sampling technique was also used whereby the identified participants made a chain referral to their other colleagues. In this method, participants with whom their contact had already been made used their social networks to refer the researcher to other people who could potentially participate in or contribute to the study (Mack et al, 2005).

Table 4.3 summarises the eighteen (18) research participants for Phase One.

No.	Interviewees’ Titles	Job	Department/Division	Innovation Case/Sustainability Topic
01	R&D Manager		Acadia R&D	Case 2: UCC and Case 3: SKMS
02	R&D Manager		Acadia R&D	Case 2: UCC and Case 3: SKMS
03	R&D Manager		Acadia R&D	Case 2: UCC and Case 3: SKMS

No.	Interviewees' Titles	Job	Department/Division	Innovation Case/Sustainability Topic
04	R&D Manager		Acadia R&D	Case 2: UCC and Case 3: SKMS
05	R&D Manager		Acadia R&D	Case 2: UCC and Case 3: SKMS
06	System Developer		Acadia R&D	Case 2: UCC
07	System Developer		Acadia R&D	Case 2: UCC
08	System Developer		Acadia R&D	Case 2: UCC
09	Assistant Manager of IT	General	IT	Green IT
10	IT Manager		IT	Case 2: UCC and Case 3: SKMS; Green IT
11	IT Manager		IT	Case 2: UCC and Case 3: SKMS
12	IT Manager		IT	Case 2: UCC and Case 3: SKMS
13	IT Manager		IT	Green IT
14	IT Manager		IT	Printer Lifecycle Management
15	IT Manager		IT	Printer Lifecycle Management
16	IT Manager		IT	Printer Lifecycle Management
17	IT Manager		IT	Printer Lifecycle Management
18	Sales Manager		Sales	Case 2: UCC and Case 3: SKMS

Table 4.3 - Research Participants (Interviews) from Phase One

In Phase Two, the data was collected over a 4-month period. It was conducted to further understand the Green information system innovation process and the complexities surrounding the emergence and the shaping of Green information system innovation in Acadia. Table 4.4 summarises the twenty six (26) research participants for Phase Two.

No.	Interviewees' Titles	Job	Department/Division	Innovation Case/Sustainability Topic
01	System Developer		Acadia R&D	Case 1: EI
02	System Developer		Acadia R&D	Case 1: EI
03	ES2 System Developer		Acadia R&D	Case 1: EI
04	System Developer		Acadia R&D	Case 1: EI

No.	Interviewees' Job Titles	Department/Division	Innovation Case/Sustainability Topic
05	Assistant General Manager of Quality Management	Quality Management	Case 1: EI
06	Assistant General Manager of Property Operations	Property Operations	Case 1: EI
07	Property Operations Manager	Property Operations	Case 1: EI
08	Property Operations Manager	Property Operations	Case 1: EI
09	Property Operations Manager	Property Operations	Case 1: EI
10	Property Operations Manager	Property Operations	Case 1: EI
11	Property Operations Technician	Property Operations	Case 1: EI
12	Assistant General Manager of Support Business	Support Business	Case 1: EI
13	Support Business Manager	Support Business	Case 1: EI
14	Finance Manager	Finance	Case 1: EI and Case 4: FMS
15	Vendor Manager	Vendor Company	Case 1: EI
16	General Manager of Human Capital	Human Capital	Case 2: UCC and Case 3: SKMS
17	Human Capital Manager	Human Capital	Case 2: UCC and Case 3: SKMS
18	Human Capital Manager	Human Capital	Case 2: UCC and Case 3: SKMS
19	Human Capital Manager	Human Capital	Case 2: UCC and Case 3: SKMS
20	Group Corporate Communications Manager	Group Corporate Communication	Case 3: SKMS; Corporate Responsibility
21	Fleet Manager	Fleet	Case 4: FMS
22	Fleet Manager	Fleet	Case 4: FMS
23	Assistant General Manager of Strategy	Strategy	General energy efficiency initiative
24	Assistant General Manager of Strategy	Strategy	General energy efficiency initiative
25	Product Manager	Product	General energy efficiency initiative
26	Product Manager	Product	General energy efficiency initiative

Table 4.4 - Research Participants (Interviews) from Phase Two

Thus, forty four (44) staff members were interviewed in total (18 from Phase One and 26 from Phase Two). The interview participants were the staff members from various divisions within Acadia as stipulated in Tables 4.3 and 4.4. More details of the research participants interviewed as well as their interviewees' identifications (IDs) are covered in Chapter 5 (Section 5.2, Table 5.2).

In general, interviews make it possible to gather rich data from people in various roles and situations (Myers, 2009). Myers (2009) has identified three types of interviews: structured, unstructured and semi-structured. The structured interview refers to questions that are defined in advance and the interviewee has limited choices in answering them. The unstructured interview has fewer predefined questions but has more open-ended questions that intend to explore interviewees' opinions in depth. The semi-structured interview sits between the structured and unstructured variants. Myers (2009) suggests that with semi-structured interviews, predefined questions should be established; however, the answers to the questions are not limited and other questions can be asked during the interview (Myers, 2009). This study employed the semi-structured face-to-face interview, which is consistent with the interpretivism approach adopted and the initial conceptual framework. In designing the interview questions, the researcher was guided by the research objectives, the three research questions and the initial conceptual framework.

Interviewees were contacted via email to set appointments with them and meetings were held at their offices. In the email, the potential interviewees were sent the invitation letters including the Plain Language Statements (see Appendix 4.2) and also the Consent Forms (see Appendix 4.3) in order to get their consent to participate in the interviews.

The duration of each interview was approximately one hour and a half. Interviews in both stages were audio recorded with the agreement of the interviewees and were later transcribed for further analysis. In the first five minutes of the interviews, the participants were given a brief overview of the research, the aim of the interviews, the content of the interview questions and the ethics process. It was also explained that participation in the interviews was voluntary and it would not affect their reputation, and they were free to decline an interview, stop the interview at anytime, not to answer particular questions,

and to have the interview withdrawn from the study after the interview session was completed.

4.4.2 Archival Documents

In terms of the archival data, the collected data covered the years from 1995 - 2011, which also included in it the organisational documents about information system process innovation conception until its adoption. The organisational documents were including minutes of meetings, annual reports from the year 2000 – 2011, sustainability reports from the year 2008 – 2011, emails, MS-PowerPoint slides and MS-Excel sheets were also collected and used. Myers (2009) argues that organisational documents are resources of data that contribute to a richer picture than just interviews and can supplement data collected in the interviews. Some of these documents were supplied by the interviewees, downloaded from Acadia's website, or downloaded from the company's internal portal by the researcher himself. They served as primary and secondary sources of data (Jarvenpaa, 1991). The details of the organisational documents analysed and used for describing the research findings are described in Table 5.3 in Section 5.2 (Chapter 5).

4.4.3 Survey

During the second phase of data collection, a survey concerning the perception of Acadia's staff members on environmental sustainability and their practices in using Green information system innovations was conducted (hosted on SurveyMonkey). The purpose of the survey was to capture wider set of views among Acadia's staff members about the diffusion of the Green information system innovations, namely the use of the Unified Communications and Collaboration (UCC) and the Sustainable Knowledge Management and Sharing (SKMS) within the company. In order to get the participants for the survey, the researcher was given access to the company's internal portal for employees. The researcher then randomly selected 500 employees and sent each employee an email inviting them to participate in the survey. This email outlined the purpose of the research and also included in it the ethics form. From the 500 emails sent, a total of 150 responses were received at the end of the survey period. The questions used for the survey can be

found in Appendix 4.6 while the results of the survey are embedded in the findings section in Chapter 5 as to further strengthen the findings.

4.5 DATA ANALYSIS

The data analysis followed a three-stage process of data transcribing, coding and analysing. During the data analysis process, the data were organised categorically and chronologically, reviewed repeatedly and continually coded (Creswell, 2003). The following section outlines the data analysis process.

4.5.1 Data Transcribing

In this research, all interviews, total of 2,641 minutes (with an average of 1hr 30minutes per interview) were audio recorded and transcribed. It is regarded as valuable if transcription is done by the researcher because it gives the researcher greater familiarity with the data (Bryman & Bell, 2007). Thus, a word by word transcription was carried out by the researcher. External notes and documents gathered from the organisation were used as supporting information whenever required. All interviews were conducted in a mixed language (English and the local language), requiring translation prior to transcribing. This step is necessary to facilitate the analysis process as well as to provide consistency in data transcription. After the entire transcription process was completed, the researcher went through the interview transcripts and audio recordings again to ensure that any important information had not been missed. All of the above steps were carried out by the researcher himself. Subsequently, the data analysis process continued with data coding.

4.5.2 Data Coding

Coding is the process of identifying justificatory statements and developing conceptual categories from them (Yin, 1994). There are three research questions guided the coding of the data. Given there was **a priori constructs** identified from the Literature Review (see Chapter 2) and a proposed Conceptual Framework (see Chapter 3), thematic coding

was considered appropriate for the data coding process. The thematic coding approach followed (Boyatzis, 1998; King, 1998) which provides a structured way of understanding how to develop the thematic coding. A detailed description of the coding used is presented in the following section.

4.5.2.1 Thematic coding

For Research Question 1 (*“What is Green information system innovation and why do organisations create and/or apply Green information system innovation?”*), Question 2 (*“How do the Green information system innovation process take place in organisations?”*), and Question 3 (*“What are the outcomes from Green information system innovation process?”*), the data were analysed by using a thematic analysis approach. The thematic analysis is one of the predominant techniques used for qualitative data analysis and is the process of searching, identifying and exploring codes and themes based on initial concepts in the description of a phenomenon (Daly, Kellehear, & Gliksman, 1997). The thematic coding used is based on the approach suggested by Boyatzis (1998, p. 4), who suggested three stages in the use of thematic analysis. The first stage involves determining the sampling and design issue. The second stage involves developing themes and codes. The third stage involves validating and using the codes.

The first stage was accomplished prior to data collection with the research participants’ selection (see Section 4.4.1). To complete the second stage and develop themes, the data from the interviews were organised in a systematic manner by organising interview transcripts into similar Green information system innovation cases. A theme is a pattern found in information that describes and interprets aspects of a phenomenon in which the researcher is interested in (Boyatzis, 1998). The initial conceptual framework, alongside the research questions and the literature review served as the original template for identifying themes for the analysis. Such an approach allows the use of existing themes and codes in order to replicate, extend or refute prior discoveries (Boyatzis, 1998). The chosen thematic approach was based on Boyatzis’ suggestion on the flexibility it gives to researchers who may not have the training or confidence to develop their own codes and thus depend on existing theories to assist them in developing themes and codes. Assisted by insights from the literature review and the conceptual framework, the collection of

themes and sub-themes were classified into four bigger categories as per the conceptual framework:

- (a) Content of Green information system innovation;
- (b) Context of Green information system innovation;
- (c) Process of Green information system innovation; and
- (d) Outcome of Green information system innovation.

The **Content of Green information system innovation** captures about the information systems that Acadia uses for supporting environmental sustainability goals. Based on the conceptual framework discussed in Chapter 3, the content of Green information system innovation is depicted through the green “spirit” given to the information system being developed by its developers during its conception; as well as the “interpretive flexibility” of the information system so that it can be re-appropriated during practice to support the environmental sustainability cause of the organisation using it. Another conceptualisation of the content of Green information system innovation encompasses the six types of Green information system innovation stated by Mines (2011), which include sustainability performance systems, carbon and energy management systems, sustainability product development software, sustainability knowledge and learning management systems, sustainable collaboration and communications systems, and smart infrastructure management software. Table 4.5 shows the list of the original category and themes for Green information system content based on the conceptual framework.

Category	Theme	Definition	References
Content	Spirit	The general intent with regard to values and goals underlying a given set of structural features.	DeSanctis & Poole (1994); Ijab et al (2010)
	Interpretive flexibility	The degree to which users have appropriated a given information system either faithfully (that is as intended) or unfaithfully (unintended)	Orlikowski (1992); Ijab et al (2010)
	Six types of Green information system	The different types of information system innovation used for environmental sustainability purposes.	Mines (2011); Butler (2011); Watson et al (2010); Watson et al (2012); Boudreau et al (2007); Hasan et al (2014)

Table 4.5– List of the Original Category and Themes for Content of Green Information System Innovation from the Conceptual Framework

Based on the data analysis conducted through the coding process, the original category and themes for content of Green information system innovation were **maintained**. However, there are also five new themes **emerged** as to provide a more detailed description about the content of the Green information system innovation. These new themes are **components, year developed and by whom, users, nature of system, and information stored/displayed**. The new themes are important because they provide additional information about the content of the Green information system innovation being studied in addition to the existing themes of spirit, interpretive flexibility, and types of Green information system.

The actual representations of these emerging themes and the existing themes on the Content of Green information system innovations are discussed in Section 5.3.3 on the Energy Informatics Innovation (Case 1), Section 5.4.3 on Unified Communications and Collaboration (Case 2), Section 5.5.3 on the Sustainable Knowledge Management and Sharing (Case 3), and Section 5.6.3 on the Fleet Management System (Case 4). Table 4.6 summarises the generated emerging thematic coding for the Content of Green information system innovations.

Category	Theme	Description
Content	Components	The component of the Green information system innovation which will form the entire system. Each component can have one or more modules as the features of the system being studied.
	Year developed and by	The year when the Green information system was first developed and the parties involved in the system development. This theme is important as it establishes the point of conception and the source of the innovation (either internally developed or externally acquired).
	Users	The intended users for the developed Green information system, either departmental or organisational users.
	Nature of system	The main objective of the system when it was conceived and developed by the system developers or system owners. This theme is dissimilar to the theme “spirit” as the “nature of system” describes about the technical aspect of the innovation while the “spirit” describes about the softer side of system (i.e., the value underlying the innovation’s conception).
	Information stored/displayed	The types of information stored in the database of the system, and/or the kind of information displayed to the users on the screen.

Table 4.6– List of the Generated Thematic Coding for Content of Green Information System Innovation

The following Table 4.7 shows an example of the quotations from the interview transcripts pertaining to the Content of Green information system innovations.

Category	Theme	Sample Quotation
Content	Spirit	<p><i>“When developing ES2, we were thinking of achieving efficiency. Because to us, green is about doing things more efficiently. When you are efficient, you are green. Things that are inefficient cause much wastage, electricity wastage included. So that is not green... During the system development, we knew from the start that we didn’t want to invest in expensive equipment. We used machines that use low energy. We even developed the system using Open Source Solutions (PHP and Java) because we don’t want to be tied up with additional cost like servicing. The system is also web-based to enable remote control and monitoring of the chilled water pump motor speed from anywhere in the world.”</i> (ES2 System Developer 01)</p> <p><i>“The system was developed using Java object oriented programming (OOP) language. One of the most important elements of OOP is the ability to reuse some of the codes. The reusability was able to speed up certain elements of the system development.”</i> (UCC System Developer 02)</p>
	Interpretive flexibility	<p><i>“Basically I use the UCC almost every day. In my capacity, I am involved in a number of initiatives within the IT Department. We meet people from R&D, other Divisions in IT, and sometimes with vendors too. Using UCC, some of the meetings that previously require me to personally go to the other offices, has been reduced. The meetings can now be done from the HQ or just about anywhere.”</i>(IT Manager 01)</p>
	Green information system type	<p>Green information system type: Information system for carbon management:</p> <p><i>“The fleet system, especially the Automatic Vehicle Location System (AVLS) could indirectly contribute towards lowering CO₂ emissions. We can monitor whenever events such as harsh braking or harsh speeding happens. These events contribute to higher fuel usage, along with carbon emissions.”</i> (Fleet Manager 02)</p>
	Components	<p><i>“For ALSS and SIMO, they are mainly operational. We want to just have better management and inventory of our vehicles. All vehicles’ information are kept in the</i></p>

		<i>database, and it contains information pertaining to their acquisitions until their disposals (as used cars or scrapped in the events of accidents).” (Fleet Manager 01)</i>
	Year developed and by	<i>“When we embarked on this project in late 2006, we want to come up with a better design and a better solution for the UCC. We want to reduce the number of servers.” (UCC System Developer 01 of Acadia R&D)</i>
	Users	<i>“The system was designed for all Acadia staff. Of course not everyone will use it. Probably more for people at the executive level than non-executive like the office boys and dispatchers who may not need to use it.” (UCC System Developer 03)</i>
	Nature of system	<i>“The UCC has so many features to support internal communications and collaboration. Like chatting function, so everyone can use it. But for file transfer and video conferencing, not everyone will use it.” (UCC System Developer 03)</i>
	Information stored/displayed	<i>“There are so many types of forms staff need to use for certain purposes. These forms were on paper. When we have e-forms, we don’t need to get the forms printed. Some e-forms are part of a workflow system. Using workflow system it is even easier because once the staff filled up the e-form, they can hit the send button, the system will notify the superior to approve, or perhaps the committee to approve. All are done electronically, even in approving the application.” (IT Manager 03)</i>

Table 4.7 – Sample of Thematic Coding for Content of Green Information System

Innovation

The **Context of Green information system innovation** captures the emergence of the information systems of interest that Acadia is using for supporting its environmental sustainability goals. In the conceptual framework discussion, it was proposed that the factors driving or influencing Green information system innovation came either from internal or external context, further elaborated using the institutional forces of regulative, normative, and mimetic. For example, the external forces are exerted through the mechanisms of government regulations, industry pressures, supplier pressures and customer expectations. On the other hand, for the internal factors, the organisation’s sustainability orientation is a driving factor motivating the Green information system innovation. The sustainability orientation is driven by the mechanisms of top management disposition towards environmental sustainability, environmental

sustainability culture among employees, innovation climate, and other business imperatives. Table 4.8 shows the list of the original category and themes based on the conceptual framework.

Category	Theme	Definition	References
Context	External	Factors from outside of the organisation influencing the organisation's sustainability orientation and desire to go green including the regulative, coercive and mimetic pressures exerted by the government, industry, suppliers and customers.	DiMaggio & Powell (1983, 1991); King et al (1994); Tornatzky et al (1990); Bose & Luo (2011); Walsham (1993); Madon (1993)
	Internal context	Factors from within the organisation driving the organisation's sustainability orientation and desire to go green including top management, environmental sustainability culture, innovation climate, and business imperatives.	Orsato (2006); Porter & Linde (1995); Butler (2011); Tornatzky et al (1990); Bose & Luo, (2011); Orlikowski, (1996); Hart (1995); Russo & Fouts (1997)

Table 4.8– List of the Original Category and Themes for Context of Green Information System Innovation from the Conceptual Framework

Based on the data analysis conducted through the coding process, the sub-themes for external context were **maintained** as normative and mimetic pressures, and as there was lack of evidence showing the existence of mimetic pressure from the data, the mimetic pressure sub-theme was **dropped**. Based on the data analysis, these institutional pressures were further exerted by various forces including market, government, consultants, vendors and partners. The internal contexts were also **maintained** as top management, business imperatives, environmental sustainability culture, and innovation climate. Further, for the internal context, the data analysis revealed that the internal drivers exerting the influence included strategy, leadership, style, resource, staff, policy and practice, system, technology, structure, culture, and capability.

The actual representations of these themes on the Context of Green information system innovations are discussed in Section 5.3.2 on the Energy Informatics Innovation (Case 1), Section 5.4.2 on Unified Communications and Collaboration (Case 2), Section 5.5.2

on the Sustainable Knowledge Management and Sharing (Case 3), and Section 5.6.2 on the Fleet Management System (Case 4). Table 4.9 summarises the generated thematic coding for the Context of Green information system innovation.

Category	Theme	Sub-Theme	Definition
Context	External	Coercive	External pressures that can be formal or informal, exerted through force or persuasion. The clearest source of coercive pressures is government mandates and the legal framework of the regional, national or international context of an organisational field (DiMaggio & Powell, 1991).
		Normative	Primarily refers to the effects of professional practice whereby the professionals convey a combination of cognitive and regulatory norms that legitimate their occupational autonomy. Such norms are produced and maintained through formal education and training, as well as through professional associations (DiMaggio & Powell, 1991).
	Internal	Top management	Powerful members of an organisation who provide leadership to the organisation with their strategies and values (Andersson and Bateman, 2000; Chen et al, 2008)
		Business imperatives	Organisations' motivation to implement sustainable practices and IS innovations that could lead to revenue generations and/or costs reductions (Seidel et al, 2010)strategy, style, resource, staff, policy and practice, system, technology, and structure.
		Environmental sustainability culture	The environmental attitudes at the employee level and organisational level which represent feelings of favourableness or unfavourableness toward a behaviour (Jenkin et al, 2010).
		Innovation climate	The organisation's predisposition or capability to create and that encourages employees to be innovative in pursuing the development of new products or processes (Santos-Vijande & Alvarez-Gonzales, 2007; Benitez-Alamo et al, 2010).

Table 4.9– List of the Generated Thematic Coding for Context of Green Information System Innovation

Table 4.10 shows an example of the quotations from the interview transcripts pertaining to the Context of Green Information System innovation.

Category	Theme	Sub-theme	Sample Quotation
Context	External	Coercive (Government)	<i>“For the record, we are going to have Carbon Management Plan (CMP) to streamline and consolidate all the green efforts and basically to align with the government's aim to reduce national carbon reduction target as per Copenhagen Climate Change Conference (COP 15) in 2009.”</i> (Corporate Communications Manager)
		Normative (Consultant)	<i>“We had a conference call with Simon Mingay of Gartner when we were developing our Green IT Framework. We told him where we are, where we want to go, what we want to do, and whether what we did was right. We did it because we subscribed to Gartner. When we subscribe to their services, they allocate some hours from the subscription cost so that we can spend talking to their consultants for advices.”</i> (IT Manager 01)
	Internal	Top management	<i>“As was informed that the General Manager of IT then was asked by the management to study the various solutions as to ease internal communications. In particular, existing Acadia’s vendors like Microsoft was invited, along with other providers such as Cisco to propose their solutions.”</i> (IT Manager 01)
		Business imperatives (Strategy: Need to reduce emissions)	<i>“The fleet system, especially the Automatic Vehicle Location System (AVLS) could indirectly contribute towards lowering CO₂ emissions. We can monitor whenever events such as harsh braking or harsh speeding happens. These events contribute to higher fuel usage, along with carbon emissions.”</i> (Fleet Manager 02)

		Environmental sustainability culture	<i>“Since we are in the midst of promoting environmental sustainability campaigns and building such sustainability culture in the company, we realised that we can use the existing Intranet portal technology to facilitate the campaign. With it, we can reach towards the wider population of Acadia, and provide the necessary information and education on environmental sustainability to our staff.”</i> (Group Corporate Communications Manager)
		Innovation climate	<i>“Acadia R&D initiated the project on their own based on their research roadmaps aimed for commercialisation. But it was later identified by Group IT that the system could also be used to serve the whole company.”</i> (IT Manager 01)

Table 4.10 -Sample of Thematic Coding for Context of Green Information System Innovation

The **Process of Green information system innovation** captures the innovation process that took place from the beginning of the information systems’ conception until its evaluation stage. Based on the Conceptual Framework discussed in Chapter 3, the process of Green information system innovation is explained through stages, people, time and critical events. Table 4.11 shows the list of the original category and themes for the process of Green information system innovation based on the conceptual framework.

Category	Theme	Definition	References
Process	Stages	The distinct steps from conception, development, implementation, and evaluation stages of the innovation process.	van de Ven (1986); Pelz (1985); Damanpour (1991); Wolfe (1994); Melville (2010)
	People	The key persons or individuals taking charge in the innovation process.	Walsham & Waema (1994); Newman & Robey (1992); Madon (1993); Orlikowski (1993); Avgerou (2001).

	Time	The point in time whereby innovation snapshot is captured and elaborated.	Orlikowski (1996); Avgerou (2001); Kaewkitipong & Brown (2008)
	Critical events	The main events that occur and influence each other and describe how the interactions among the events produce results.	Kim & Pan (2006)

Table 4.11 - List of the Original Category and Themes for Process of Green Information System Innovation from the Conceptual Framework

Based on the data analysis conducted through the coding process, the three original themes found in the conceptual framework were still relevant and therefore, are **maintained** (i.e., stages, critical event, and people). However, the “Time” theme is now **reclassified** as “Phases” as this term is more appropriate in explaining the many distinct innovation steps specific to the Green information system innovation cases being studied. The “Phases” are further described as sub-themes in order to describe the different (or similar) components of the Green information system innovation as they progress over time. The sub-themes for “Phases” are: “When”, “What system”, “Developers”, “Target users”, “Cost”, “Development environment”, “Key operational challenges/problems”, “Key environmental problems”, “Functions”, and “Key benefits”. However, it needs to be mentioned that some of the sub-themes for “Phases” are overlapping with the themes for “Content” of Green information system (refer Table 4.6). This is unavoidable because the same sub-themes are also useful and applicable when describing about the content of Green information system innovation. The overlapping themes between “Phases” and “Content” are “What system” (called “Components” under Content), “When” (called “Year developed” under Content), “Developers” (called “By” under Content), “Target users” (called “Users” under Content), “Functions” (called “Nature of system” under Content).

The existing sub-themes for “Stages” are generally **maintained** (i.e., conception, development, implementation, and evaluation stages). However, based on the data analysis, while the “implementation” sub-theme was maintained, it was **broken down** into five new sub-themes emerging from it, including “use”, “metastructuring”, “expand

functional affordance”, “use extension”, and “use discontinuance”. These new sub-themes are the instances of faithful appropriation emerging from the data.

The “Critical events” is now called “Events” as to recognise the various events occurring in the innovation process. Lastly, the “People” theme is **reclassified** as “Key people” to showcase the prominence of the key people’s role in the Green information system innovation process.

The actual representations of these themes on the Process of Green information system innovations are discussed in Section 5.3.4 on the Energy Informatics Innovation (Case 1), Section 5.4.4 on Unified Communications and Collaboration (Case 2), Section 5.5.4 on the Sustainable Knowledge Management and Sharing (Case 3), and Section 5.6.4 on the Fleet Management System (Case 4). Table 4.12 summarises the generated thematic coding for the Process of Green information system innovation (for Phases, Stages, Events, and Key People themes) of the overall coding process.

Category	Theme	Sub-Theme	Description
Process	Phases	When	The year when the Green information system was first developed.
		What system	The component of the Green information system innovation which will form the entire system. Each component can have one or more modules as the features of the system being studied.
		Developers	The parties involved in the system development of the Green information system innovation.
		Users	The intended users for the developed Green information system, either department or organisational users.
		Cost	The overall cost of development or purchased of the Green information system.
		Development environment	The computing environment where the Green information system was developed such as using Windows Socket Programming; Application Programming Interface (API); Open Source development tool, etc.
		Key operational challenges/problems	The main operational issues that the Green information system developed intend to

			address.
		Key environmental problems	The main operational issues that the Green information system developed intend to address.
		Functions	The main objective of the system when it was conceived and developed by the system developers or system owners.
		Key benefits	The main benefit that the Green information system developed was able to accomplish.
	Stages	Conception	The idea for the Green information system innovation is conceived by the system owner or the top management driven by internal and/or external factors.
		Development	The stage whereby the idea for the Green information system innovation is realised by developing the system with the help of the system developers.
		Implementation	The stage whereby the developed Green information system innovation is put to real deployment in the actual workplace with the system users.
		Use	The stage whereby the Green information system innovation is faithfully used (appropriated) by the system users to accomplish their daily works or to achieve certain task objectives.
		Metastructuring	The stage whereby the Green information system innovation is appropriated in diverse ways, given different meanings and effects for different users.
		Expand functional affordance	The stage whereby the existing Green information system innovation is given extra functional affordance (i.e., features) as to make the information system more meaningful and more effective in achieving the intended goals.
		Use extension	The stage whereby the existing Green information system is extended its uses as to cover new potentials that are not recognised earlier even by the system developer.
		Use discontinuance	The Green information system is terminated its uses due to certain reasons.
		Evaluation	The benefits of the Green information system innovation is evaluated by tracking, capturing, and reporting the data for certain purposes such as for

			management reporting or audit compliance on daily/monthly/yearly basis.
Events	Problem recognition and definition		The organisation is recognising and understanding the problem it is facing, the importance in addressing it, the intensity of the problem and the impacts that cause the organisation if the problem is not addressed.
	Intent to adopt IS		The organisation's intention to adopt information system having recognised the problem that they are facing, and recognised the needs for the information system.
	Intent to incubate		The organisation's intention to incubate or develop information system for its own use and/or as commercial product for external market.
	Recognise utility		Usefulness of the existing system for other benefits beyond what the system developer intended it for. The system is not changed in any way in terms of its features or functionality.
	Project scoping		The organisation is defining the scope of the information system to be created such as by explicitly stating what the information system will do and will not do.
	Define functional requirements		The organisation (as a customer) is defining the technical functionality of the information system expected from the supplier or developer.
	Decide development environment		The developer is deciding on the development environment that the information system will be used such as the use of system development methodology, the software suite to develop the information system, the programming language, and architecture of the information system to be.
	Evaluate sourcing options		The organisation is evaluating the sourcing option for the information system: whether buying it commercial-of-the-shelf; or incubating it internally (internal development) as well as the sourcing policy.
	Decide sourcing		The organisation is making decision pertaining to the sourcing options: whether to buy COTS; or incubate themselves(internal development).

		Decide implementation environment	The organisation is making decision pertaining to the implementation environment of the information system such as the testing, installation, migration, user training, and system use guideline.
		Develop the IS	The developer is involved in the coding, configuration and integration of software modules.
Key People	Top management	Top executives such as the Chief Executive Officer, Chief Financial Officer or Chief Technology and Innovation Officer who have the authority to make decision, allocate/move resources, and exert their influence to the lower level staff members.	
	Managers	IT and non-IT managers who are tasked to manage the strategic and operations of the organisation, have limited authority to make decision but have influential power to exert to their sub-ordinates.	
	System developers	IT/IS professionals who develop systems commissioned to them.	
	System owner	Division or department managers who commission and fund the development of the systems to the system developers.	
	System users	The users of the systems developed. It can be any end users for general computing solutions (such as UCC or SDAM and MyEarth portal), or specific type of users such as technicians and drivers for specific purpose systems (such as for ES2 or CSM/e-Log Book).	
	Consultants	Industry experts who study the technology, industry and the market, and are paid to provide advisory or technical services to organisations.	
	Vendors and Partners	Products or service providers who supply organisations with their expertise in certain areas of products or services.	

Table 4.12– List of the Generated Thematic Coding for Phase, Stages, and Events

Themes of Process of Green Information System Innovation

The following Table 4.13 shows an example of the quotation from the interview transcripts pertaining to the events, stages, and key people in the Process of Green information system innovation.

Theme	Sub-theme	Sample Quotation
Events	Decide sourcing	<i>“We started AVLS project in 2006/2007. We bought it from DG Inc, a local company. It has business relation with Acadia Geomatics. Geomatics provides the platform for AVLS. It is more like “mapping system” detail with Exchanges as point-of-interests POIs. With lots of details for whole country. Geomatics develops the mapping system and DG Inc takes the map service.” (Fleet Manager 02)</i>
Stages	Conception	<i>“When developing ES2, we were thinking of achieving efficiency. Because to us, green is about doing things more efficiently. When you are efficient, you are green. Things that are inefficient cause much wastage, electricity wastage included. So that is not green... During the system development, we knew from the start that we didn't want to invest in expensive equipment. We used machines that use low energy. We even developed the system using Open Source Solutions (PHP and Java) because we don't want to be tied up with additional cost like servicing.” (ES2 Developer 01)</i>
Key People	Managers, System users (technicians), System developers	<i>“During training, we demonstrated to them (Property Operations managers and technicians) how to operate it. Basically they know about the system as they were engaged and participated in the system development as system user. They are also familiar with the existing IBMS. ES2 extended that function of IBMS but for air-conditioning. So, it is not something totally new to them. There was also a user manual for them to refer to if they need it.” (ES2 Developer 01)</i>
	Top management (Chief Financial Officer, GMs, VPs)	<i>“Structure-wise, the top management of Support Business would report to Acadia's Chief Financial Officer (CFO). Members of the SB top management include the VP, the GMs of Property Operations and Fleet Management, and some GMs from Finance Division. People like me and my staff, we form the working level” (Assistant General Manager of Support Business)</i>

Table 4.13 – Sample of Thematic Coding for Process of Green Information System Innovation

The **Outcome of Green information system innovation** captures the outcome gained by the organisation from their Green information system innovation. In the Conceptual Framework discussion in Chapter 3, it was proposed that the outcomes of Green

information system innovation are seen from the eco-efficiency, eco-equity, and eco-effectiveness. Table 4.14 shows the list of the original category and themes for outcome of Green information system innovation based on the conceptual framework.

Category	Theme	Definition	References
Outcome	Eco-efficiency	A businesses' ability to deliver competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts.	DeSimone & Popoff (1997; p. 47); Chen at al (2008; 2010); Jenkin et al (2011).
	Eco-equity	The equal rights of people to environmental resources and a business's 'social responsibility' for the future generations.	Gray & Bebbington (2000); Chen at al (2008; 2010); Jenkin et al (2011).
	Eco-effectiveness	Attempts to stop contamination and depletion of natural resources by directing individual and organisational attention to the underlying and fundamental factors of environmental problems through a fundamental redesign of the system.	McDonough & Braungart (1998); Chen at al (2008; 2010); Jenkin et al (2011).

Table 4.14– List of the Original Category and Themes for Outcome of Green Information System Innovation from the Conceptual Framework

Based on the data analysis conducted through the coding process, the **emerging** themes showed that the outcomes from the Green information system innovation were not described from the “conceptual” outcomes of eco-efficiency, eco-equity, or eco-effectiveness as discussed in the Conceptual Framework (see Section 3.3.4 in Chapter 3). Instead, the evidence revealed that the outcomes or benefits of Green information system innovation can be seen from the direct or indirect outcomes. The direct outcomes include environmental, economic, and operational benefits, while the indirect outcomes include social benefits related to positive changes in attitudes and behaviours as well as the rebound effect from the Green information system innovations (i.e., the unused and abandoned old servers, and abandoned black boxes and RFID tags). Therefore, the themes of eco-efficiency, eco-equity, and eco-effectiveness were **dropped** and were then **replaced** with the direct and indirect outcomes.

The actual representations of these themes on the Outcomes of Green information system innovations are discussed in Section 5.3.5 on the Energy Informatics Innovation (Case 1), Section 5.4.5 on Unified Communications and Collaboration (Case 2), Section 5.5.5 on the Sustainable Knowledge Management and Sharing (Case 3), and Section 5.6.5 on the Fleet Management System (Case 4). Table 4.15 summarises the generated thematic coding for the Outcome of Green information system innovation.

Category	Theme	Sub-Theme	Definition	References
Outcome	Direct	Environmental	Environmental benefits from Green information system innovation such as in carbon emissions reduction, energy efficiency, and waste minimisation.	Hart (1997); Melville & Whisnant (2012); Watson et al (2010); Hasan et al (2014)
		Economic	Economic benefits from Green information system innovation such as in reduction in energy, water, and other resources costs.	Chen et al (2008); Watson et al (2010); Seidel et al (2010); Hasan et al (2014)
		Operational	Operational benefits from Green information system innovation such as reduction in business travels, resource utilisation, better productivity and IT efficiency.	Mithas et al (2010); Bose & Luo (2011); Elliot (2011); Hasan et al (2014);
	Indirect	Social	Social benefits from Green information system innovation such as in attitudinal and behavioural change as well as in providing thermal comforts in the workplace.	Bose & Luo (2011); Elliot (2011); Jenkin et al (2011)
		Rebound effect	Side impact from sustainability	Hilty & Ruddy (2000); Plepys (2002); Fuchs

			practice such as accumulation of e-waste from server consolidation practice.	(2008); Gossart (2014)
--	--	--	--	------------------------

Table 4.15– List of the Generated Thematic Coding for Event Theme of Outcome of Green Information System Innovation

The following Table 4.16 shows an example of the quotations from the interview transcripts pertaining to the Outcome of Green information system innovation.

Theme	Theme	Sub-theme	Sample Quotation
Outcome	Direct	Environmental: Less emissions from reduction in energy consumption	<i>“With the SKMS, we consolidated those hardware or server after migrating the application to SharePoint 2007. We have closed as many as 100 websites (belonged to different workgroups (divisions, units, functions, etc) and now we only have 23. We are saving in terms of the energy consumption to power the electricity to so many machines to lesser servers now.” (IT Manager 01)</i>
		Environmental: Energy efficiency	<i>“When developing ES2, we were thinking of achieving efficiency. Because to us, green is about doing things more efficiently. When you are efficient, you are green. Things that are inefficient cause much wastage, electricity wastage included. So that is not green... During the system development, we knew from the start that we didn’t want to invest in expensive equipment. We used machines that use low energy. We even developed the system using Open Source Solutions (PHP and Java) because we don’t want to be tied up with additional cost like servicing. The system is also web-based to enable remote control and monitoring of the chilled water pump motor speed from anywhere in the world.” (ES2 Developer 01)</i>
		Operational: Resource consolidation	<i>“In the past, we have so many applications and those are running on different machines and different software platforms. With the SKMS, we consolidated those hardware or</i>

			<i>server after migrating the application to SharePoint 2007. We have closed as many as 100 websites (belonged to different workgroups (divisions, units, functions, etc) and now we only have 23.” (IT Manager 01)</i>
	Indirect	Rebound effect: Creation of more e-waste	<i>“The IT Application team is looking at this issue(e-waste). Now we are having what we call resource management planning... we are relooking and is still planning on what to do with those old servers. Perhaps to salvage the components... memory storage, etc. This is a complicated issue and not a straight forward process.” (IT Manager 01)</i>

Table 4.16 - Sample of Thematic Coding for Outcome of Green Information System Innovation

The connections between each theme is discussed and reported in the research findings write-up (refer Chapter 5).

4.6 RESEARCH TRUSTWORTHINESS

Researchers argued that quality concerns play a major role throughout all steps of a research process, from the development of a research question and data collection, to the analysis and presentation of research findings (Ali & Yusof, 2011; Cameron, 2011). In this research, quality is determined by adhering to the principles of trustworthiness, which is preferred in qualitative research (Cameron, 2011).

Trustworthiness was a term proposed by Lincoln and Guba (1985) is often referred to as ‘goodness of fit’ criteria which parallels the term rigor in quantitative research. There is a set of four criteria upon which to determine the trustworthiness of qualitative research: credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). Table 4.17 summarises how the four trustworthiness criteria were implemented in this research project.

Criteria	Description	Techniques Available for Establishing the Criteria	How it was conducted in this research?
Credibility (in preference to internal validity)	Credibility is about determining how congruent the findings are with reality.	<ul style="list-style-type: none"> • Prolonged Engagement • Persistent Observation • Triangulation • Peer debriefing • Negative case analysis • Referential adequacy • Member checking 	<ul style="list-style-type: none"> • The techniques used to establish credibility include: <ol style="list-style-type: none"> i. prolonged engagement (six months of empirical data collection in Acadia with 2 months allocated for Phase One, and another 4 months was spent on Phase Two); ii. persistent observation whereby the researcher observed several demonstrations on how the systems were used by the users and/or system developers (i.e., for Case 1 – Energy Informatics; Case 2 – Unified Communications and Collaboration; Case 3 – Sustainable Knowledge Management and Sharing; and Case 4 – Fleet Management System); iii. triangulation by applying and combining several research methods to study the same Green information system innovation phenomenon, and in this research include interviews, organisational documents, as well as from the survey; iv. referential adequacy with the gathering and collection of thirty archival (organisational) documents; and v. member-checking whereby findings were shared and discussed with the research supervisors.
Transferability (in preference to external validity/generalisability)	Transferability is about providing sufficient data and context to enable the audience to judge whether the	Thick description	<ul style="list-style-type: none"> • The technique used to establish transferability is thick description whereby: <ul style="list-style-type: none"> ○ Details of the data collection process were presented in this chapter (i.e. Chapter 4). ○ The number of participants for the entire study is appropriate

Criteria	Description	Techniques Available for Establishing the Criteria	How it was conducted in this research?
	findings can be applied to other situations and contexts.		<p>and reached data saturation as no new information was observed.</p> <ul style="list-style-type: none"> ○ Data coded based on emerging themes in the data, the constructs of innovation concepts, contextualist-processual approach and insights from the relevant literature review (as per Conceptual Framework) guided the research questions (Refer Chapter 3). ○ Findings for each of the studied Green information system innovation cases are described in detail, from all relevant aspects to the research.
Dependability (in preference to reliability)	Dependability refers to having sufficient detail and documentation of the methods employed so that the study can be scrutinised and replicated.	Inquiry audit	The technique used to establish dependability is inquiry audit whereby all the evidence from the interview protocols, interview transcripts, and survey data were documented and made available in the Appendices section, while the supporting organisational will be made available upon request for anyone requesting to audit the research process and findings. Further, data were analysed and findings were linked to the research questions, conceptual model, research findings and research conclusions (refer Chapters 5, 6 and Chapter 7).

Criteria	Description	Techniques Available for Establishing the Criteria	How it was conducted in this research?
Confirmability (in preference to objectivity)	Confirmability is about ensuring the study's findings are the result of the experiences of the informants rather than the preferences of the researcher(s).	<ul style="list-style-type: none"> • Confirmability audit • Audit trail • Triangulation • Reflexivity 	<ul style="list-style-type: none"> • The techniques used to establish confirmability include: <ol style="list-style-type: none"> i. confirmability audit whereby the researcher asked for the IT Manager 01 and R&D Managers 01-03 to reconfirm on interview transcripts based on interviews with them; ii. audit trail which recorded the research process, documented all the raw data generated, and assessing the method of data analysis to be suitable for the research. iii. triangulation (refer the above from “credibility”); and iv. reflexivity whereby the researcher reflected the entire research process with Acadia’s environmental sustainability initiatives and the information systems used against his past experience working for Acadia. Overall, his experience provided him with the necessary understanding of Acadia’s stand on environmental sustainability, and the extent of information system use for environmental sustainability within Acadia.

Table 4.17 - Strategies taken to ensure ‘trustworthiness’ in this research

(Adapted from Lincoln & Guba (1985))

4.7 CHAPTER SUMMARY

This chapter covers the overall research methodology in undertaking this research. The empirical data collection was guided by the interpretive research paradigm. The data was analysed using thematic coding following the thematic coding principles. The research took into consideration the necessity for research quality and rigor by applying the concept of trustworthiness. The detail of the findings derived from the qualitative data collection and analysis are discussed in Chapter 5.

CHAPTER 5 : CASE FINDINGS

5.1 INTRODUCTION

This chapter provides the findings of the four Green information system innovation cases in Acadia that were investigated in detail. These four Green information system innovations are Energy Informatics (EI), Unified Communications and Collaboration (UCC), Sustainable Knowledge Management and Sharing (SKMS), and Fleet Management Systems (FMS).

The chapter is structured as follows. Section 5.2 highlights the research setting for this study by giving an overview of Telecom Acadia (also called Acadia for brevity) in terms of its business background, vision and mission, organisation structure, the environmental sustainability initiatives undertaken by the company, and details of the research participants for this study. The chapter then proceeds with the four Green information system innovation cases by systematically presenting the findings from the context, content, process, and outcome perspectives (Section 5.3). At the end of this chapter, a summary of the research findings are presented (Section 5.4).

5.2 RESEARCH SETTING

5.2.1 Introduction to Telecom Acadia

Telecom Acadia (anonymous) is a leading provider of telecommunications and the related services in one of the Asian countries. The principal activities of Telecom Acadia are the establishment, maintenance and provision of telecommunications and related services. In particular, Telecom Acadia (or Acadia, for the purpose of brevity) provides high-speed broadband services and fixed line telephony to both enterprise and retail customers. It has over 2 million fixed broadband subscribers and over 4 million traditional fixed line telephony subscribers. It employs more than 25,000 people including those who work in

its international offices. Acadia owns and manages a range of telecommunication networks and buildings.

The historical overview of the company over the years is summarised below:

- 1874: Known as the Department of Posts and Telegraph, involved in setting up the country's first telegraph line.
- 1946: Known as the Telecommunications Department, a stated-owned agency.
- 1984: Known as Telecom Acadia, and was incorporated as a private company.
- 1987: Telecom Acadia was corporatised.
- 1990: Telecom Acadia was listed in the main board of the country's stock exchange.

While Telecom Acadia is a public company since 1990, it maintained close association with the Government of the country stemming from its early history as a stated-owned department. Due to this, Telecom Acadia is one of the most influential and important members in the country's government-linked companies (GLCs).

In terms of its products and services over the years, the following summarises its offerings to the customers:

- 1946 – 2000: Telephony (fixed and mobile cellular)
- 2001: Telephony, narrowband and broadband services
- 2003: Largest mobile operator in the country
- 2005: Launched the first 3G service in the country
- 2007-2008: Undertook a demerger exercise separating the fixed line and broadband business from the mobile services, forming two business groups: Telecom Acadia for serving fixed line and broadband business and Telecom Acadia Mobile serving the mobile business
- 2008: Telephony (fixed line), narrowband and broadband
- 2008: Initiated the country's first high-speed broadband network (HSBB)
- 2010: The commercial HSBB was launched.
- 2010: HSBB reached 750,000 premises passed.

- 2011: A total of 2 million broadband customers and out of that, 240,000 were their HSBB customers.
- 2011: A total of 1.2 million premises passed for the HSBB.

In 2011, Acadia received Australian Dollar (AUD) \$2.90 billion in revenue, which is an increase of about 4% from its 2010 revenue of AUD \$2.79 billion. In summary, Telecom Acadia managed to turn around the company by arresting the declining fixed line business with its new and innovative HSBB services.

5.2.2 Vision and Mission of Telecom Acadia

The vision of Telecom Acadia is to be the country's champion in new generation communications provider by fulfilling customer needs through innovation and service excellence.

In order to achieve the vision, thus, the mission of Telecom Acadia is to strive towards customer excellence and operational efficiency, enrich its residential customers' lifestyle and experience by providing innovative new generation services, improve the performance of its business customers by providing high value information and communications solutions, and deliver value for its stakeholders by generating shareholder value and supporting the country's growth and development.

From the vision and mission statement above, there are a few observations made. First, Telecom Acadia is emphasising on innovation in its vision. Second, in the mission statement, there are at least four contexts being targeted through the innovation (and service excellence). In particular, Telecom Acadia is gearing its internal capabilities towards operational efficiency through innovation. The aim of achieving cost and operational efficiency are found to be the Telecom Acadia's main drivers for its sustainability initiatives besides for achieving environmental and social reasons. Some evidences from the data collection from a few Assistant General Managers (AGMs) of Acadia also supported this view as shown below.

“The main reason we go green is certainly because of operational efficiency and costs.” (Assistant General Manager of IT)

“When we go ISO14001 Environmental Management System way, the benefits from the implementation include cost reduction from consumption of water and electricity. We also generated less waste.” (Assistant General Manager of Quality Management)

“From the reduction of electricity, water, that kind of things, the benefits will come back to us. Mainly from the economic aspect such as cost savings and there is also efficiency in doing operations as well.” (Assistant General Manager of Property Operations)

5.2.3 Organisation Structure of Telecom Acadia

Acadia is organised around the corporate and business functions overseen by the Board of Directors and led by the Group Chief Executive Officer (GCEO). The corporate functions include Strategy Division, Procurement Division, Human Capital Division, Group Corporate Communications Division, Marketing Division, Technology and Innovation Division, and Finance Division. These divisions are headed by officers with various titles including Chief Strategy Officer, Chief Group Corporate Communications, and Chief Technology and Innovation Officer among others. The business functions include Wholesale Division, Global Division, Support Business Division, Consumer Division, Small Medium Enterprise Division, Enterprise Division, Government Division, and New Media Division. All these business divisions are headed by officer carrying the post of Vice President (VP). All Chiefs of Divisions and Vice Presidents report directly to the GCEO except for VPs of Wholesale, Global, and Support Business who report directly to the Chief Financial Officer. For the purpose of fulfilling the corporate governance and transparency in its business conduct, the corporate and business functions of Acadia is governed by the Internal Audit Division headed by the Chief Internal Auditor.

Under each division, there are smaller sub-divisions, referred to as Department in this thesis. For examples, under the Technology and Innovation Division, there are IT Department, Network Technology Department, Network Development Department, and

Acadia R&D. Similarly, for the Support Business Division, there are Property Operations Department, Property Management Department, Fleet Management Department, and Security Department. As for the Group Corporate Communications Division, there are Corporate Responsibility Department, External Communications Department, and Internal Communications Department. In most instances, each department is headed by a General Manager (GM) who reports to either their respective Chief of Division or Vice President. Most General Managers are assisted by Assistant General Managers (AGMs), who then have managers and assistant managers under their care. All the positions stated above are considered as managerial staff. In most divisions, there are also non-managerial staff that support the managerial staff with daily activities. These include clerical staff and technicians. However, for the task of office and/or building, such as maintenance, cleaning and sanitary services is outsourced to a vendor company. This vendor operation is under the responsibility of the Property Operations Department. Figure 5.1 depicts the organisation structure of Acadia.

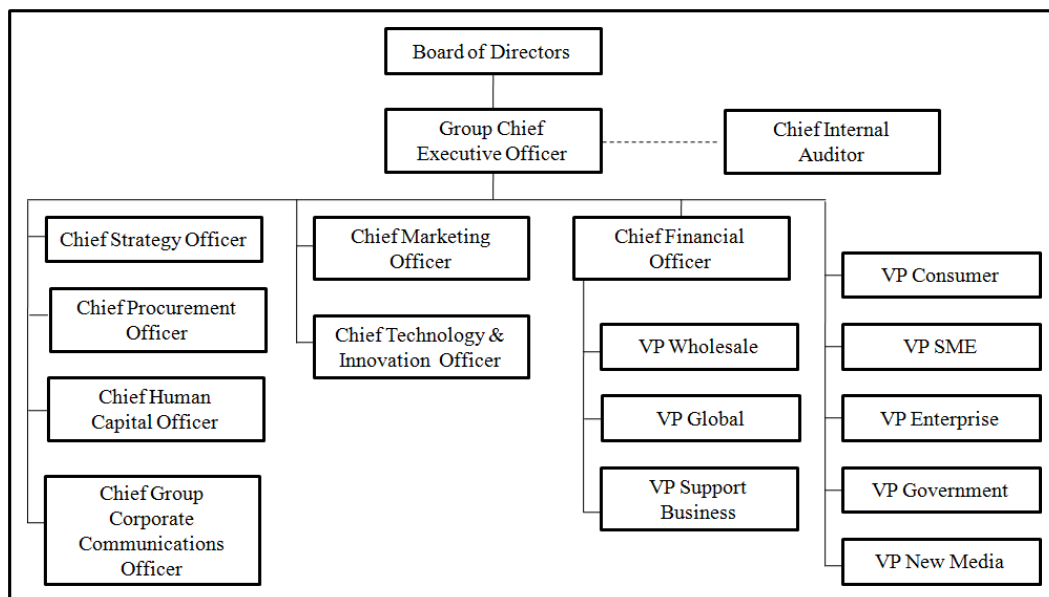


Figure 5.1– Telecom Acadia’s Organisation Structure

(Source: Annual Report 2011, AR2011)

For the purpose of this research, the data was collected from the staff members who come from the Group Corporate Communications Division, Human Capital Division, Technology and Innovation Division (including its R&D subsidiary called Acadia R&D, and IT Department), Strategy Division, Finance Division, Support Business Division

(particularly the Property Operations Department and the Fleet Management Department). The details of the data collection was covered in Chapter 4 while the details of the research participants and organisational documents collected for supporting the data analysis is discussed in Section 5.2.5.

5.2.4 Telecom Acadia's Environmental Sustainability Journey

Acadia is vocal in communicating its ambition to become an eco-conscious company. For example, the Chief Executive Officer (GCEO) has his own blog on the company's Intranet and in a few occasions focuses his thoughts and ideas on "greening" the company. In his blog entry on 30 October 2009, he said:

" ... the recent launch of our MyEarth programme is one of the company's initiatives to instil awareness among staff members on the importance of protecting the natural environment and our Earth, the only home that we have ... 'green technologies' can be used for the objectives of optimising the use of natural resources and in conserving the natural environment ... thus, ICT can play a big role to support those two objectives." (Source: The GCEO Blog, Acadia internal website, AIW01)

In that such a brief entry, he underscored the importance of environmental sustainability and the use of Green information system innovation towards achieving the goals of environmental sustainability. The personal words used by him in his blog entry can be reflected as his personal positive disposition pertaining to environmental care for him and his expectation from his staff members.

In 2011, Acadia has introduced a Carbon Management Plan (CMP) intending to reduce its scope one (through fleet management), scope two (through electricity management) and scope three (through behavioural management) emission. The Group Corporate Communications Manager mentioned:

"Our CMP is aimed to consolidate all the green efforts that we have and ultimately to align and support the government's objective in reducing the national carbon reduction target as per UN Conference of Parties (COP 15) in Copenhagen." (Group Corporate Communications Manager)

Details of Telecom Acadia’s environmental performance indicators are shown in Table 5.1.

Indicators	Acadia’s Performance
Energy Consumption	<ul style="list-style-type: none"> • 2010: Reduced monthly average electricity consumption from 1.86 million KWh to 1.81 mil KWh • 2011: 10% reduction in electricity consumption at the headquarter building
Water use	<ul style="list-style-type: none"> • Reduced water use at the headquarters and five other buildings from 539,650m³ in 2009 to 510,800m³ in 2011
Waste reduction	<ul style="list-style-type: none"> • Reduced solid waste of headquarters and five other buildings from 1,866,000kg in 2009 to 1,149,000kg in 2011 • No penalty from the country’s Department of Environment (DOE)
Emission reduction	<ul style="list-style-type: none"> • 2011: 15,215MT of CO2 emissions from petrol and 5,847MT from diesel (Scope 1); 40,500MT of CO2 emissions from electricity usage at six buildings (Scope 2); 612MT of CO2 emissions from air travel (Scope 3) • Lacks historical data to track total emission reduction
Environmental initiatives	<ul style="list-style-type: none"> • 2007: The first Environmental Awareness Campaign (EAC) was launched • 2009: MyEarth an employee education and engagement programme to promote behavioural change and encourage greener work style • 2009: Car-pooling (allocated 50 parking bays for car-poolers) • 2010: Green IT initiative by IT Department • 2011: Carbon Management Plan adopted the GHG Protocol Classification for emission calculation
Environmental management systems	<ul style="list-style-type: none"> • 2006-2007: ISO14001 preparation and pilot • 2008: ISO 14001 certification
Environmental spending	<ul style="list-style-type: none"> • Increased budget for environmental programmes from USD \$33,600 in 2008 to USD \$252,000 in 2011
Environmental disclosure	<ul style="list-style-type: none"> • 2008: Publication of inaugural sustainability report • 2009-2011: Publication of annual sustainability reports
Environmental reputation	<ul style="list-style-type: none"> • 2010: “Honourable Mention”, Prime Minister’s Corporate Social Responsibility (CSR) award • 2011: National “CSR and Green Initiatives” award • Member, Silver Book Circle on Climate Change (SBC-CC) initiative

Table 5.1 - Telecom Acadia’s Environmental Performance

(Source: Compilation of information from Telecom Acadia 2008-2011 Sustainability Reports (SR2008, SR2009, SR2010, SR2011))

5.2.5 Details of Research Participants and Organisational Documents

In total, forty four (44) research participants were interviewed (i.e., forty three Acadia's staff and one vendor's staff) for the four Green information system innovation cases, namely (i) Case 1 – Energy Informatics (EI), (ii) Case 2 – Unified Communications and Collaboration (UCC), (iii) Case 3 – Sustainable Knowledge Management and Sharing (SKMS), and (iv) Case 4 – Fleet Management Systems (FMS).

Out of the forty four (44) interviewees, thirty five (35) staff members were directly involved in the Green information system innovation cases in different capacities. Another nine interviewees provided additional information such as opinions related to the wider environmental sustainability initiatives implemented in Acadia such as on Green IT, general energy efficiency initiatives, and printer lifecycle management. A summary of the research participants interviewed including their interviewee identification (ID) for evidence cross-referencing in the Green information system innovation case discussions is provided in Table 5.2.

In terms of organisational documents, a total of thirty (30) archival (organisational) documents were collected. These include annual reports, sustainability reports, websites, products' descriptions, Green IT initiative and SKMS overview in MS-PowerPoint slides, electricity consumption data in MS-Excel table, as well as a minute of meetings on Green IT in MS-Word document. The organisational documents were used in providing additional information or in supporting the evidence given by the staff, as a measure to enhance the data triangulation from the interviewees. A summary of the organisational documents collected and used is provided in Table 5.3 along with the document identification (ID) for evidence cross-referencing in the Green information system innovation case discussions.

No.	Innovation Case/ Sustainability Topic	Interviewees' Identification (ID)	Department/ Division	Job Scope
01	Case 1: EI	ES2 System Developer 01	Acadia R&D	Development of IBMS and ES2.
02	Case 1: EI	ES2 System Developer 02	Acadia R&D	Development of IBMS and ES2.
03	Case 1: EI	ES2 System Developer 03	Acadia R&D	Development of IBMS and ES2.
04	Case 1: EI	ES2 System Developer 04	Acadia R&D	Development of IBMS and ES2.
05	Case 1: EI	Assistant General Manager of Quality Management	Quality Management	Management of quality initiatives (ISO14001; ISO9001).
06	Case 1: EI	Assistant General Manager of Property Operations	Property Operations	Overall management and operations of Acadia's buildings and properties.
07	Case 1: EI	Property Operations Manager 01	Property Operations	Management and operations of Acadia's buildings and properties (ISO14001).
08	Case 1: EI	Property Operations Manager 02	Property Operations	Management and operations of Acadia's buildings and properties (IBMS/ES2).
09	Case 1: EI	Property Operations Manager 03	Property Operations	Management and operations of Acadia's buildings and properties (electrical).
10	Case 1: EI	Property Operations Manager 04	Property Operations	Management and operations of Acadia's buildings and properties (facilities).
11	Case 1: EI	Property Operations Technician	Property Operations	Daily maintenance and operations of Acadia's buildings and properties (IBMS/ES2).
12	Case 1: EI	Assistant General Manager of Support Business	Support Business	Management and operations of Support Business (strategy, policy, initiatives).
13	Case 1: EI	Support Business Manager	Support Business	Operations of Support Business (strategy, policy, initiatives).
14	Case 1: EI and Case 4: FMS	Finance Manager	Finance	Financial matters of Support Business (Property Operations & Fleet).

No.	Innovation Case/ Sustainability Topic	Interviewees' Identification (ID)	Department/ Division	Job Scope
15	Case 1: EI	Vendor Manager	Vendor Company	Maintenance & Cleaning Vendor to Property Operations.
16	Case 2: UCC and Case 3: SKMS	R&D Manager 01	Acadia R&D	Management of Acadia R&D projects (project management and CMMI).
17	Case 2: UCC and Case 3: SKMS	R&D Manager 02	Acadia R&D	Management of Acadia R&D projects (project management and partnerships).
18	Case 2: UCC and Case 3: SKMS	R&D Manager 03	Acadia R&D	Development and management of Acadia R&D strategy (strategy formulation and development).
19	Case 2: UCC and Case 3: SKMS	R&D Manager 04	Acadia R&D	Development and management of Acadia R&D strategy (strategy formulation and development).
20	Case 2: UCC and Case 3: SKMS	R&D Manager 05	Acadia R&D	Development and management of Acadia R&D strategy (strategy implementation).
21	Case 2: UCC and Case 3: SKMS; Green IT	IT Manager 01	IT	Management and development of Acadia IT policy & governance (strategy).
22	Case 2: UCC and Case 3: SKMS	IT Manager 02	IT	Management and development of Acadia IT policy & governance (implementation).
23	Case 2: UCC and Case 3: SKMS	IT Manager 03	IT	Management and development of Acadia IT policy & governance (implementation).
24	Case 2: UCC and Case 3: SKMS	Sales Manager	Sales	Product sales for Enterprise customers.
25	Case 2: UCC and Case 3: SKMS	General Manager of Human Capital	Human Capital	Overall management of human capital policy.
26	Case 2: UCC and Case 3: SKMS	Human Capital Manager 01	Human Capital	Operations of human capital policy (strategy and policy).
27	Case 2: UCC and Case 3: SKMS	Human Capital Manager 02	Human Capital	Operations of human capital policy (strategy and policy).
28	Case 2: UCC and Case 3: SKMS	Human Capital Manager 03	Human Capital	Operations of human capital policy (recruitment policy).

No.	Innovation Case/ Sustainability Topic	Interviewees' Identification (ID)	Department/ Division	Job Scope
29	Case 2: UCC	UCC System Developer 01	Acadia R&D	Development of UCC.
30	Case 2: UCC	UCC System Developer 02	Acadia R&D	Development of UCC.
31	Case 2: UCC	UCC System Developer 03	Acadia R&D	Development of UCC.
32	Case 3: SKMS; Corporate Responsibility	Group Corporate Communications Manager	Group Corporate Communication	Management and implementation of Acadia's Corporate Responsibility.
33	Case 4: FMS	Fleet Manager 01	Fleet	Management and operations of Acadia fleet (AVLS/CSM/SIMO/Excel).
34	Case 4: FMS	Fleet Manager 02	Fleet	Management and operations of Acadia fleet (AVLS).
35	Green IT	Assistant General Manager of IT	IT	Management and development of Acadia IT policy & governance (strategy and policy).
36	Green IT	IT Manager 04	IT	Implementation of Acadia IT policy & governance (strategy and policy).
37	Printer Lifecycle Management (PLCM)	IT Manager 05	IT	Operations of IT infrastructure for Acadia (IT assets).
38	PLCM	IT Manager 06	IT	Operations of IT infrastructure for Acadia (IT assets).
39	PLCM	IT Manager 07	IT	Operations of IT infrastructure for Acadia (IT assets).
40	PLCM	IT Manager 08	IT	Operations of IT infrastructure for Acadia (IT assets).
41	General energy efficiency initiative	Assistant General Manager of Strategy 01	Strategy	Development and management of Acadia corporate strategy.
42	General energy efficiency initiative	Assistant General Manager of Strategy 02	Strategy	Development and management of Acadia corporate strategy.
43	General energy efficiency initiative	Product Manager 01	Product	Management of Acadia's product lines (New media).

No.	Innovation Case/ Sustainability Topic	Interviewees' Identification (ID)	Department/ Division	Job Scope
44	General energy efficiency initiative	Product Manager 02	Product	Management of Acadia's product lines (New media).

Table 5.2 – Summary of Research Participants Interviewed for the Research

No.	Name of Document	Document ID	Source	Information Sought
01	Sustainability Report 2008	SR2008	Acadia website	Acadia CR and environmental sustainability initiatives.
02	Sustainability Report 2009	SR2009	Acadia website	Acadia CR and environmental sustainability initiatives.
03	Sustainability Report 2010	SR2010	Acadia website	Acadia CR and environmental sustainability initiatives.
04	Sustainability Report 2011	SR2011	Acadia website	Acadia CR and environmental sustainability initiatives.
05	Annual Report 2000	AR2000	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
06	Annual Report 2001	AR2001	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
07	Annual Report 2002	AR2002	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
08	Annual Report 2003	AR2003	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
09	Annual Report 2004	AR2004	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
10	Annual Report 2005	AR2005	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
11	Annual Report 2006	AR2006	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
13	Annual Report 2007	AR2007	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
14	Annual Report 2008	AR2008	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
15	Annual Report 2009	AR2009	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
16	Annual Report 2010	AR2010	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.

No.	Name of Document	Document ID	Source	Information Sought
17	Annual Report 2011	AR2011	Acadia website	Acadia annual business report and summary of environmental sustainability initiatives.
18	Acadia Official Website	AOW01	Acadia official website	Vision, mission, history, products and services, organisation structure, annual reports, sustainability reports.
19	Acadia Internal Website	AIW01	Acadia internal website	SDAM; MyEarth portal (Case 3: SKMS)
20	SKMS Project Document	SKMS01	Group Corporate Communications Manager	MS-PowerPoint slide on SDAM; MyEarth portal (Case 3: SKMS)
21	IBMS Product Description	IBMS01	ES2 System Developers	MS-PowerPoint slide on IBMS (Case 1: EI)
22	ES2 Product Description	ES201	ES2 System Developers	MS-PowerPoint slide on ES2 (Case 1: EI)
23	Electricity Consumption Data	ECD01	AGM of PO	MS-Excel table on Acadia's electricity consumption data (Case 1: EI)
24	UCC Product Description	UCC01	UCC System Developers	MS-PowerPoint slide on ES2 (Case 2: UCC)
25	Acadia R&D Technology Map	AR&DRM	R&D Manager 03	MS-PowerPoint slide on extract of Acadia R&D Technology Roadmap (Case 2: UCC)
26	AVLS Brochure	AVLS01	Fleet Managers	MS-PowerPoint slide on AVLS (Case 4: FMS)
27	Customer Service Module (CSM) Website	CSM01	CSM website	Modules available on CSM (Case 4: FMS)
28	e-Log Book Website	ELB01	e-LogBook website	Modules available on e-Log Book (Case 4: FMS)
29	Green IT Overview	GreenIT01	IT Manager 01	MS-PowerPoint on Green IT initiative
30	Green IT Minutes of Meetings	GreenIT02	IT Manager 01	MS-Word documents on selected Green IT Taskforce Minutes of Meetings

Table 5.3– Summary of Organisational Documents Collected and Used for the Research

5.3 CASE 1: ENERGY INFORMATICS

The first case study examines Acadia's approach to EI as it pertains to electricity. First we provide why EI can be considered as an important exemplar of Green information system innovation. This is followed by the discussion of the context, content, process, and outcomes of the EI innovation.

5.3.1 Introduction to the EI Innovation

Although many organisations have deployed enterprise systems to manage their core business processes, the use of information systems to manage energy within enterprises is not a widely diffused practice (Bose & Luo, 2011; The Climate Group, 2008). One of the seminal articles that outlines the potential role of IS in energy management is written by Watson et al. (2010). In this article, the authors define energy informatics (EI) as “analysing, designing, and implementing information systems to increase the efficiency of energy demand and supply systems” (Watson, et al., 2010, p. 24). EI systems automate the energy supply network; improve the visibility of energy consumption and bring it to users' consciousness as an environmental problem; highlight the relevance of organisational behaviour towards the problem; and increase the degree of organisational control to deal with the problem. EI systems are considered as Green information system innovation by academics such as Watson et al., (2010) because such systems help to tackle energy consumption as a sustainable development issue. Hasan et al. (2014) also claim that EI systems are important Green information system innovation because organisations typically have poor environmental practices resulting in many forms of waste, unused resources, energy inefficiencies, noise, friction, and emissions. Further, EI systems according to Watson et al (2010, p. 24) enables “collection and analysis of energy data sets to support optimisation of energy distribution and consumption networks”. EI can also be deployed for systematic and comprehensive organisational energy use planning.

5.3.2 The Context of EI Innovation in Acadia

A number of **internal** and **external** events set the context that led to the development and refinement of EI applications in Acadia. These include **business imperatives** motivation from the internal context, and the **normative** as well as **coercive** pressures from the external context.

The initial motivation for EI was purely technical and operational that can be categorised as **business imperatives**. It was related to Acadia's construction of a new building. In 1995, Acadia started constructing a new headquarters and purchased eleven standalone Building Automation Systems (BAS) from different mechanical and engineering vendors for the new building. Each of the system works on its own platforms and protocols; and each was used to manage a specific aspect of the building systems (such as air conditioning, lighting, power, lift, escalator, and plumbing).

From the **normative pressure** perspective, as the systems were acquired from separate IT market providers who pushed different high price structure if the system were integrated by the IT provider, the systems acquired lacked integration. In order to overcome the lack of integration between the different BASs, Acadia developed an Integrated Building Automation System (IBMS) in 2002 operated by Acadia's Property Operations Department. The IBMS integrated all the vendors' specific sub-systems but had limited functionality to measure electricity consumption. Business imperative-wise, the capability of Acadia R&D to integrate these separate building automation systems can be attributed to Acadia's innovation climate that encourage the staff to apply their know-how and experiences into the benefits of the company.

Additionally, from the **normative pressure** perspective, Acadia's energy audit conducted in 2006 prior to the ISO14001 implementation found that electricity to power air conditioning systems contributed approximately 60% to the cost of Acadia's electricity bills. This audit's finding was consistent with the findings of energy bodies such as the United Nation's Industrial Energy Efficiency Improvement Project (IEEIP). Further, during the 2006 - 2011 periods, a combination of events increased the need for measurement and visibility of electricity use: (a) Acadia's desire to obtain ISO14001

certification, (b) Acadia's plan to improve energy efficiency and reduce the cost and consumption of electricity; and (c) rising national electricity tariffs. In 2006, Acadia's top management instructed for the pilot implementation of ISO14001 due to the escalating electricity consumption and bills that have become the top of mind agenda among the company's leadership. The ISO 14001 is an international standard for environmental management systems (EMS) that enables companies to manage environmental risks associated with running their business. The pilot ISO14001 project in Acadia involved measuring and monitoring the consumption of electricity from buildings. As part of the ISO14001 requirements, monthly electricity consumption data needed to be captured, monitored, reported and managed internally. In the spirit of ISO14001, the company worked towards showing improvement over time on its environmental performance.

In terms of the **coercive pressure** from the outside, in 2006, the country's stock exchange started to encourage large local and multinational corporations to report their Corporate Responsibility (CR) strategy and initiatives. One of the elements within the CR was environmental sustainability. In 2008, Acadia started reporting its environmental performance data and released its inaugural sustainability report. One of the reported data was electricity consumption which was obtained from the ISO14001 data tracking and reporting. In 2011, Acadia adhered to the government's instruction for companies to configure their air-conditioning to 24°C (of a summer setting). Acadia immediately implemented this in all of its offices nationwide except for buildings that require specific cooling requirements such as data centers. In the headquarters, the scheduling of air-conditioning and lights turn-off was done using an information system.

At the national level, from 2006 to 2010, the national electricity tariff increased by 12% (2006), 26% (2008) and 8.3% (2011) due to *escalating fuel costs* (coal by 69%, and oil and gas by 230%). Resulting from the rise in electricity tariff, Acadia's electricity costs also increased significantly (refer Figure 5.2). One of the justifications the government used at that time for the tariff increase was to educate and encourage consumers to use electricity sparingly. The Minister of Energy, Water and Communications when announcing the hike in 2006 argued:

“The new tariff structure encourages consumers to conserve energy instead of using electricity as if there is no tomorrow.” (Source: “Electricity up by 12%”, Local English daily newspaper citing the words of the Minister of Energy, Water and Communications, 25 May 2006. Details of the publication withheld as to provide anonymity to Acadia and its specific country context.)

The above internal and external events are the background context that led to the development of EI applications which will be described in detail in the next section.

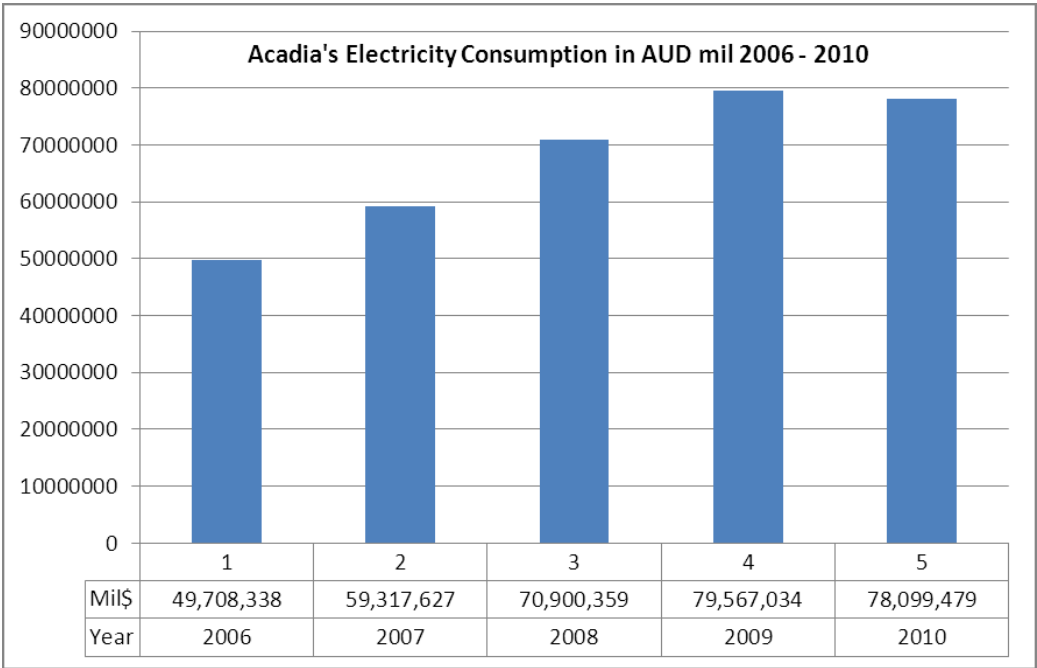


Figure 5.2 - Acadia’s Electricity Cost in AU\$ Million for 2006 - 2010
 (Source: Electricity Consumption Data, ECD01 supplied by the Assistant General Manager of Property Operations, Telecom Acadia)

5.3.3 The Content of EI Innovation at Acadia

Acadia’s EI applications are composed of four components: Building Automation Systems (BAS), Integrated Building Management Systems (IBMS), Energy Savings System (ES2) and MS-Excel. These clusters of applications use and manipulate sensor-based data to manage and control the facility and electricity consumption from air-conditioning, lighting and equipments. Table 5.4 summarises the four applications is followed by a detailed description of each.

Component	Year Developed and By	Users	Nature of system	Information stored/displayed
Building Automation System	1996 – 2000 Purchased from different vendors	Departmental: Property Operations staff	Separately handling the mechanical and engineering operations of the building operations	Building related operations (i.e., lightings, air-conditioning, water supply, lift and escalator, high voltage, low voltage, etc)
Integrated Building Management System	1996 (Internal – R&D Subsidiary)	Departmental: Property Operations staff	Integrating the operations of the BAS	Integrated information from the operations of the BAS, and displayed on the video wall at the Building Control Room (BCR)
ES2	2006 (Internal – R&D Subsidiary)	Departmental: Property Operations staff	Controlling the chilled water pump (CWP) motor speed for	Monitoring and controlling the speed of CWP via a website or

			air-conditioning system	mobile device
MS-Excel	-	Departmental: Property Operations staff	Customised report generation based on users' needs	Extracting data for analysis from ES2

Table 5.4 - Summary of Acadia's Energy Informatics

(Source: Compiled based on combination of information from (i) interviews with the IBMS/ES2 system developers, and (ii) IBMS01 and ES01 MS- PowerPoint slides shared by the ES2 system developers)

The Building Automation Systems comprise of three modules: Building Automation (BA), Facility Management (FM) and Integrated Office Automation (IOA) modules. The main function of the BA is to communicate with the BA sub-system computers and gather data that is deposited into the centralised repository. While the FM assists and automates the building management process, the IOA offers conducive working environment for the employees and tenants.

All the sub-systems of the BAS were acquired from different vendors (i.e., lightings from Clipsal; air-conditioning from Metronix; high and low voltage from Johnson Controls; lift and escalator from Hitachi). Each of the sub-systems was running on its own platform and doing different tasks for different building management functions. As indicated earlier, when Acadia moved to a new building it developed a new Integrated Building Management System (IBMS) to integrate all the BAS functions as depicted in Figure 5.3. The IBMS was developed using Windows Socket Programming, Application Programming Interface (API) and required translation of different "protocols and development languages" used by different sub-systems to communicate back to IBMS. The IBMS is connected to a large video wall located on the building control room where the managers and technicians of Property Operations monitor the running of the mechanical and electricity systems of the building. Its main functions as related to energy management are to:

- Control the direct high voltage energy input from the supplier; segregate the high voltage energy to lower voltage supplies and provide power to lighting, lifts, escalators, networks, computers, and other devices;
- Manage the lighting systems; air-conditioning and ventilation system; generator set system; lift and escalator system; centralised vacuuming system; and the plumbing system from one dashboard;
- Project the different user interfaces of the BAS sub-systems to the Video Wall as a single dashboard for ease of monitoring by the technicians and managers of Property Operations.

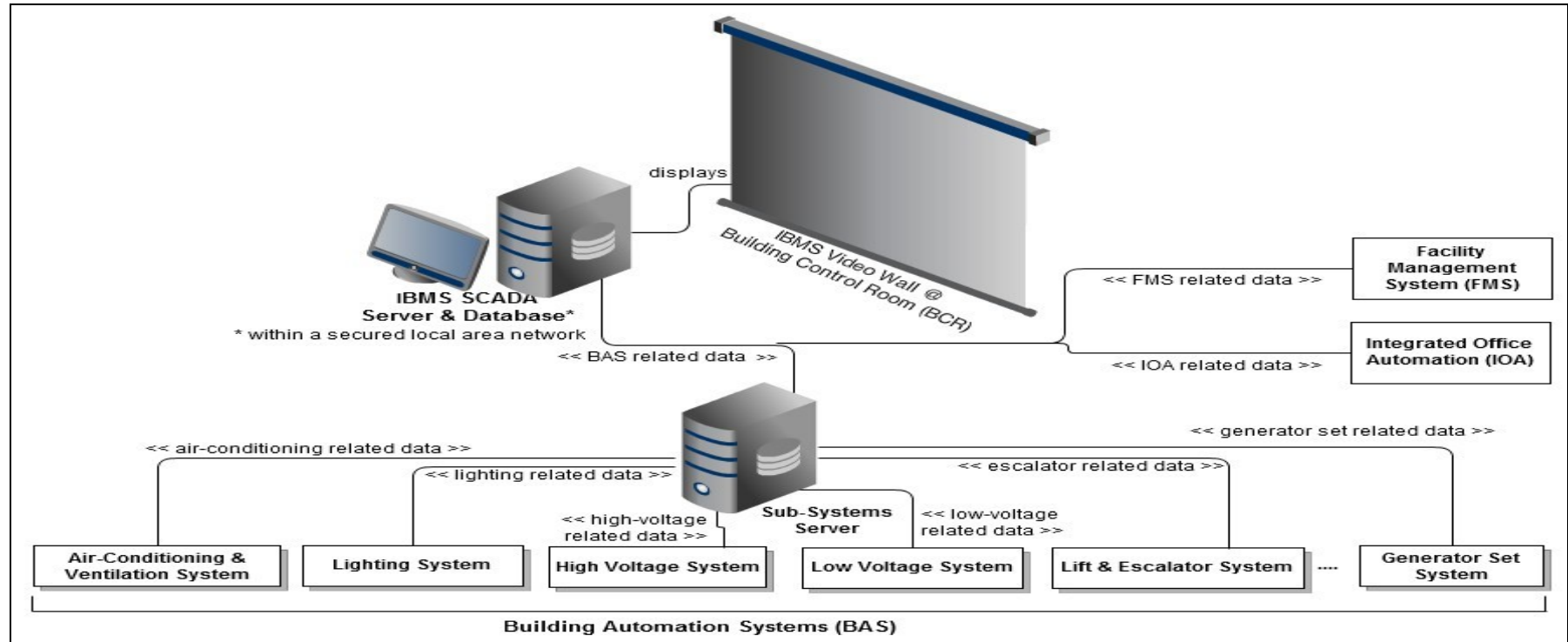


Figure 5.3- BAS and IBMS Architecture

(Source: Developed based on interviews with ES2 System Developers and simplification of the IBMS Product Description (IBMS01) and ES2 Product Description (ES201) supplied by ES2 System Developers)

The Energy Savings System (ES2) on the other hand, is a web-based system running on a secure network developed to configure the motor speed of the chill water pump (CWP) between 25 to 28Hz from anywhere in the world. Figure 5.4 shows the architecture of ES2. Previously, the chilled water pump speed was set at the maximum speed of 50Hz, and the setting can only be done manually at the physical locations of the CWPs. These CWPs are located at seventeen separate locations within Acadia's high-rise building. ES2 therefore enables staff at the Property Operations' Building Control Room to monitor and control the pump speed of the chilled water pump (CWP); track the motor pump performance, temperature distribution, pressure point reading, cooling capacity flow and the electricity consumption in kWh measurement. The most important functions of the ES2 are to:

- provide real-time monitoring and control of the speed of the CWP motor to Property Operations' technicians;
- provide feedback using sensors to monitor the environment temperature;
- enable remote access, remote override and remote control of the air-conditioning system;
- optimise the air-conditioning system by managing the performance of component pumps, heat transfer and chilled water distribution;
- manage the air-conditioning system through real-time components measurement, monitoring, control and verification;
- monitor instrumentation and controllers to the air-conditioning components throughout the buildings' air-condition system;
- provide system scheduling in setting the required room temperatures when needed

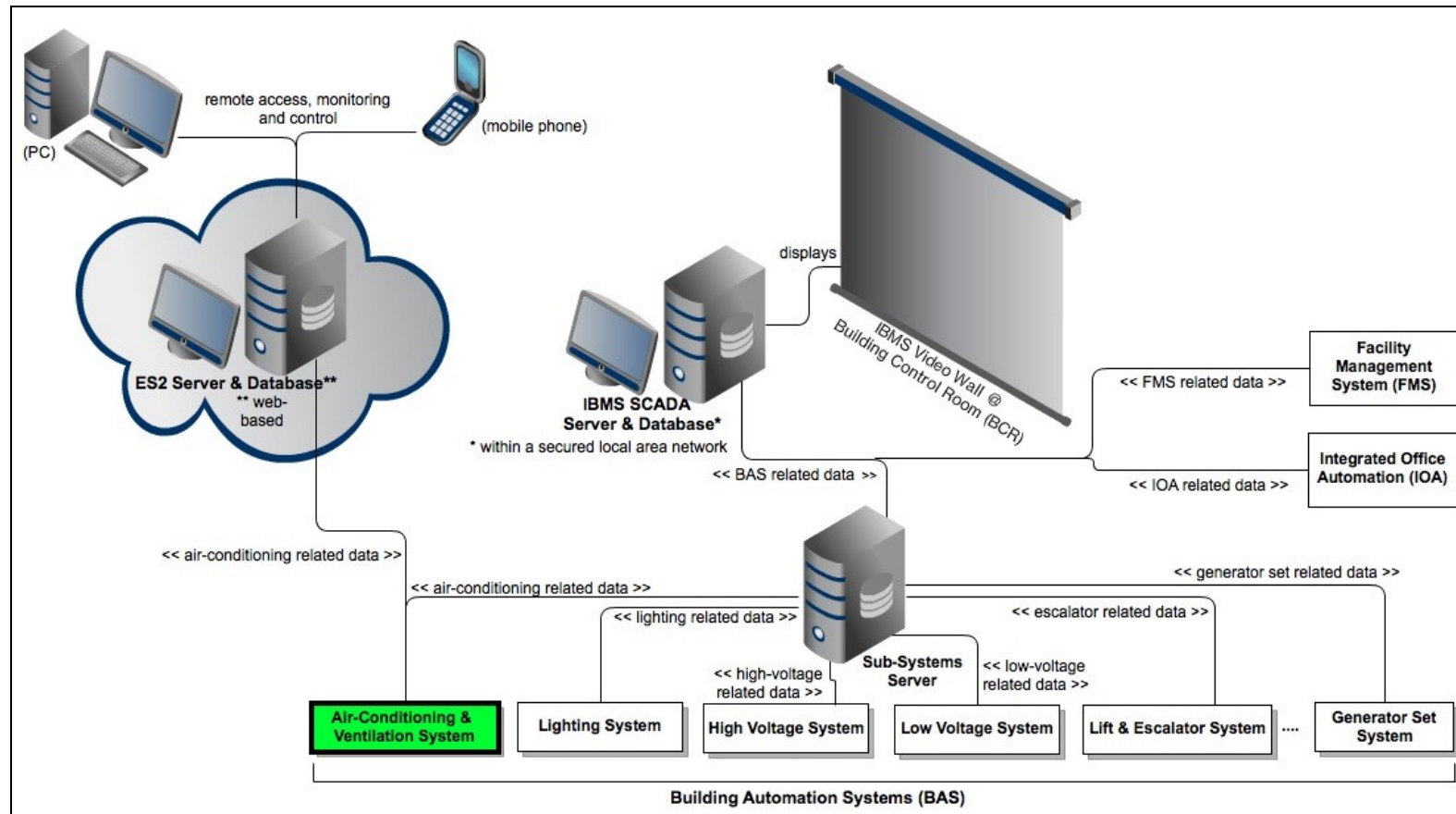


Figure 5.4 - ES2 Architecture

(Source: Developed based on interviews with ES2 System Developers and simplification of the IBMS Product Description (IBMS01) and ES2 Product Description (ES201) supplied by ES2 System Developers)

As ES2 was not developed with an advanced analytics capability due to the absence of specific requirements from the customer (i.e., the Property Operations), the electricity consumption data captured in ES2 was not able to be acted upon easily. While the managers are able to view the historical data of electricity consumption from the ES2 web interface, the data needs to be transferred to MS-Excel for data analysis. The use of MS-Excel in the broader context of Acadia's EI is shown in Figure 5.5.

Pertaining to the **general intent** with regards to values and goals underlying the EI innovation, it can be said that the “**spirit**” of environmental sustainability was given to the EI when it enters the “Energy Measurement and Monitoring” Phase with the development of ES2. Detail on the inscription of the green “spirit” into the EI is described in Section 5.3.4.2.

With regards to the **interpretive flexibility** of the system as intended by the system developers, the evidence shows that the EI innovation was used as it was intended by the system developers and system owner (i.e., the Property Operations Department). The details on the faithful appropriation of the IBMS and ES2 during their use stage are discussed in the “Building Measurement Capability” phase (see Section 5.3.4.1) and during the “Energy Measurement and Monitoring” phase (see Section 5.3.4.2), respectively. In addition, the reappropriation of MS-Excel as a tool to collect, store and report Acadia's reporting of its sustainability performance on electricity consumption is discussed in the “Energy Management” phase discussed in Section 5.3.4.3.

From the perspective of the **Green information system type**, the EI innovation can be categorised as both information system for energy management (Boudreau, et al., 2007; Mines, 2011; Watson, Howells, et al., 2012) as well as IS for smart infrastructure management software for helping organisations to manage their facilities operations (Boudreau, et al., 2007; Mines, 2011; Watson, Howells, et al., 2012). For the purpose of this thesis, both categories where the IBMS, ES2 and MS-Excel represent are called information system for Energy Informatics (EI).

The above discussion on the content of EI applications provides an overview of the information system used by Acadia for managing its electricity consumption. The following section offers the detail discussion on the related process and mechanisms throughout the innovation process of the EI applications.

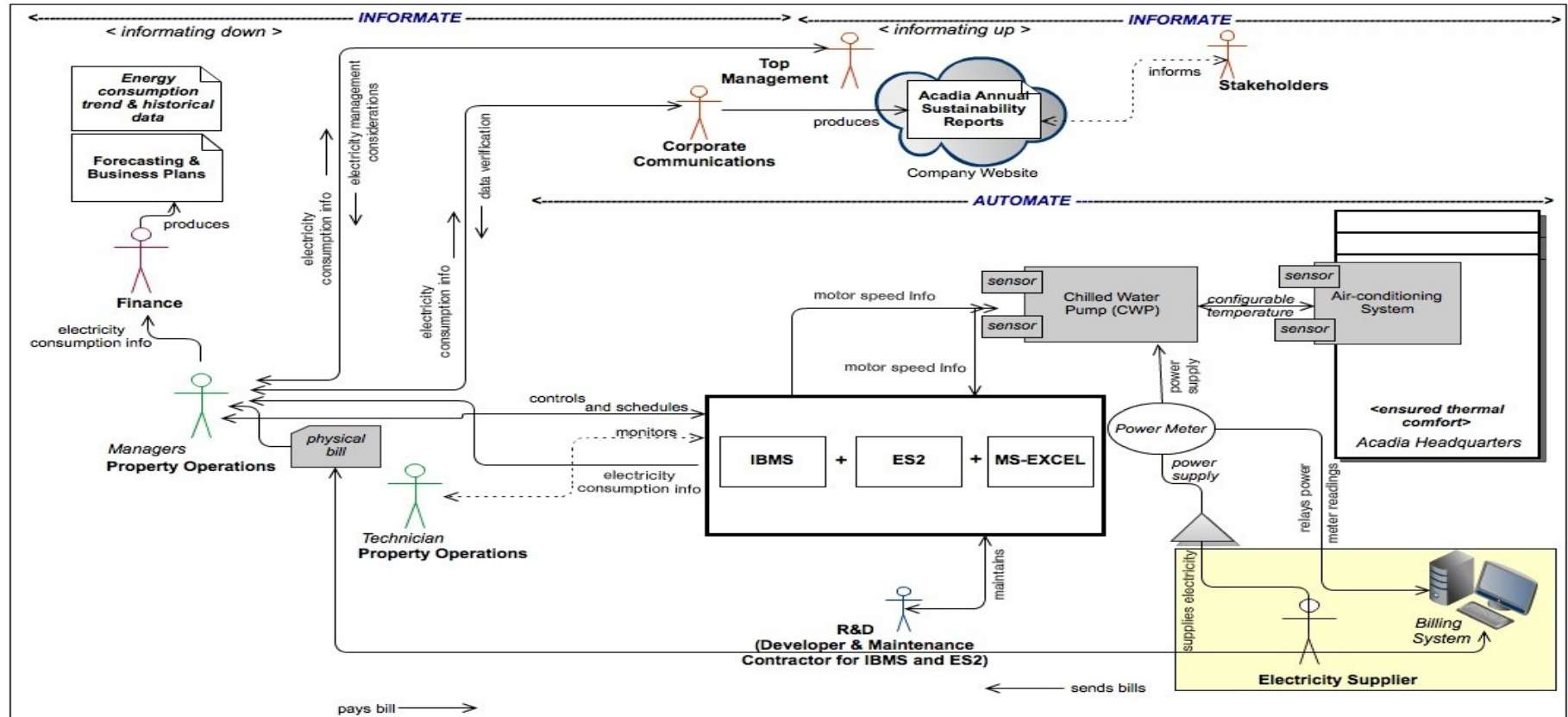


Figure 5.5 - Energy Informatics Architecture

(Source: Developed based on interviews with ES2 System Developers, Assistant General Manager and Managers of Property Operations, Finance Manager, Assistant General Manager and Manager of Support Business)

5.3.4 The Process and Mechanisms of EI Innovation at Acadia

At Acadia, managing energy through EI has gone through three phases: (a) Building Measurement Capability; (b) Energy Measurement and Monitoring, and (c) Energy Management Phase. These three phases are summarised in Table 5.5 and described in the ensuing sections.

Descriptor	Building Measurement Capability	Energy Measurement & Monitoring	Energy Management
When	1995-2005	2006-2009	2010
What system	BAS+IBMS	BAS+IBMS+ES2	BAS+IBMS+ES2+Excel
Developers	Internal R&D	Internal R&D	Internal R&D
Target users	Property Operations (Departmental users)		
Cost	IBMS: AUD \$5.8 mil; BAS: AUD \$18.2 mil		ES2: AUD \$0.5mil
Development environment	Windows Socket Programming; Application Programming Interface (API); Active-X; OLE for Process Control; Oracle; Windows NT		Open source development tool (PHP, Java); Web-based; MySQL; running on normal PCs and servers “Green” is defined as one of Acadia’s technology development roadmaps
Key operational challenges/ Problems	Lack of integration of vendor specific building management systems to measure electricity	To monitor and measure Acadia’s electricity consumption	To improve the supply of data for sustainability and annual reports
Key Environmental problems	N/A	ISO14001 compliance, energy efficiency	Environmental disclosure, greening the company
Functions	Integrate the control of mechanical and engineering (M&E) sub-systems (air conditioning, lighting, lift and escalator, high voltage, low voltage, plumbing)	Automatically measure energy consumed from air conditioning use; Remotely control and monitor the speed of the motors at the Chilled Water Pump (CWP) system	Data analysis for the energy consumption from the air-conditioning system
Key Benefits	Manage the “flow” and distribution of electricity supply and develop measurement capability	Reduce time and effort of adjusting air-conditioning systems and measure their electricity consumption	Showcasing eco-efficiency eco-goal is possible

Table 5.5 - Energy Informatics Innovation Characteristics

(Source: Developed based on interviews with ES2 System Developers, Assistant General Manager and Managers of Property Operations, and documents (IBMS01 and ES201) supplied by the ES2 System Developers)

5.3.4.1 Building measurement capability phase

The building measurement capability phase covers the period from 1995 to 2005. It includes the conception, development, use and evaluation of the integrated building management systems (IBMS). It is influenced by the internal strategy, technology, capability, resource, and practice, as well as the IT market trends. The following Figure 5.6 shows the pictorial depiction of the innovation process during the building measurement capability phase.

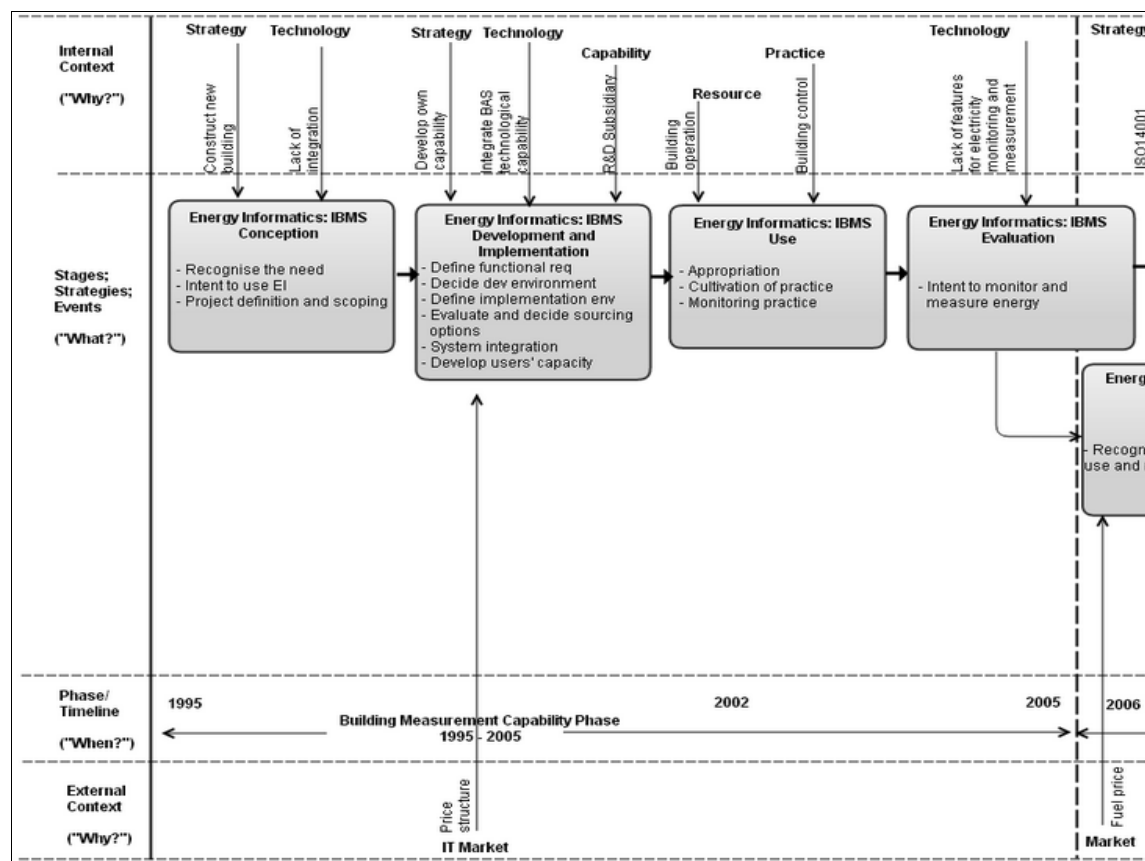


Figure 5.6 – Building Measurement Capability Phase of Energy Informatics Innovation (Source: Developed for the thesis)

As noted in the Context Section (see Section 5.3.2), Acadia first conceived of the use of energy informatics in 1995 when it was planning to construct a new building. The new building had 26 vendor specific modules. Acadia realised that managing the building and associated electricity consumption using these different systems was difficult. To address these technical and operational challenges, Acadia decided to develop an Integrated Building Management System (IBMS) in 1996 as the technology that can be used to integrate the distinct systems. In the development of IBMS, Acadia considered internal vs. external sourcing options vis-à-vis (i) the cost of off-the-shelf integrated building management systems (for example, the price a German firm quoted to develop an integrated system was around AUD\$31.6million), (ii) the desire to develop internal capability and (iii) the capability of its R&D subsidiary. Eventually, Acadia commissioned its internal Research and Development (R&D) Subsidiary to develop and implement an Integrated Building Management System (IBMS). According to the IBMS/ES2 System Developer 01, the development of the IBMS started in 1996, slowed down in 1998 due to the Asian financial crisis, and was completed in 2002 with a total cost of AU\$5.8million excluding the cost of the 11 building automation sub-systems which cost AU\$18.2million.

Most of the task of the development of the IBMS was focused on integrating the 26 modules of the Building Automation Systems. Because of the problem of compatibility of the different modules, developers had to rely on system integration tools such as Windows Socket Programming, Windows Application Programming Interface (API), Active-X, OLE for Process Control and Oracle was used and Windows NT machines were used as user terminals and to run the servers. As part of the system implementation, all the technologies from the building automation systems (BAS) and the newly developed IBMS were integrated into a single interface.

In the implementation stage, the Building Control Room (BCR) staff members consist of one manager and 6 technicians were given familiarisation training on how to use the IBMS. According to the system developer:

“When the system was completed and ready for operations, we conducted a few rounds of trainings to the staff like technicians and their managers. We also conducted high level briefings for the top management.” (ES2System Developer 01)

The IBMS is connected to a large video wall in the BCR to ease the monitoring of all building activities within a single interface. According to one of the Property Operations technician:

“Using IBMS is easy because it provides us at the BCR to monitor the running of all the building systems using the huge display on the wall. Otherwise, we have to monitor individual building systems, each from different PC monitors which is cumbersome.” (Property Operation Technician)

The direct departmental users operated the IBMS remotely to monitor and control the individual building automation modules. In the event of system failure for individual modules, the IBMS would display the points of error on the screen and rectification actions could be escalated to the system maintenance team. The first level of the maintenance team for the BAS is the building contractor appointed by Acadia, while the second level of the team is R&D Subsidiary team who developed the IBMS.

In the use stage, as the IBMS is a fully automated system, all the management of the “flow” and distribution of electrical supply are done by the systems. The departmental users (i.e., the technicians) only monitor and control the systems from the terminals and the video wall. If there is a situation requiring troubleshooting or maintenance, the users at BCR would identify the problems using the sensor alerts shown on their terminals (and video wall). Once knowing the real root cause of the problem, the technician team would physically go to the area where the problem was detected. If the problem could not be addressed at the BCR staff level, they would contact the system maintenance people (i.e., the Acadia R&D staff who was also the system developer) to help address the problems.

Although energy management is inherently an environmental issue and any system that is used to manage energy can have an environmental impact either implicitly or explicitly, in the development of IBMS, there was neither explicit green functional specification nor any green consideration in choosing the development and implementation environment.

In addition, the main purpose of using IBMS was to ensure running of the building systems and support day-to-day operations. Thus, there was no enactment of green

practice by the users. Consequently, the benefits of the IBMS can be evaluated from both operational and capability building perspectives. For Property Operations, the IBMS enabled managing the “flow” of electricity supply, aggregating building management functions into a single operation and maintenance system and collecting and monitoring operational data in real-time. From the R&D perspective, the IBMS led to creating internal capacity for developing energy informatics systems; establishing capability in managing and coordinating large projects with multiple vendors and business partners; developing new business in maintaining the completed system and developing building automation systems consulting and advisory capability.

The IBMS satisfied the operational need of Acadia until 2005. However during that period the requirements for a web-based system to enable remote monitoring and controlling of the building automation system had increased. Further, following Acadia’s adoption of the ISO 14001 certification and ever increasing electricity price, which intensified the need for energy measurement, the IBMS’s limited functionality in measuring electricity consumption became visible. There was also limited functionality to increase the visibility of electricity use and cost and thus limited capacity to make energy use to become top of the mind within Telecom Acadia. As the Assistant General Manager of Property Operations puts it:

“If you ask me the extent of IBMS in measuring electricity consumption is not successful... in actual fact, it was never meant to measure or manage electricity consumption. And we couldn’t even capture energy consumption data using IBMS.”

(Assistant General Manager of Property Operations)

Thus, a decision was made at the end of 2005 by the management of Property Operations to have a new system leading to the energy measurement and monitoring phase.

5.3.4.2 Energy measurement and monitoring phase

The energy measurement and monitoring phase covers the periods from 2006 to 2009. It includes the conception, development, implementation, use and evaluation of the ES2. It is influenced by the internal strategy, technology, leadership, practice, capability, system, and resource, as well as market trends, government, and institution forces. The following Figure 5.7 shows the pictorial depiction of how the innovation process is unfolded during the energy measurement and monitoring phase.

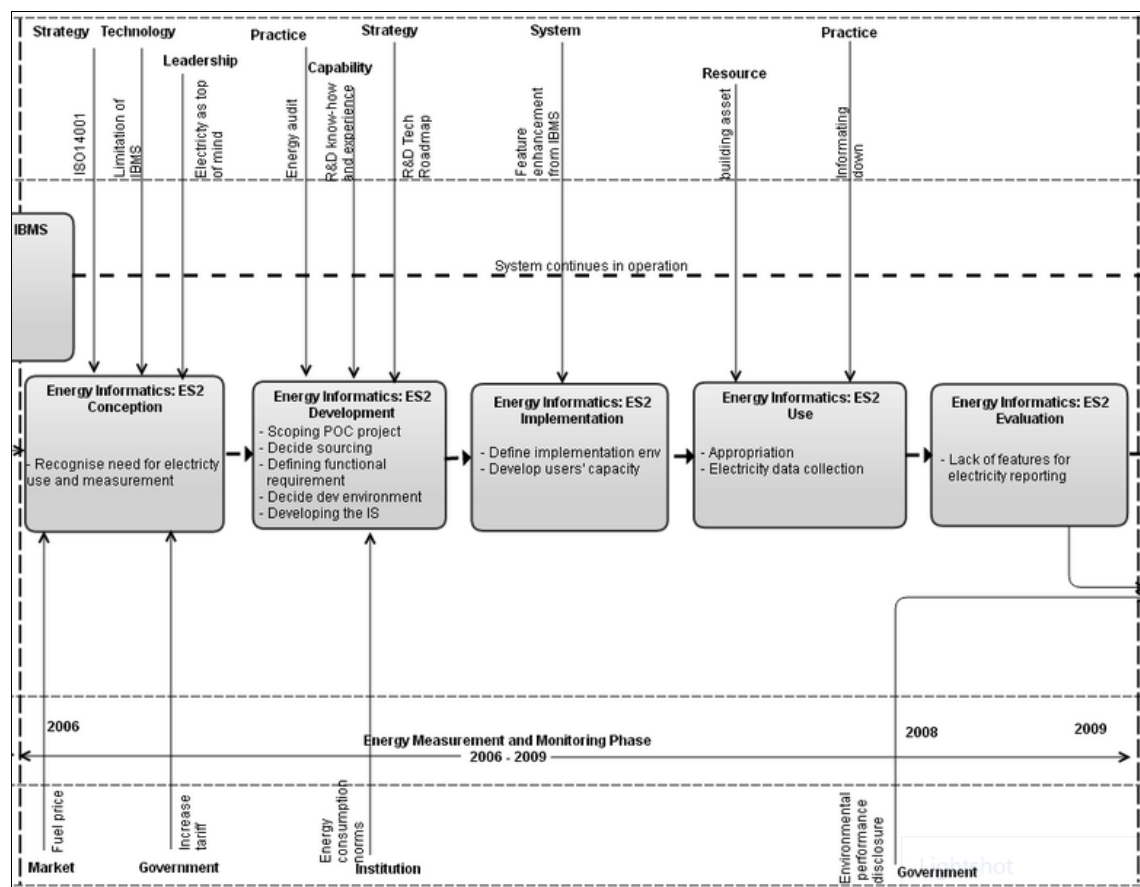


Figure 5.7– Energy Measurement and Monitoring Phase of Energy Informatics Innovation

(Source: Developed for the thesis)

The ES2 was **conceived** when Property Operations recognised the need for electricity measurement and monitoring which was heightened during the implementation of the ISO14001 in 2006. Since ISO14001 is a management system that is record- and performance-oriented, electricity data needed to be provided. Nevertheless, the existing

system (i.e., IBMS) had limited functional affordance to provide the required data and to control the motor speed of the air-conditioning system. Therefore, a decision was made in 2006 to develop a new system (Energy Savings System (ES2) to address the limitations of the IBMS.

In developing ES2, a number of the related events were unfolded which included deciding the sourcing option, defining project scope, defining functional requirement and determining development environment. Each of these events was influenced by both internal and external factors.

As regards *sourcing* option, the ES2 project was commissioned to Acadia's R&D Subsidiary because of the experience and capacity created in developing the IBMS.

“ES2 actually came to us as a request from Property Operations. They approached us because we happened to help develop the Integrated Building Management System (IBMS) for them before. So they asked us to look at this project as we have the expertise to build such a system.” (ES2 System Developer 04)

Acadia's definition of the *scope* of the ES2 project had taken into consideration prevalent institutional norms as well as the findings of its energy audit. According to a study conducted by the United Nation's Industrial Energy Efficiency Improvement Project (IEEIP), the electricity provided to air conditioning systems contributes approximately 60% to the cost of organisations' electricity bills as compared to all the other organisational electricity consumption. In 2006, Acadia had conducted an Energy Audit as part of its preparation for ISO14001. The audit, similar to IEEIP's findings, identified that air-conditioning accounted for a significant proportion of its electricity consumption. Thus, the scope of ES2 was to measure and monitor electricity consumption from Acadia's air-conditioning and ventilation systems.

“Based on our study, the building consumes 60% of electricity for air-conditioning. The rest is for lighting and others. That's why we decided to develop and use ES2 as our air-conditioning systems which use chilled water pump system. The ES2 is able to control the speed variable of the pump. The slower the speed of the water pump

means lower energy consumption but without comprising the comfort level of the staff.” (Assistant General Manager of Property Operations)

In defining the **functional requirement** of ES2, both green functional and non-green (operational) requirements were defined. The green functional requirements were that ES2 must be able to help Acadia to gather and track electricity consumption especially from the high energy use areas such as the air-conditioning as well as control the speed of the chilled water pump (CWP) system by a variable number in order to improve energy efficiency. According to IBMS-ES2 System Developer 02, the ability to control the speed of the CWP implies financial savings to Acadia because when the motor speed is set to lower Hz, the electricity consumption would also be reduced up to half of the original speed, resulting in cost savings for the company.

The operational requirements of the ES2 were defined as that it must be web-based and enable remote monitoring and controlling of CWP. In the past, the speed of the CWP can only be changed at the physical location of the water pump itself. Hence, ES2 was functionally envisioned to be able to allow configuration of speed from any remote computer (i.e., from the Building Control Room) or from the handheld devices of the Property Operations managers.

The development of ES2 started late in 2006 and was completed at the end of 2007 at an estimated cost of AU\$0.5 million. During the development, there was an effort to use a green development environment as Acadia’s R&D had developed its R&D Master Plan or a technology roadmap in which, green themes was emphasised in all R&D Subsidiary development endeavours.

“When developing ES2, we were thinking of achieving efficiency. Because to us, green is about doing things more efficiently. When you are efficient, you are green. Things that are inefficient cause much wastage, electricity wastage included. So that is not green... During the system development, we knew from the start that we didn’t want to invest in expensive equipment. We used machines that use low energy. We even developed the system using Open Source Solutions (PHP and Java) because we don’t want to be tied up with additional cost like servicing. The system is also web-based to

enable remote control and monitoring of the chilled water pump motor speed from anywhere in the world.” (ES2 System Developer 01)

To implement the green development environment themes, Acadia had used open source solutions to develop ES2. The open source, according to Boudreau et al (2007) is an example of “cleaner technology” whereby software is developed with zero-cost licensing structure. The open source also enables collaborative development among system developers (Boudreau, et al., 2007). Hasan et al (2012) and Hasan et al (2014) also claim that the open source development is an example of Green IS Development (Green ISD). For ES2, the system developers use PHP and Java for scripting the website system for enabling the system to be accessed from anywhere with Internet connection. The database for ES2 was running on MySQL.

When the ES2 was completed and ready for implementation, the system developers conducted user trainings with the departmental users (i.e., the technicians and managers of Property Operations). According to the system developer,

“During training, we demonstrated to them (Property Operations managers and technicians) how to operate it. Basically they know about the system as they were engaged and participated in the system development as system user. They are also familiar with the existing IBMS. ES2 extended that function of IBMS but for air-conditioning. So, it is not something totally new to them. There was also a user manual for them to refer to if they need it.” (ES2 System Developer 01)

From the perspective of ES2 use, ES2 was **used or appropriated** as it was intended by the system developers (faithful appropriation), which extended the capability of the IBMS and allowed Property Operations to collect the electricity consumption data and measure the electricity consumption of Acadia’s air-conditioning systems. It has four major outcomes from ES2 – capability, operational, social, and environmental. In terms of capability, ES2 enhanced R&D’s expertise and know-how in energy informatics for energy conservation and reduction from air-conditioning systems. Operationally, the return on investment was achieved within two years by reducing the annual cost of electricity by about AUD\$192,000. It has also facilitated remote control and management

of the Chilled Water Pump (CWP) by applying variable motor speed of the CWP and by configuring the required temperature setting; simplified the monitoring of “sensor networks” (i.e., the temperature sensors, the air pressure sensors, the motor speed sensors), and “flow networks” (i.e., the electricity and air-conditioning supplies) and the regulating of the “sensitised” objects (i.e., the air-conditioner units). Socially, the use of ES2 has enabled Acadia to maintain acceptable thermal comfort and conduciveness of the workplace despite the controlling of the CWP speed according to the variable speed set by the Property Operations managers. Environmentally, the use of ES2 enabled the implementation of ISO14001 Environmental Management System and reduced energy use in air-conditioning systems (approximately 133,000kWh per month of electricity in 2008).

Although ES2 has a basic data reporting function that enables users to view the history of electricity consumption, the information is mainly able to “informate down” to operational personnel rather than to “informate up” to decision makers and stakeholders. This is because at the time of ES2 development in 2006, there were no defined requirements for greater data analytics functionality. However, following Acadia’s inaugural sustainability report in 2008, the need for accurately reporting electricity consumption to the top management level (instead of just internally within Property Operations) and energy management became stronger leading to the next phase.

5.3.4.3 Energy management phase

The energy management phase covers the periods from 2010 onwards. It includes the use of MS-Excel in managing the energy reporting in Acadia. It is influenced by internal strategy and practice. The following Figure 5.8 shows the pictorial depiction of the innovation process during the energy management phase.

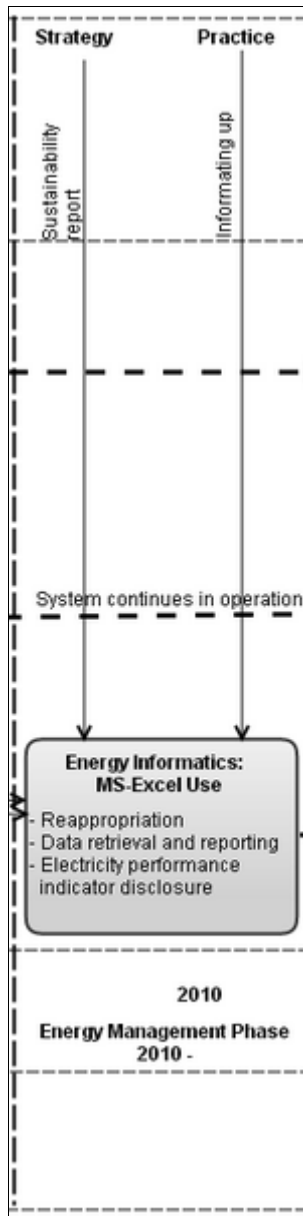


Figure 5.8 – Energy Management Phase of Energy Informatics Innovation

(Source: Developed for the thesis)

As Acadia became more engaged with eco-sustainability, it had placed more interest in making its electricity consumption not only visible to internal decision makers but also to the general public. Beginning in 2008, Acadia started reporting its sustainability performance where electricity consumption became one of its environmental performance indicators. To satisfy the information needs of various internal and external stakeholders, despite the inherent problems and limitations of using MS-Excel such as lack of data integrity, validity, sharing, completeness and accuracy, Acadia started using the reappropriated MS-Excel on top of ES2 and IBMS more rigorously from 2010 onwards.

The data retrieved from ES2 are transferred to MS-Excel on monthly basis by the Property Operations managers and is shared with Finance Division who used the data for overall forecasting and business planning for the whole company. Within Property Operations, electricity consumption information (in addition to all other information such as waste generation, water consumption, etc) is presented in the monthly operation meetings where necessary actions are taken if needed.

Further, from time to time, the top management were updated on Property Operations' efforts in reducing its electricity consumption where the data are shared with the top management. Electricity management advises from the top management would be considered for action by the Property Operations. The compiled data on Acadia's annual electricity consumption information is also shared with Group Corporate Communications who would also consolidate other environmental performance data into the company's annual sustainability reports.

Thus, the electricity consumption data retrieved from ES2 and processed via MS-Excel are used for informing up to (a) Acadia's shareholders as electricity consumption data for the whole year are reported in the company's annual reports, (b) Acadia's stakeholders as the company's sustainability report features detailed electricity consumption information, and (c) Top management to evaluate electricity reduction targets within the whole company. Further, the Property Operations, Group Corporate Communications Division and the Finance Division use the information (informate down) to understand and cost Acadia's electricity consumption as well as to display the building's electricity consumption for staff to see. Particularly, the Group Corporate Communications Division use these data (i.e., graphical form displayed on an intranet portal) to engage staff in efforts towards enhancing their eco-participation in company-wide electricity conservation initiative.

5.3.5 The Outcomes of EI Innovation for Acadia

Based on the discussion above, there are a few direct and indirect benefits from Acadia's Energy Informatics. The direct outcomes are summarised in Table 5.6 while the indirect outcomes are discussed following the table.

Outcome Type	Category	Area	Benefit
Direct	Environmental	Emission	Savings in electricity consumption and associated carbon emissions.
		Strategy	Showcases an eco-efficiency eco-goal, that is, being green and efficient, is possible. Acadia, in its 2010 and 2011 annual reports and in its 2009 and 2010 sustainability reports features ES2 as one of the main enablers in its cost savings and sustainability initiatives.
		Engagement	Using graphical data to illustrate high electricity consumption pattern, soliciting feedback and persuading employees to react accordingly was much easier compared to when no such data was available.
	Economic	Cost	Better estimation of the cost of electricity consumption for budgeting purpose.
	Operational	Technical	Improved the control, monitoring and management of

			the building's air-conditioning system.
		Informational	Ease of access to electricity consumption data for preparing sustainability and annual reports.
		IT	Developing energy informatics systems development capacity.
Indirect	Social	Workplace	Energy informatics used to maintain acceptable thermal comfort and conduciveness of the workplace.

Table 5.6 - Outcomes of Energy Informatics at Acadia

From the indirect outcome perspective, the benefit of Energy Informatics is in social terms whereby the green values were promoted among individual staff leading to potentially greener behaviours. The green value is claimed by some research participants to be consistent with the Islamic belief, the dominant religion in the country where Telecom Acadia operates. Further, a majority of the staff members of the company are Muslims. For example:

“Actually what we do is very much in line with our religion’s teachings. The religion says don’t be wasteful. The religion says be kind to everything around us, including the environment. The trees, the animals, the natural resources. After all, we are just borrowing this earth from our future generations. If we don’t care for it, I don’t want to imagine what lies ahead in the future.” (Assistant General Manager of Property Operations)

“The concept of green is easy. It is aligned well with our Islamic values like the religion says don’t be wasteful. Ninety nine percent of us at this company are Muslims and what we (Telecom Acadia) preach about green is for something that is good. To reduce waste, to reduce consumption, to reduce damage to natural resources, it is in

line with the basic teachings (of the religion). So to me, it is a value thing. When everyone is having that value, it becomes a norm and automatically become a practice.” (General Manager of Human Capital)

5.3.6 The EI Innovation Process Model

Based on the presented findings above, the overall Green information system innovation process model for Acadia’s Energy Informatics is shown in Figure 5.9.

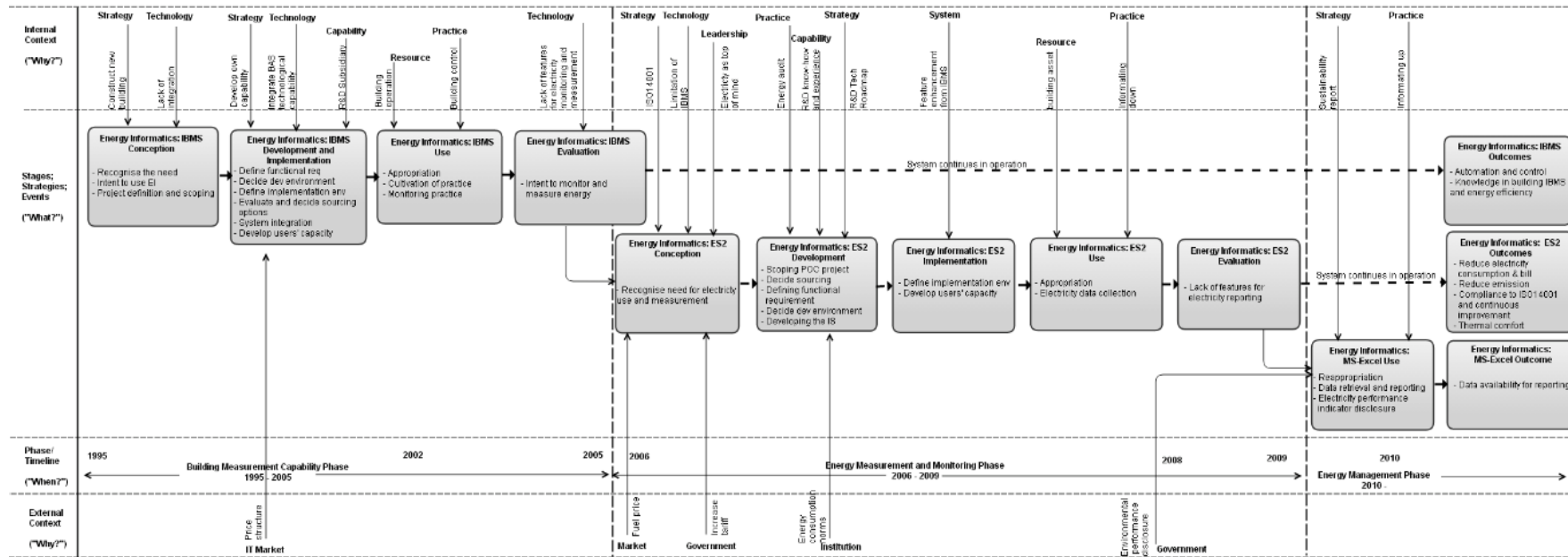


Figure 5.9 - Energy Informatics Innovation Process Model

(Source: Developed for the thesis)

5.4 CASE 2: UNIFIED COMMUNICATIONS AND COLLABORATION (UCC)

5.4.1 Introduction to the UCC Innovation

This section focuses on the innovation process of a Unified Communication and Collaboration (UCC) system in Acadia. The communication and collaboration practices and processes are important for organisations particularly for a telecommunication operator such as Acadia. DeSanctis and Monge (1998, p. 1) posit that communication and collaboration, especially those electronically-enabled allow “parties to link across distance, time, departments and organisations”. This view is supported by Kryvinska, Strauss, and Zinterhof (2010) and Bullock and Davis (2011) who further argue that communication and collaboration tools help organisations to improve their employee’s productivity, and reduce the delays and costs associated with sharing of the business knowledge.

Traditionally, communication and collaboration systems were not unified. It was only lately (since early 2000) that these systems started to be unified into a suite of applications called unified communication and collaboration (UCC) systems in order to support both communication and collaboration within a single platform.

For telecommunication companies, UCC implies both an operational challenge as well as a market opportunity. This is because telecommunication companies are both users of communication and collaboration technologies and providers of such systems to their customers. . Operationally, the UCC enables people to use the most appropriate communication medium for the task to be done and leveraging on the previously separate communication and collaboration channels (Kryvinska, et al., 2010). From the market opportunity perspective, telecommunication providers use their network infrastructure to provide UCC systems to their customers.

The communication and collaboration systems are considered as instantiations of Green information system innovation by academics (Butler, 2011; Chen, et al., 2008; Hasan, et

al., 2014; Kazlauskas & Hasan, 2009) and the industry (Mines, 2011; The Climate Group, 2008). For example, Chen et al (2008) argue that the adoption of eco-friendly technologies and practices such as UCC is the first step towards ecological sustainability. The diffusion and institutionalisation of UCC systems is also recognised as one of the instruments in the efforts of organisations to reduce environmental degradation (Hasan, et al., 2014; Kazlauskas & Hasan, 2009). Industry experts such as Mines (2011) consider communication and collaborations systems to be useful to help knowledge workers in organisations to reduce travel and improve workforce efficiency. The Climate Group (2008) in its Smart 2020 report has also claimed that ICT solutions including UCC is not only enable efficiency but also alter behaviour as the operational challenge in having effective communication and collaboration could be turned into “an opportunity by developing business models to enable adoption of low carbon solutions to mitigate rising carbon emissions and adapt to a world dealing with the impact of climate change” (The Climate Group, 2008, p. 14).

This section discusses the **content, context and process** of the UCC innovation in Acadia, both as an internal system as well as a market offering.

5.4.2 The Context of UCC Innovation in Acadia

A number of **internal** and **external** events set the context that led to the development of the Unified Communications and Collaboration in Acadia. These include the **business imperatives, top management, environmental sustainability culture, and innovation climate** motivations from the internal context, and the normative pressure from the external context.

From the **business imperatives** perspective, as a large company employing 25,000 staff nationwide, communication and collaboration are important undertakings for Acadia. Particularly Acadia’s physical locations; the volume of meetings; intra-company collaboration; and its organisational structure and committee based work practices chart the internal operational context out of which the UCC system was created and applied.

In terms of location, Acadia's headquarters are located in the fringe of the city centre with operations spreading into seven business zones in 14 states. Due to its size of operations, the volume of internal and external communication and collaboration are massive. While there is no official data about the number of meetings, the staff size and Acadia's physical locations can give hint to the volume of meetings held every day within the organisation. It was (and to some extent continues to be the case) a typical practice for the staff to travel from one office to another to attend meetings. As a personal reflection, the author during his tenure at Acadia, had attended around two to three meetings in the headquarters on monthly basis. Further, Acadia's organisational structure is hierarchical; many meetings need to be conducted within working level, and then reported to the higher levels. Staff members were also working in cross-functional teams making the formation of various kinds of committees a rampant practice. Reflecting on personal experience working in Acadia, the researcher at one point in time, became a member of at least five committees in the company (i.e., on Technology Roadmap, on Strategy, on Board Secretariat, on purchasing of consultant services, and on KPI) which required a lot of meetings within and outside of the company.

Traditionally, communication in Acadia was conducted via paper-based circulars, letters, reports, newsletters, face-to-face interactions, fax, telegrams and phone calls. On the other hand, the coordination and collaboration were done via secretariat that invited meeting participants and scheduled their availability for meetings. The collaboration usually required physical meetings, brainstorming sessions where ideas were proposed and debated, town hall meetings where questions and answers were held. The challenges then were in looking for finite number of meeting spaces; scheduling everyone's busy schedule; and paying for the "invisible" costs such as electricity from lightning, air-conditioning. In some meetings, paper documents such as meeting agenda and handouts had to be distributed. Another challenge was staff travel related costs and inconveniences as prior to 1993, there was no low cost flights and for those driving the highway connecting from the south to the north of the country was only completed in 1994.

In 1993, Acadia adopted an enterprise email system- Windows for Workgroups Mail with the client software called Microsoft Mail. However, this enterprise email system was only available for use by senior managers only and was limited in terms of features as it just provided emailing facility and lacked mobility support. In 1998, Microsoft Mail was

upgraded with the newer MS-Outlook 97 running on Microsoft Exchange Server. Access for email was given to bigger number of staff and eventually, all staff including non-executives was given their own personal email addresses in 2000. Over the years, Acadia had upgraded from MS-Outlook 97 to MS-Outlook 2000, MS-Outlook 2003 and MS-Outlook 2007. Although MS-Outlook combined the email, contacts, and calendaring with tasks, notes and journal, it did not have the collaborative functions (such as real-time video conferencing) and flexibility (such as location, time and device independence) needed by Acadia.

From the **innovation climate** perspective, in 2005, Acadia R&D, which is a technology research, development and commercialisation arm of Acadia developed and implemented a R&D Technology Roadmap (see Figure 5.10) and defined the incubation and commercialisation of UCC, both for internal use as well as market solution. It is important to notice that Acadia R&D has been ahead (i.e., earlier) than technology consultants in coming with the idea of UCC for large corporations when they included this technology in their R&D Roadmap (i.e., circa 2005 for the Roadmap 2006-2010).

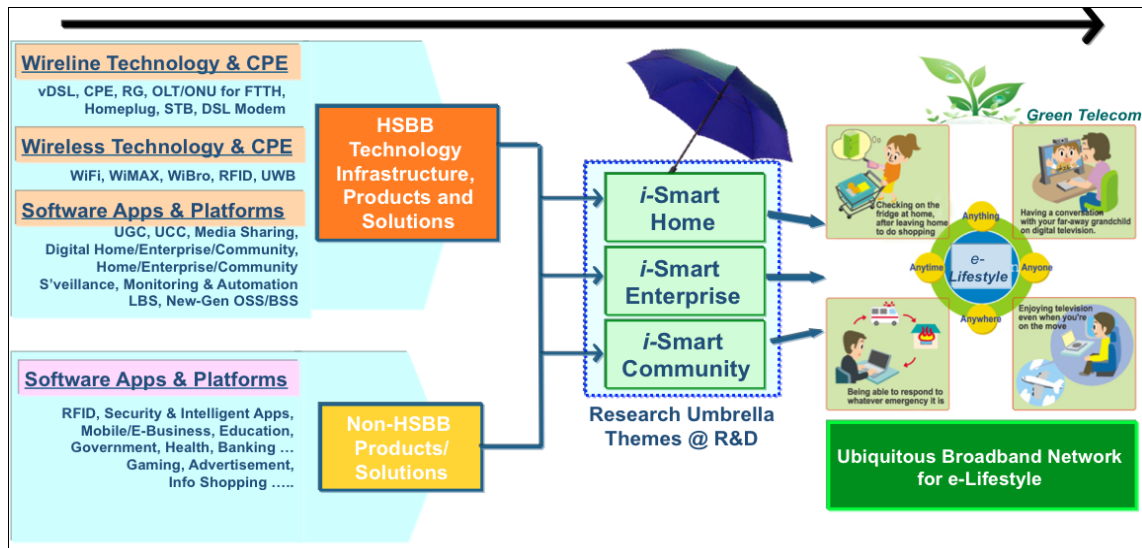


Figure 5.10- Sample of Acadia R&D Technology Roadmap

(Source: Acadia R&D Technology Roadmap, AR&DRM, supplied by R&D Manager 03)

From the **normative pressure** perspective, around 2006 and early 2007, unifying communication and collaboration systems was recognised as an issue by IT vendors when they started pushing their UCC products to large corporations including Acadia.

Technology consultants such as Gartner on the other hand, based on their analysis of the technologies incubated or under development in R&D companies and software houses developed white papers on the benefits of UCC and started “selling” the idea of the adoption of UCC technologies as a strategic investment for firms in order to become effective in their operations. This can be seen from Gartner’s UCC hype cycle shown in Figure 5.11.

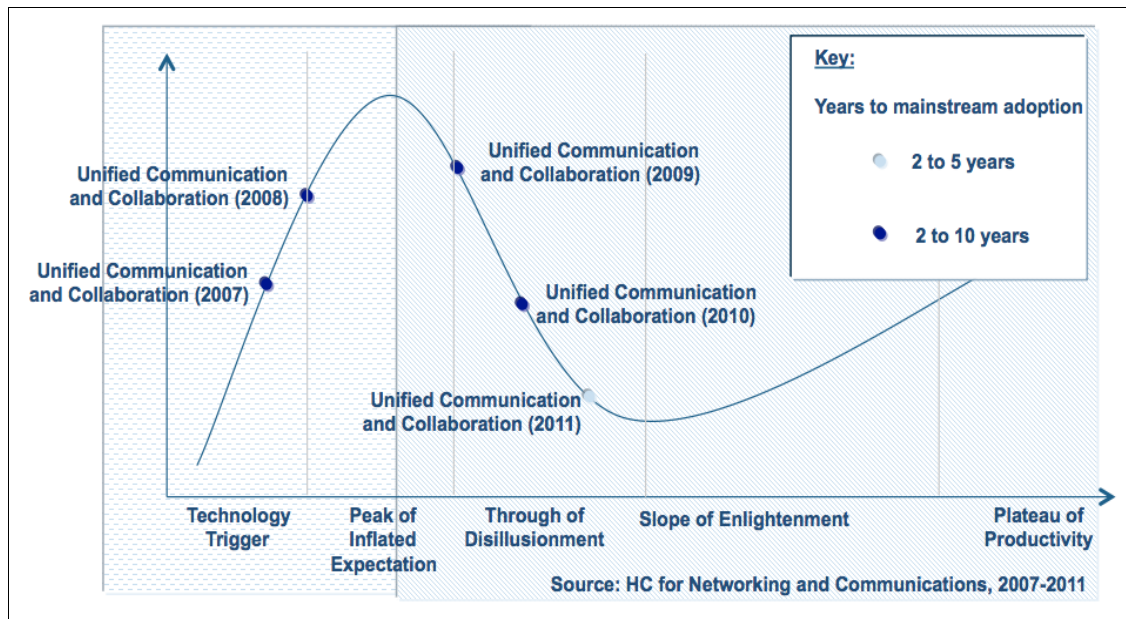


Figure 5.11 - Gartner’s UCC Hype Cycle

(Source: Extracted and modified from the actual Gartner’s Hype Cycles for Networking and Communications, 2007-2011)

The figure above indicates how Gartner analysed and positioned the strategic relevance of UCC for organisations between 2007 and 2011. The figure also implies that UCC was only started to be promoted by technology consultants in 2007 when UCC was seen to be climbing the cycle of technology hype. In the following year, 2008, UCC was gaining more hype traction as a strategic investment. In 2009, UCC was claimed to be entering its adoption stage in large corporations and in 2010 it fell from the hype cycle and entered productivity stage in 2011, heading towards mainstream adoption.

Overall, due to the operational problems felt internally, the market opportunity identified by Acadia’s R&D and external developments in the UCC landscape, in around late 2006 and early 2007, Acadia has felt the need to adopt an enterprise-wide unified

communication and collaboration (UCC) tool to facilitate a more effective internal communication and collaboration, as well as commercialising the same UCC solutions to other companies as a revenue income for Acadia R&D. Nevertheless, the UCC was not meant to totally replace MS-Outlook, instead it extends the communication and collaboration aspects that are missing from MS-Outlook. The IT Manager 01 said:

“Acadia R&D initiated the project on their own based on their research roadmaps aimed for commercialisation. But it was later identified by Group IT that the system could also be used to serve the whole company.” (IT Manager 01)

In terms of the **environmental sustainability culture** and the **top management** influences, from 2007- 2010, the utility and symbolism of UCC has changed especially following the popularisation of Green IS and Green IT by the academics and the industry for the benefits of environmental protection. As IT staff of Acadia were exposed to the latest development in the ICT industry (more on this will be discussed in the Process section), Acadia became aware of the potential of UCC for supporting environmental sustainability. Thus, this has influenced how UCC is viewed and used by organisations including Acadia. The role played by the Chief Technology and Innovation Officer (CTIO) in expanding the functional affordance of the metastructured UCC also has influential in the evolution of the UCC innovation in Acadia. The following section describes the UCC innovation from the content perspective before discussing the detailed process and mechanisms of UCC innovation.

5.4.3 The Content of UCC Innovation at Acadia

The Acadia’s UCC is a single innovation with multiple modules inside it. The modules are:

- (a) Voice communication which enable voice-based communication such as VoIP call,
- (b) Fax to enable the sending and receiving of fax messages from desktop computer,
- (c) Presence to enable knowledge on status availability (available, away, busy, etc) of other staff,

- (d) Messaging and chat to enable multiparty messaging (i.e., SMS) and chatting
- (e) Video conferencing which enable one-to-one and multiuse video, conferencing with 5 active participants and unlimited passive participants,
- (f) Collaborative which enable group discussion in collaboration window and collaborative working on documents, and
- (g) File sharing which enable document sharing for collaboration purposes.

Table 5.7 summarises the UCC application and is followed by a detailed description of the UCC.

Component	Year Developed and By	Users	Nature of system	Information stored/displayed
UCC	Late 2006 – Present Acadia R&D	Organisational: All Acadia staff, particularly those holding executive levels.	Handling the online communications and collaboration among staff members.	Communications and collaboration related information (i.e., user presence management, identity management, chat history, shared documents and files)

Table 5.7 - Summary of Acadia’s Unified Communications and Collaboration

(Source: Compiled based on combination of information from (i) interviews with the UCC system developers and IT managers and (ii) UCC Product Description, UCC01 shared by the UCC system developers)

The UCC modules listed before Table 5.7 are used for supporting communication, coordination and collaboration. For communication, the UCC is facilitating information exchanges and messaging among Acadia’s staff. The features used for communication include chatting, Short Messaging Service (SMS), desktop video conferencing, and VoIP call. Communication also entails some activities for coordination of such communication activities. Coordination in UCC enables Acadia’s staff to coordinate for online meetings whereby a team could create a virtual meeting room to meet on the UCC. The UCC also supports version management of files whereby when one user edited the shared file, a

new version is created and the edited file can be shared across with the other staff. The collaboration feature of UCC enables Acadia's staff to accomplish shared goals, shared responsibility and work on shared objects such as a document. Staff members are able to collaborate in a team environment where multiple users discuss and collaborate to solve certain issue in a virtual meeting room and share documents for discussion.

The UCC was developed using open source object-oriented programming, reusable object strategy and modular programming. According to one of the UCC developers, some of the modules were developed from scratch while some others were borrowed from existing Windows library of modules from the open source components. The methodology used in developing the UCC is the combination of rapid prototyping and waterfall software development model called incremental life cycle model.

“We used the incremental life cycle model because in the UCC, there are many modules. Each module was developed by different developer within the team. The development ran concurrently and in several phases. After one phase is completed, we deploy and then start another phase. So that is why we are using the rapid prototyping and combining it with the waterfall model.” (UCC System Developer 02)

The UCC was built using a peer-to-peer (P2P) technology as opposed to client-server computing architecture found in other UCC solutions. According to the system developer, they have also introduced the multicast technology within the P2P concept where no middle server is required for computing purposes as the communication and collaboration session are done based on end-to-end or point-to-point approach.

“When we embarked on this project in late 2006, we want to come up with a better design and a better solution for the UCC. We want to reduce the number of servers. As such, we utilise the P2P technology and for the video conferencing function, we want to use multicast technology where conferencing is held directly from end-to-end or point to point.” (UCC System Developer 01)

The anticipated **organisational users** of the UCC are all Acadia staff nationwide, in particular the staff members who are holding executive levels.

“The system was designed for all Acadia staff. Of course not everyone will use it. Probably more for people at the executive level than non-executive like the office boys and dispatchers who may not need to use it. The application has so many features to support internal communications and collaboration. Like chatting function, so everyone can use it. But for file transfer and video conferencing, not everyone will use it.” (UCC System Developer 03)

Pertaining to the **general intent** with regards to values and goals underlying the UCC innovation, it can be said that the **“spirit”** of environmental sustainability was not given to the UCC when it was developed by the system developers. This is illustrated in the discussion on UCC Phase in Section 5.4.4.1. However, the green benefits of the UCC was only realised and enacted “during practice” when IT Department metastructured the UCC as part of their solutions for Green IT initiative (refer Section 5.4.4.2 on “The Metastructuring of UCC as SCC” phase).

With regards to the **interpretive flexibility** of the system as intended by the system developers, the evidence shows that the UCC innovation was used as it was intended by the UCC system developers and system owner (i.e., the IT Department). Therefore, the UCC was faithfully appropriated by the users during its use during the “UCC” phase (see Section 5.4.4.1), and was faithfully appropriated through metastructuring during “Metastructuring of UCC as SCC” phase (see Section 5.4.4.2). The UCC was also faithfully appropriated through expansion of functional affordance into SCC 2.0 during the “Sustainable Communication & Collaboration 2.0” phase (see Section 5.4.4.3).

From the perspective of the **Green information system type**, the UCC innovation can be categorised as information system for supporting sustainable communications and collaboration in helping organisations to reduce travel and improve workforce efficiency (Boudreau, et al., 2007; Hasan, et al., 2014; Mines, 2011).

The above discussion on the content of UCC application provides an overview of the information system used by Acadia for managing its internal communications and collaboration. The following section offers the detail discussion on the related process and mechanisms throughout the innovation process of the UCC application.

5.4.4 The Process and Mechanisms of UCC Innovation at Acadia

The three distinct phases that can be identified in the process of UCC innovation in Telecom Acadia are: the UCC Phase, the Metastructuring of UCC Phase, and the SCC 2.0 Phase. Table 5.8 summarises the three phases of UCC innovation characteristics.

Descriptor	Unified Communication & Collaboration	Metastructuring of UCC	Sustainable Communication & Collaboration 2.0
When	Late 2006--2009	2010--	2011-
What system	UCC	UCC	SCC 2.0
Developers	Internal R&D implementing a Microsoft solution	Internal R&D	Internal R&D
Target Users	Everyone within the company (Organisational users)		
Cost	AUD 400,000	N/A	N/A
Development environment	Java OOP, Peer-to-Peer (P2P) architecture		N/A
Key operational challenges/problems	Lack of electronic communication and collaboration systems beyond the existing email systems	N/A	Lack of high-quality, high-definition TelePresence capability
Key Environmental problems	N/A	Sustainable communication and collaboration	Almost real-life experience of communication and collaboration
Functions	Voice communication via VoIP, fax, presence, messaging, video conferencing, collaborative, file sharing		Voice communication via VoIP, fax, presence, messaging, collaborative, file sharing, high-quality TelePresence
Key Benefits	Post-hoc realisation of potential for reduction in business travel	Perception of savings from business travels, change work practices, and lessen carbon emissions	N/A

Table 5.8 - Unified Communication and Collaboration Innovation Characteristics
(Source: Developed based on interviews and document (UCC01) supplied by the UCC System Developers)

5.4.4.1 The UCC phase

The UCC phase covers the periods from late 2006 to 2009. It includes the conception, development and implementation, and uses of UCC. It is influenced by internal resource, capability, strategy, practice and style, as well as the vendor's influence. The following Figure 5.12 shows the pictorial depiction of how the innovation process is unfolded during the UCC phase.

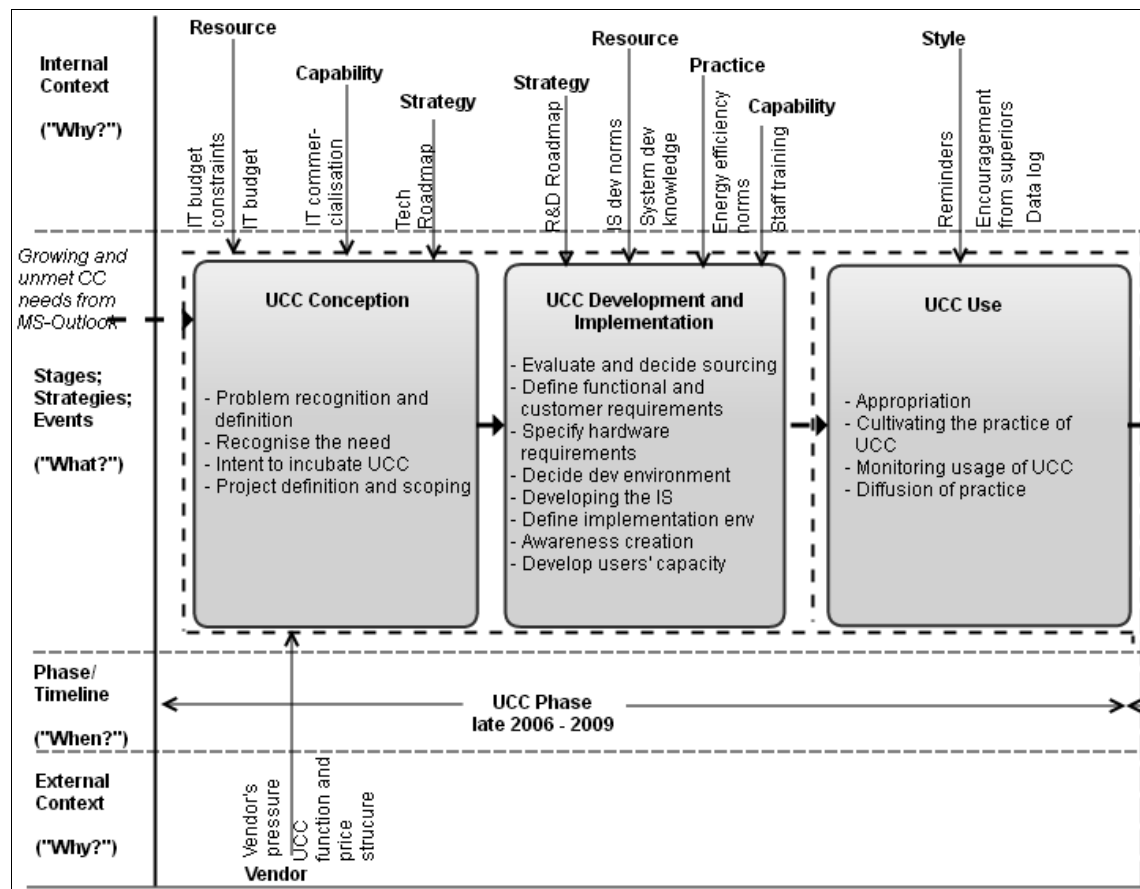


Figure 5.12 – UCC Phase of UCC Innovation

(Source: Developed for the thesis)

In terms of the conception of UCC, the four main events are unfolded: (i) Acadia R&D's intention to incubate UCC, (ii) IT Department's intent formation to adopt UCC, (iii) IT Department's evaluation of alternative adoption strategies, and (iv) IT Department's decision to source UCC internally.

Since 2005, Acadia's R&D had intended to incubate UCC and reserve the right to play in the UCC market particularly in the local industry (see Section 5.4.2). This intention was influenced by the emergence of UCC in the IT market (see also Figure 5.11 in Section 5.4.2 on Gartner's UCC Hype Cycle) as a technology with a market potential, R&D's technology roadmap strategy and Acadia's capability to commercialise its own IT solutions to the wider market.

At the same time, there was recognition of the growing and unmet communication and collaboration needs in Acadia as described in Section 5.4.2 as well as vendors' pressure to adopt UCC. Particularly, in late 2006 and early 2007, a number of UCC vendors marketed their UCC solutions to the IT Department. As the caretaker of Acadia's IT operations, the IT Department was constantly approached by companies such as IBM who promoted their Sametime UCC solution, and Microsoft with their Live Meeting and Office Communication Server UCC products. The top management of Acadia instructed the IT Department to evaluate these UCC solutions and propose recommendations. According to the IT Manager 01:

“As was informed that the General Manager of IT then was asked by the management to study the various solutions as to ease internal communications. In particular, existing Acadia's vendors like Microsoft was invited, along with other providers such as Cisco to propose their solutions.” (IT Manager 01)

The Acadia's IT Department evaluated two alternative strategies: (i) procuring the UCC from commercial vendors; or (ii) developing the UCC in-house. The evaluation of these alternative adoption strategies had taken into consideration (i) Acadia's existing capability, particularly R&D's incubation of UCC which was triggered by UCC's emergence as a strategic investment with a market potential, (ii) IT budget constraints and (iii) the functions and price structure of off-the-shelf UCC solutions.

Following the evaluation, the IT Department decided to source internally (that is from R&D Subsidiary) the development of UCC. This decision was reached because first, Acadia's top management, as indicated in the R&D's technology roadmap, had committed to develop R&D's capability to play in the UCC market. Second, the cost of commercial off the shelf UCC solutions was very expensive due to the newness of these

technologies. The early adopters of new technologies would normally bear the cost of high investment made by a technology company in developing the product.

Notably, however, eco-sustainability goals were not explicit drivers during the conception of the UCC– that is, the UCC as Green information system emerged serendipitously after the company launched its Green IT initiative despite the R&D’s Technology Roadmap that stated green features of software and applications developed by the R&D. One of the UCC developers noted the following:

“Actually, it (UCC) was not (intended) for that (green initiative) at the beginning. The green part only came later when the IT Department recognised the potential of the UCC for greening the company.” (UCC System Developer 01)

According to UCC System Developer 01, for the development of UCC, Acadia budgeted an AUD\$400,000. As a comparison, the commercial-of-the-shelf (COTS) products were priced around AUD\$2.2million excluding maintenance and licensing fees.

The development of UCC involved (i) decision on development environment tool (i.e., use of open source and object oriented paradigm), system architecture (i.e., P2P) and approach (i.e., modular design); (ii) definition of the functional and customer requirements; (iii) specification of the hardware requirements (i.e., energy efficient servers and computers); (iv) developing and testing; and (v) user training.

Although in the conception stage of the UCC, eco-sustainability objectives and considerations were not given primary consideration, the development of the UCC, has benefited from Acadia’s R&D Technology Roadmap (see Figure 5.10, Section 5.4.2). The Roadmap emphasised on infusing green considerations in the products incubated by Acadia to achieve its goal of “green telecom”. As a result the UCC development team decided to use open source and object-oriented paradigm which are considered as green options due to allowing reusable components to make system development modular and agile (Chen, et al., 2008; Pattinson & Gordon, 2011).

According to one of the system developers:

“The system was developed using Java object oriented programming (OOP) language. One of the most important elements of OOP is the ability to reuse some of the codes. The reusability was able to speed up certain elements of the system development.” (UCC System Developer 02)

In defining the functional and customer requirements, there was no specific “green” feature requested by the IT Department. However, the system developers claimed that they explicitly requested for energy efficient servers equipment – making the UCC development environment to be in line with energy efficiency norms. One of the developers who were also responsible in preparing the hardware specifications and logistics of the UCC project said:

“To support the UCC system development, we purchased new PCs and new Blade servers that are energy efficient.” (UCC System Developer 03)

According to the main system developer, the UCC was developed using a combination of rapid and waterfall development methodology called “incremental life cycle” methodology. The system developer also argued that the UCC was developed in modular fashion, in which the system was developed module by module and later integrated as a whole UCC system. This model of system development is considered as “green” because it allows for systems to be developed more rapidly, hence reduce the needs for extended development time which would consume more cost, efforts and resources including electricity (Huang, 2009; Zhang et al, 2011).

“We developed the system using an incremental life cycle because the system has many modules or features that support chatting, video conferencing, SMS, file transfer, VoIP call, collaboration room and etc. Each module has its own developer. They developed the modules in parallel. There are also a few phases in the system development. After each phase, we integrate and test the prototype, and then we start with another phase. We do this until the system was completed.” (UCC System Developer 01)

As the UCC was targeted to be used by all the 25,000 Acadia staff, a load balancing technique was used to avoid bottleneck when too many users are connected at one time.

Further, the UCC was designed as a peer-to-peer (P2P) technology making reliance on a central server unnecessary. Instead, all communication and collaboration are executed on computer-to-computer basis. According to Mansoori (2011), peer-to-peer technology is more energy efficient compared to client-server computing (CS), and hence, is a greener option in contrast to its alternative architecture.

“When we developed UCC, we used the Peer-to-Peer (P2P) technology where the need for a central server is being taken out. We could reduce energy and reduce emission because one or a few main servers are no longer needed now.” (UCC System Developer 01)

Another system developer added:

“From design aspect, in order to cater for huge traffic, we have load balancing system in place by implementing some replication strategies.” (UCC System Developer 02)

The UCC development was completed in early 2009 and after some internal testings and user trainings as part of the implementation stage, the UCC was fully operational in the middle of 2009. However, the user trainings and awareness sessions conducted during this period were not focused on the use of UCC for greenness.

The events occurring at UCC use stage were: (i) cultivating the practice of communication and collaboration via UCC; and (ii) monitoring UCC usage.

The UCC started to be used in the mid-2009. In order to cultivate the practice of UCC use among Acadia’s staff, IT Department and Group Corporate Communication Division sent reminders to the staff on the existence of the system. The staff members were encouraged to install the software from the main Intranet portal (the SKMS – refer to Case 3 in Section 5.5). The staff were also able to contact IT Help Desk to enquire and get assistance in the events they are having problems of using the UCC. Additionally, some managers instructed their staff to use UCC to communicate with one another as well as with the staff from other locations throughout the country.

“My superior reminded us in the Unit to use the system on daily basis. Not only to communicate with staff within the same department or same building, but also with those in other departments or in other states.” (IT Manager 02)

The IT Department with the help of the UCC developers from R&D Subsidiary monitor the usage of the UCC. Based on the data log, one of the UCC developers mentioned that there was a steady increase of UCC usage. The developer said:

“We track the usage of the UCC. Generally, we have usage data for daily, weekly and monthly basis. Based on the data, we have about 800-1200 staff using the UCC at any one time. While the figure is still not so encouraging, with more awareness, we expect the number to increase.” (UCC System Developer 01)

Based on the survey conducted with 150 Acadia staff members reinforced the view that UCC has yet to be adopted widely in Acadia and most respondents did not utilise all the features of UCC (see Table 5.9). For example, only half of the respondents used UCC to chat with colleagues and 42% used short message service (SMS) to colleagues. Only less than one third of the respondents used UCC for file transfer (30%), engaged in collaboration by creating special interest group (28%), established collaboration by making VoIP calls (25%), and for video conferencing (20%). The least frequent use of UCC was for faxing documents (18%).

Practice Use of UCC ...	Using (%)	Not Using (%)
To chat with colleagues	50	50
To send SMS to colleagues	42	58
To make VOIP calls	25	75
To do video conferencing with colleagues	20	80
To do file transfer with colleagues	30	70
To fax documents to colleagues	18	82
To create special interest group with colleagues	28	78

Table 5.9 -UCC Diffusion Among Acadia Staff

(Source: Survey conducted for the thesis)

It is important to note that the UCC had been in operation for more than 2 years when the above survey data was collected. The findings indicated that the use of UCC was not too successful judging from the relatively low use of the UCC features. However, in 2010, the UCC was given a new symbolic meaning for supporting environmental sustainability. We refer to this as the metastructuring process of UCC into Sustainable Communication and Collaboration (SCC) Systems which is discussed in the next sub-section.

5.4.4.2 The metastructuring of UCC as SCC phase

The metastructuring of UCC as SCC phase covers the periods from 2010 onwards. It includes the metastructuring process of UCC as SCC itself. It is influenced by internal strategy, resource, leadership, and staff, as well as the vendor's and consultant's influences. The following Figure 5.13 shows the pictorial depiction of how the innovation process is unfolded during the metastructuring of UCC as SCC phase.

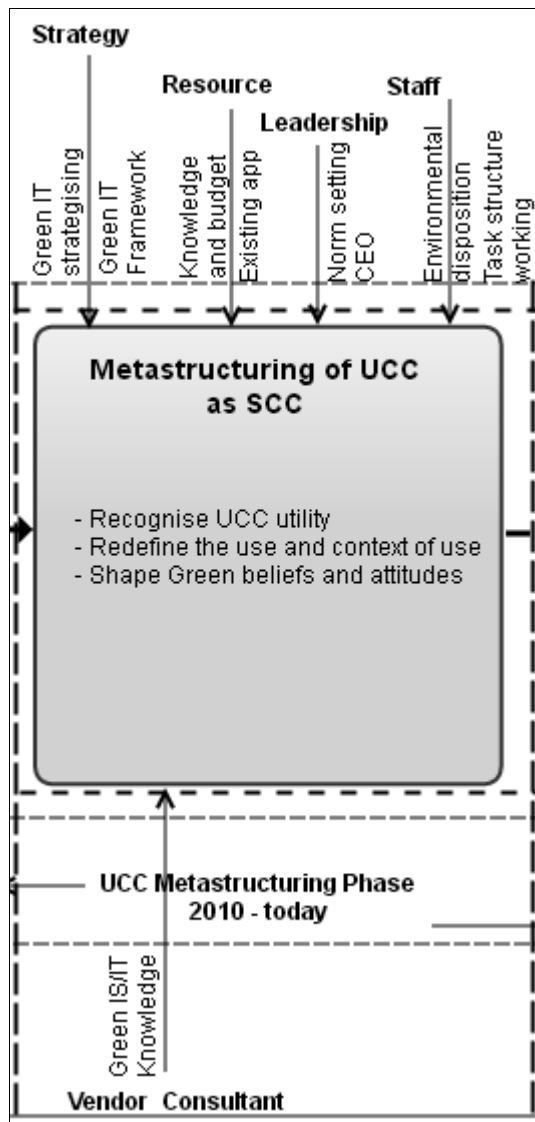


Figure 5.13– Metastructuring of UCC as SCC Phase of UCC Innovation
 (Source: Developed for the thesis)

The concept of metastructuring is introduced by Orlikowski, Yates, Okamura, and Fujimoto (1995). Orlikowski et al., (1995, p. 424) in their study of the adoption and assimilation of a communication technology (i.e., a newsgroup) describe metastructuring process as the *‘deliberate, ongoing, and organisationally-sanctioned intervention within the context of use that helps to adapt new communication technology to that context, modifies the context as appropriate to accommodate use of the technology, and facilitates the ongoing effectiveness of that technology over time’*. The metastructuring does not involve any changes to the features of the existing system. Instead, the system is given a new symbolic meaning. Orlikowski et al (1995) further indicated that other agents (besides end users) can act as mediators as they modify the technology and the

institutional environment through their explicit (and sanctioned) actions, and thus influence the technical and institutional context in which individual-level structuring occurs.

In Acadia, the IT Department was the main agent who acted as the mediator to modify the technology “symbolically”. This was done under the institutional environment of going green and through the explicit action of defining a Green IT strategy that included UCC. During this period of metastructuring, Acadia (through its IT Department) recognised the utility of UCC to enable sustainability, redefined the use and context of UCC into SCC, and started shaping green beliefs and attitudes to encourage the wider diffusion of SCC. These events were influenced by a number of internal and external forces and factors and the following sections discuss how these events are unfolded and the influencing forces.

In terms of recognising the utility of UCC as an enabler of eco-sustainability, in early 2006, Acadia’s R&D had conceived and developed UCC under the wider umbrella of “Green Telecom”. However, the utility of UCC as an enabler of Acadia’s internal eco-sustainability initiatives was only recognised by the IT Department in 2010. In March 2010, the IT Department of Acadia launched a Green IT initiative. Although the initiative is called Green IT, in reality it combines aspects of both Green IS and Green IT. In order to oversee the Green IT initiative, the IT Department formed the Green IT Central Committee. According to the IT Manager 01 who served as the Secretariat of the Green IT Central Committee:

“When we formed the Green IT initiative, the first task was to set up a Green IT Central Committee which was responsible in overseeing the overall Green IT initiative.” (IT Manager 01)

The Green IT Central Committee was composed of (a) Steering Committee, chaired by the Senior General Manager of IT Department; (b) Green IT Project Director; (c) Green IT Project Manager, and (d) four teams working on governance and policy, architecture and consolidation, Green IT Roadmap, and cost-saving initiatives and compliance. Appointment letters signed by the Senior General Manager of IT were given to the members of the Green IT Central Committee. The appointment letter was a way to

recognise the contribution of the identified staff members, and to give legitimacy for their involvement in helping and championing Acadia's Green IT initiative.

Although the Green IT Central Committee and structure was setup and the organisational documents stated the intentions of Acadia's top management to make the company "greener", ironically, this was not translated in terms of adequate resource allocation, most evidently in terms of financial resources. As a result, the Committee, in its strategising activity, was forced to search for "low hanging fruit" green initiatives that primarily exploit existing technologies. In the words of the IT Manager 04:

"For now, we actually don't have the budget for green solutions. That is why we are choosing the UCC as one of the green products showcase as it is already there and we sort of self-funded its development and deployment. For [the] short-term, we are looking at simple solutions which do not incur any cost. But for middle to long-term, yes, we are willing to invest for example in an integrated solution which can track our carbon emissions and energy consumption." (IT Manager 04)

The Acadia's Green IT Central Committee team members search for low hanging fruit green initiatives, in addition to financial constraints, was also influenced by both internal and external knowledge sources and the industry norms of 2009-2010. In order to develop knowledge about Green IT, the members of the Green IT Central Committee attended various forums and seminars on the topics of eco-sustainability and ICT. Particularly, as Acadia subscribed to the services of Gartner, they had an exclusive "subscription hours" to personally engage with some of Gartner's experts on Green IT. The Secretariat of the Green IT Central Committee, who was also the IT Manager 01 mentioned:

"We had a conference call with Simon Mingay of Gartner when we were developing our Green IT Framework. We told him where we are, where we want to go, what we want to do, and whether what we did was right. We did it because we subscribed to Gartner. When we subscribe to their services, they allocate some hours from the subscription cost so that we can spend talking to their consultants for advices." (IT Manager 01)

The above discussion highlights that the recognition of UCC as an enabler of reductions in paper consumption, business travels, and fuel consumption was influenced by the search for “low hanging fruit” strategy as well as the limited financial resource available to the champions of Green IT initiative. Thus, the availability and provision of resources influence the process of Green information system innovation within an organisation so that the limitation of economic resources can lead to re-appropriation of the existing information system innovations as Green information system rather than the development of new Green information system innovation. Further, the knowledge resources available to the sponsors and champions of the Green IT initiative as well as the ICT industry via consulting advice and interactions with other industry players play a role in the materialisation of Green information system innovation.

In terms of redefining the use and context of UCC, once the UCC was recognised as a low hanging fruit solution to implement the Green IT strategy, Acadia has given a new meaning to the UCC as an information system that could be used to enable Acadia’s environmental sustainability initiative in the unveiled Green IT Roadmap which outlined the Green IT Framework (see Figure 5.14) consisting of governance, technology, process, and people.

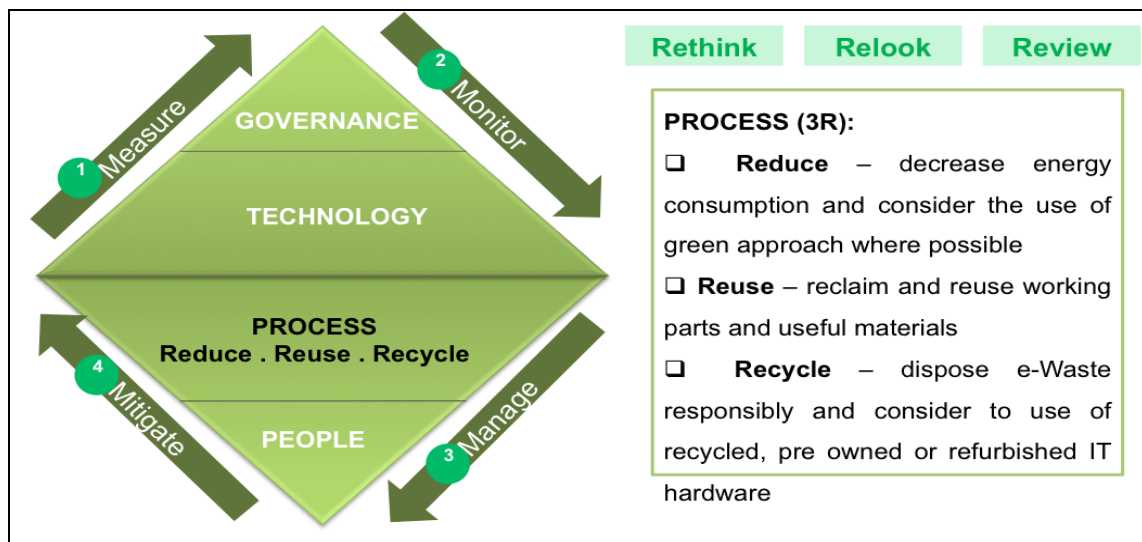


Figure 5.14– Acadia’s Green IT Framework.

(Source: Green IT Overview, Green IT01 supplied by IT Manager 01)

In order to execute the Green IT framework, the Central Committee set up Green IT Working Threads. One of the working threads was called the “End User Computing” Working Thread which was tasked to identify the existing technologies available in Acadia that were ready to use in supporting the Green IT initiative. Based on their analysis, the End User Computing Working Thread had identified three main initiatives. One of it was “to simplify communication and collaboration for end users to increase productivity” (see Figure 5.15).

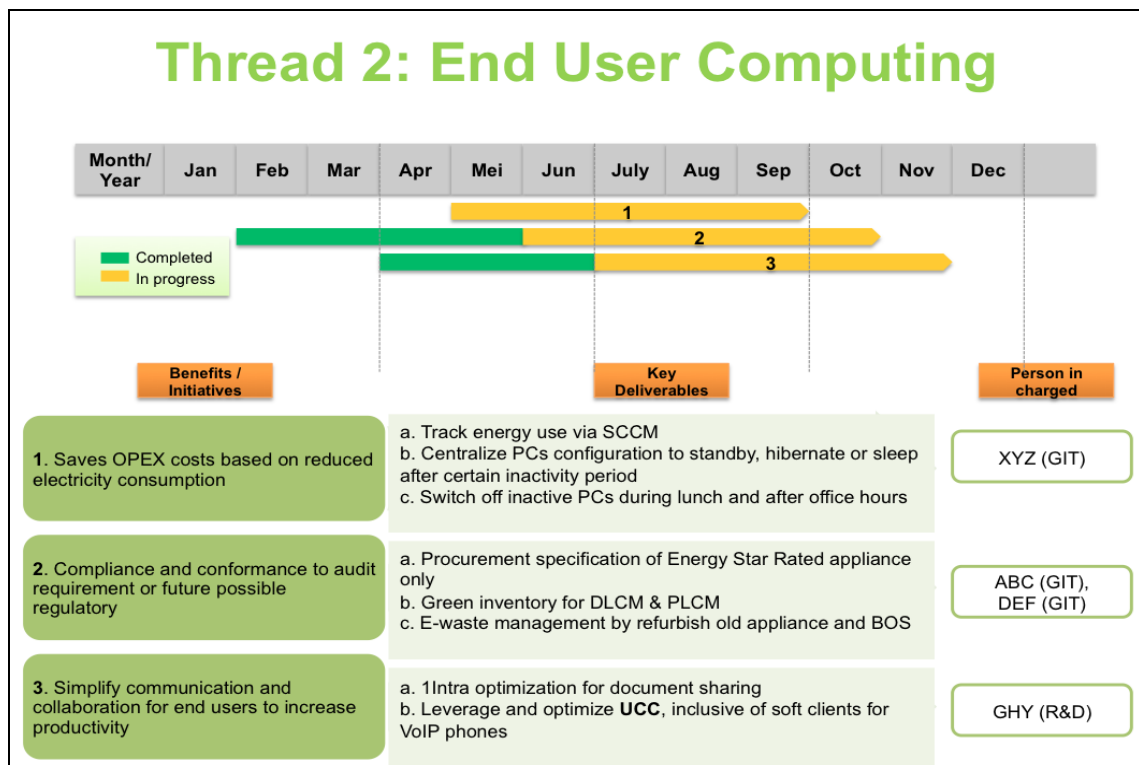


Figure 5.15- The inclusion of UCC as one of the Green IT’s End User Computing Solutions

(Source: Green IT Overview, Green IT01 supplied by IT Manager 01)

This means that the context and use of UCC was redefined within the Green IT strategy implementation initiatives. The Green IT Secretariat who was also IT Manager 01 claimed:

Internally, we have also been thinking about what kind of things that we can include for our Green IT initiative. We don’t want to invest in new thing because we don’t have much budget for Green IT. The bosses said either free or cheapest solution

possible for our Green IT initiative. So that is why we include the UCC, in addition to server virtualisation, PC and notebooks compliance to Energy Star, and Managed Print services.” (IT Manager 01)

Pertaining to the shaping of green beliefs and attitudes to encourage UCC diffusion, numerous awareness sessions to re-introduce the UCC and how Acadia may gain green benefits from the recurrent use of the UCC were undertaken. The mechanisms used to shape the green beliefs and attitudes included the email blast sent to all staff every fortnight communicating to the staff on Acadia’s Green IT initiative and the use of ICT such as UCC for supporting environmental sustainability.

In March 2011, the company also organised a one-day event called “Productivity Day” where the concept of Connect, Communicate and Collaborate was used as the main theme. One of the topics presented to the audience during the Productivity Day event was on greater cross-departmental collaboration and communication. The use of UCC was given prominence in the talk. In addition to increase productivity, the UCC was pitched as a tool to help to reduce carbon emission, reduce paper consumption, and reduce tree being cut and in overall, save the natural environment.

The event was hosted by the IT Department in collaboration with the Group Corporate Communications Division and Microsoft, as the technology vendor was also giving a presentation on the use of MS-SharePoint products for productivity. During the Productivity Day event, the UCC was also promoted and highlighted to staff members by the UCC developer team from Acadia R&D and they were also ready at hand answers to questions and inquiries. Thus, it is during this event that the UCC is considered to be officially redefined or metastructured as the Sustainable Communications and Collaboration (SCC). During the event, the staff can drop by and test pilot the SCC as well. The objective was to give awareness to the staff on the availability of SCC and for them to take up SCC in their daily communication and collaboration needs. The Productivity Day event, beside promoting the use of SCC, it was also used as a platform to promote MyEarth, Acadia’s soft approach or campaign to facilitate staff engagement, education and awareness on environmental sustainability initiative. Next, the phase of SCC transformation whereby it was envisioned to support greater communications and collaboration capability enabled by better technological feature is discussed.

5.4.4.3 The SCC 2.0 phase

The SCC 2.0 phase covers the periods from 2011 onwards. It includes the expansion of the functional affordance of the metastructured UCC. It is influenced by internal leadership, resource, and technology. The following Figure 5.16 shows the pictorial depiction of how the innovation process is unfolded during the SCC 2.0 phase.



Figure 5.16 –SCC 2.0 Phase of UCC Innovation

(Source: Developed for the thesis)

During the data collection in 2011, there was a proposal to upgrade and integrate the existing SCC features with a TelePresence capability. We refer to this development as

SCC 2.0. The SCC 2.0 was initiated by the Chief Technology and Innovation Officer (CTIO) who requested for a TelePresence business case to be developed by considering the monthly average number of physical meetings, business travels, fuel consumption, and the associated carbon emissions. For this purpose, the original developers of UCC were tasked to develop the business case of SCC 2.0. According to one of the UCC system developers:

“For the old project (UCC), we did not have those aspects of sustainability being explicitly considered and included in the project proposal. But for the new project, this is a specific requirement by the CTIO.” (UCC System Developer 01)

It was expected that the expansion of the functional affordance of the metastructured UCC with TelePresence would facilitate a high-quality video conferencing for a better virtual meeting experience. According to the IT Manager 01:

“We (IT Dept) have a plan to let the communications and collaboration system be integrated with a TelePresence feature in the near future. That is probably a new project between us (Acadia R&D and IT Department). The idea is that, when we have the new system, it will be easier. The bosses don’t have to come for meeting at the HQs, or vice versa because meetings can be held easily. From what I heard, the CTIO wants Acadia R&D to propose for the new project. The existing system cannot cater for HD video because it was not meant for that. Further, the network was not ready for that back then when the UCC was developed. Now, with the high-speed broadband that we ourselves supply, we can use TelePresence for a more effective communication and collaboration.” (IT Manager 01)

The above discussion shows that the internal motivation by a single champion (i.e., the CTIO) who has the power and resources is able to drive and shape an organisational environmental sustainability initiative. The existence of a champion is able to shape for a Green information system innovation, which is conceived with greenness element right from the conceiving stage. From the overall findings presented above, it can also be conjectured that institutional pressures and norms are the social context and outside triggers which shaped the re-materialisation of information systems as Green information system innovation.

5.4.5 The Outcomes of the UCC Innovation for Acadia

Based on the discussion above, there are one direct and two indirect outcomes from Acadia’s Energy Informatics. These direct and indirect outcomes are summarised in Table 5.10 and is further discussed following the table.

Outcome Type	Category	Area	Benefit
Direct	Environmental	Emission	Savings from reductions in business travels and associated carbon emissions.
	Economic	Cost	Savings from reductions in business travels.
Indirect	Social	Workplace	UCC is used to motivate change in daily work practice into more sustainable ones.
		Shaping of green beliefs and awareness	UCC is used to shape green beliefs and increase environmental sustainability awareness among staff members.

Table 5.10 - Outcomes of Unified Communications and Collaboration at Acadia

From the environmental and economic perspectives, the staff members viewed that there was a reduction in business travels when UCC was used to conduct inter-office communication and collaboration with their colleagues. Prior to the implementation of UCC, the practice of conducting meetings especially for the staff who are working in projects that are cross-functional and required them to attend meetings in various places are common. While such work arrangement are typical in any work conditions, the use of UCC particularly for reducing the need for making too frequent business travels (resulting in lesser travel claims) have resulted in some Acadia staff to turn to UCC.

“Basically I use the UCC almost every day. In my capacity, I am involved in a number of initiatives within the IT Department. We meet people from R&D, other Divisions in IT, and sometimes with vendors too. Using UCC, some of the meetings that previously requires me to personally go to the other offices, has been reduced. The meetings can now be done from the HQ or just about anywhere.” (IT Manager 01)

From the social perspective, the indirect outcome can be seen from the workplace aspect, particularly the change of some work practices. For example, one of the managers has transformed her physical weekly meetings on CMMI onto online meetings enabled by the UCC. According to her, the interactions are more open and the “doors” for the meeting are never closed.

“Normally, if the project managers have problems on certain issues, they would look for our (internal consultants’) help. This “Clinic” was originally a physical session. We have it every Wednesday at certain time. So during that time, project managers could just walk in and get our assistance. But due to some problem (access to meeting room was contested by another person), we have decided to conduct it online. We don’t have to find a physical meeting room. We just meet online. And now instead of just Wednesdays, the Online Clinic is open anytime during office hours. We provide support to the project managers anytime they want to get our help and we are fully leveraging the UCC and its features to collaborate on the CMMI initiative.” (R&D Manager 01)

The use of UCC innovation, particularly when it was metastructured into SCC can facilitate the shaping of green beliefs and increase the level of environmental sustainability awareness among Acadia staff members.

“I personally believe in climate change, global warming and whatever things related to this topic....I use the UCC on daily basis to communicate with my colleagues. With the UCC, I don’t have to drive and burn the petrol just to meet my colleagues in the other office located several kilometers from the HQs in order to conduct meetings.” (IT Manager 01)

5.4.6 The UCC Innovation Process Model

Figure 5.17 shows the UCC Innovation Process Model.

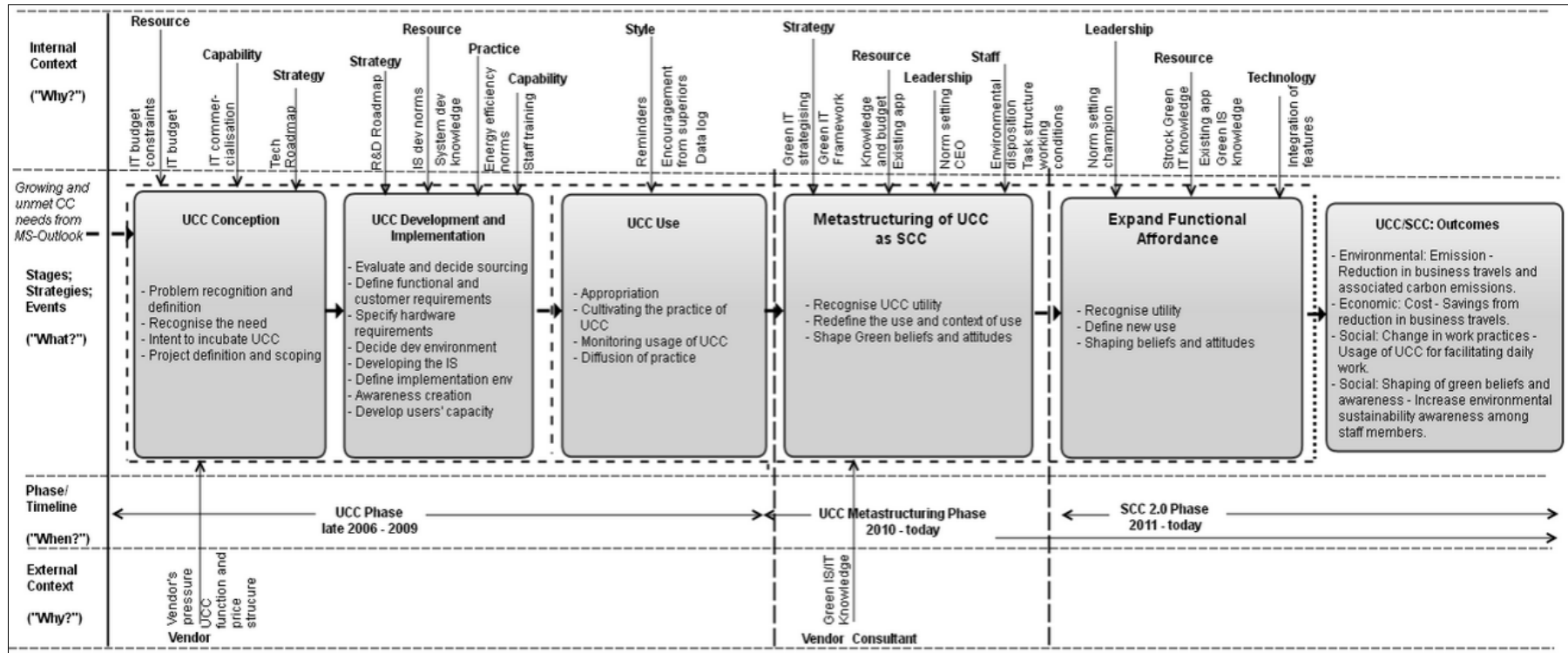


Figure 5.17- UCC Innovation Process Model

(Source: Developed for the thesis)

5.5 CASE 3: SUSTAINABLE KNOWLEDGE MANAGEMENT AND SHARING (SKMS)

5.5.1 Introduction to the SKMS Innovation

This section focuses on the innovation process of Acadia's Intranet portal. The portal is used as the company's knowledge repository as well as workflow management and small application development platform whereby the staff members are able to get the latest activities and news happening in the company and develop small scale applications.

An Intranet portal can be considered as an example of the Green information system innovation because the capabilities of an Intranet portal are suitable for promoting sustainable knowledge management and sharing (Watson, Lind, et al., 2012). Further, Intranet portal is one of the six types of software that can meet a company's environmental sustainability needs (Mines, 2011). According to Mines (2011), such systems fall into the category of Sustainability Knowledge and Learning Management (SKLM) and are used by everyone within an organisation to support staff environmental engagement and sustainability education initiatives. Academics also discuss the role of Intranet to encourage green behavior (York et al, 2009) and to shape environmental orientation with respect to environmental cognition, attitudes and behaviors, at both employee and organisational levels (Jenkin et al, 2011). Additionally, Hasan, Molla and Cooper (2012) identify "knowledge repositories" as one example of a Green information system used for creating, managing and using sustainability related information.

The Acadia's use of Intranet for supporting and enabling some of its environmental sustainability initiatives is aligned to Mine's (2011) SKLM type of sustainability software; York et al (2009) and Jenkin et al (2011) idea of using Intranet for encouraging greener behaviour; and Hasan et al's (2012) Green information system knowledge repositories concept. Therefore, we consider Acadia's Intranet portal as an example of Green information system innovation and henceforth, based on Mines (2011), refer to it as Sustainable Knowledge Management and Sharing system (SKMS). The following sections focus on the context, content, process, and outcomes of the SKMS.

5.5.2 The Context of SKMS Innovation in Acadia

The Acadia's SKMS innovation emerged out of **internal context** driven by the **business imperatives, top management** and **environmental sustainability culture**. From the perspective of **business imperatives**, as a large telecommunications operator, Acadia was faced with the challenges of managing and controlling the mushrooming of contents and servers as well as cultivating knowledge sharing culture. Environmentally, Acadia was increasingly seeking to reduce its resource, such as paper, consumption and instil environmental sustainability culture in its workforce.

Prior to 2009, Acadia's corporate Intranet was managed by the IT Department while the content was provided by the Group Corporate Communication Division. However, there was little governance of how other divisions and subsidiaries of Acadia create portals. As a result, many of the departments, divisions and subsidiaries of Acadia created their own portals and hosted them on different servers that run on different computing environments (i.e., Apache, MS-Internet Information Services IIS, MS-SharePoint, Sun Java Server). For example, a portal developed by Human Capital Division was located at <https://hcm.acadia.com>, and a portal for Finance Division was located at <https://finance.acadia.com>. Although these portals were using the same "acadia.com" sub-domain address, they were not consolidated into and accessed from a single Intranet portal (i.e., <https://intra.acadia.com>). For example, a 2008 annual IT audit has discovered that there were 256 portals hosted on fifty servers scattered throughout Acadia. The situation according to the interviewees from the IT Department and Group Corporate Communications Division has generated both content, knowledge and server management issues.

In terms of the content and knowledge management, most of the time, the staff members were unaware of the existence of multiple portals created by various divisions. There was no centralisation and consolidation of contents that made the task of managing the company's "knowledge resources" increasingly difficult. As such Acadia lacked a consolidated knowledge platform to cultivate a knowledge sharing culture among its staff. Thus, Acadia was seeking to address the problem of having too many fragmented portals

within the organisation and to consolidate it into a single portal, with links to multiple sub-portals. In terms of server management, the lack of control in the proliferation of servers resulted in inefficient use of IT resources when the servers purchased to develop, store and run portals were not fully utilised. Further, the IT Division in allowing various divisions to purchase their own servers to house their websites and applications perpetuated a lack of control and governance. Reflecting on the situation, the IT Manager 02 claimed:

“In the past, my department alone has so many applications developed to support various organisational needs. These applications were developed on different platforms and hosted on different servers. Some of the servers hosting the application were kept just under the desk of the application developer” (IT Manager 02)

Under the **top management**'s direction that provided commitment and resources, the Group Corporate Communications and the IT Department were instructed to address the problems, which will be detailed out in Section 5.5.4.

From the **environmental sustainability culture** perspective, Acadia started out with the corporate social responsibility (CSR) and the CSR had a long tradition in Acadia especially by being philanthropic and in giving back to the society. The focus in the past had been around community and nation building (education and educational sponsoring of students). In 2006, with the government's Economic Transformation Plan (ETP) initiative, Government-Linked Corporations (GLCs) including Acadia were encouraged to undertake GLC “Silver Book” guideline on the more comprehensive form of CSR, called Corporate Responsibility (CR). At the same time, the country's market bourse imposed voluntary environmental performance reporting. In 2007/2008, Acadia streamlined its CR effort with a new theme called “Reaching Out” encompassing four dimensions: marketplace, workplace, community, and environment. In 2008, Acadia first published its Sustainability Report (SR). Acadia was concerned about reducing its paper consumption by digitising forms and workflows as well as cultivating an environmentally conscious workforce.

Traditionally, Acadia relied heavily on paper based communication and work flows (see also Case 2 on UCC in Section 5.4). Staff members typically had to complete paper-based

forms, such as to apply for annual leave, purchase requisitions, lodge change request form, and book meeting rooms. Digitising these forms and work flows (in addition to using UCC systems) entail creating e-forms and e-work flows. The e-form refers to the converted paper-based form into electronic form while the e-workflow system refers to an application to process certain activities such as creating and approving a change request. One of the IT Managers claimed:

“There are so many types of forms staff need to use for certain purposes. These forms were on paper. When we have e-forms, we don’t need to get the forms printed. Some e-forms are part of a workflow system. Using workflow system it is even easier because once the staff filled up the e-form, they can hit the send button, the system will notify the superior to approve, or perhaps the committee to approve. All are done electronically, even in approving the application.” (IT Manager 03)

In order to cultivate an environmentally conscious workforce, Acadia launched environmental awareness and educational campaign among its staff members. The environmental awareness and education campaign is important to shape the attitude and belief among Acadia’s staff on environmental sustainability, as well as in promoting the environmental orientation and norms that Acadia wants to project to its own staff and the stakeholders. Following the implementation of the ISO 14001 certification in 2006, the first environmental awareness campaign in 2007 and the inaugural sustainability report in 2008, there was a renewed effort for spreading and deepening the staff environmental engagement. The Group Corporate Communications Division was tasked with this responsibility and started to look for information systems solutions to support and enable the initiatives leading to the MyEarth component of SKMS. The use of MyEarth portal for environmental knowledge sharing using forums was widely encouraged in Acadia.

5.5.3 The Content of the SKMS Innovation at Acadia

There are two components of SKMS: (a) Sustainable Document and Application Management (SDAM), and (b) MyEarth portal. Table 5.11 summarises the SKMS application and is followed by a detailed description of the SKMS components and modules.

Component	Year Developed and By	Users	Nature of system	Information stored/displayed
SDAM	Dec 2008 – Present IT Department/ Microsoft	Organisational: All Acadia staff.	Handling the sharing of documents and developing small applications that enables staff to automate business workflow such as e-forms, forums, and personal website (MySite).	Shared documents, e-forms, forums interactions, user information.
MyEarth portal	Oct 2009 – Present IT Department/ Group Corporate Communications/ Microsoft	Organisational: All Acadia staff.	Handling the dissemination and information sharing pertaining to the environmental awareness and education campaign.	Environmental news and campaigns, memberships for volunteers, e-Calendar, environmental tips, environmental posters and brochures

Table 5.11 - Summary of Acadia's Sustainable Knowledge Management and Sharing
(Source: Developed based on interviews with the Group Corporate Communications Manager and the Acadia's internal website, AIW01)

The Acadia's SKMS is composed of two components, namely the SDAM and the MyEarth portal. The modules for SDAM are:

- (a) Acadia main portal which is the main internal website containing internal information for consumption by all staff and have links to features such as forums, latest news, CEO's Blog, and related company information as well as links to workgroup sub-portals (i.e., HCM portal, IT Department portal, etc)
- (b) MySite, which enable creation of personalised website for each staff and also the enterprise social networking aspect within the company,

- (c) e-Forms system which enable creation of electronic forms to replace paper-based forms,
- (d) e-Workflow system which enable creation of e-Workflow system such as for reservation of meeting rooms, or other resources such as overhead projectors and electronic white boards.

On the other hand, the MyEarth portal component is composed of one module, named MyEarth portal. It is a sub-portal used to share information on Acadia's environmental sustainability initiative. The following describes the SKMS innovation in more detail.

The SDAM is used for sharing documents and developing small applications that enables the staff to automate business workflow such as e-forms. Using SDAM, the staff are able to participate in forum discussion to share their views on issues, access various sub-portals or Workgroups belonging to all divisions in Acadia; read the CEO' blog; and access the staff' personal web space called MySite that facilitates social networking among the staff. The MySite also enables the staff to personalise their web space with personal information, upload and share documents including photos and other work-related documents, as well as to add other staff members as "colleagues". On top of the MySite, users are able to develop small applications for meeting room reservations and e-forms for facilitating administrative activities.

The MyEarth portal is one of the sub-portals within the main Intranet portal. It is used by the Group Corporate Communications Division of Acadia to disseminate and share information pertaining to the environmental awareness and education campaign. The campaign is a company-wide environmental education and awareness initiative targeting at all Acadia employees. The MyEarth portal provides the latest activities and news pertaining to Acadia's environmental awareness and education activities. The staff are able to share environmental sustainability knowledge in the form of sustainability tips, read the tips shared by other employees, register themselves to become "environmental" volunteers; sign up to become a member to a Nature Loving Society dedicated to pursuing environmental related activities, and download materials such as e-Calendar and the environmental campaign e-posters and brochures.

Both of the SDAM and the MyEarth portal support the operational aspect of knowledge management and sharing among Acadia staff, as well as in helping to facilitate and shape an environmental behaviour towards greener work practices and lifestyle among the staff members.

The Acadia's SKMS is powered by MS-SharePoint Server 2007. Figure 5.18 illustrates SKMS system components: the portals including MyEarth portal, and SDAM from the application and presentation layers, and MS-SharePoint from the data and physical layers.

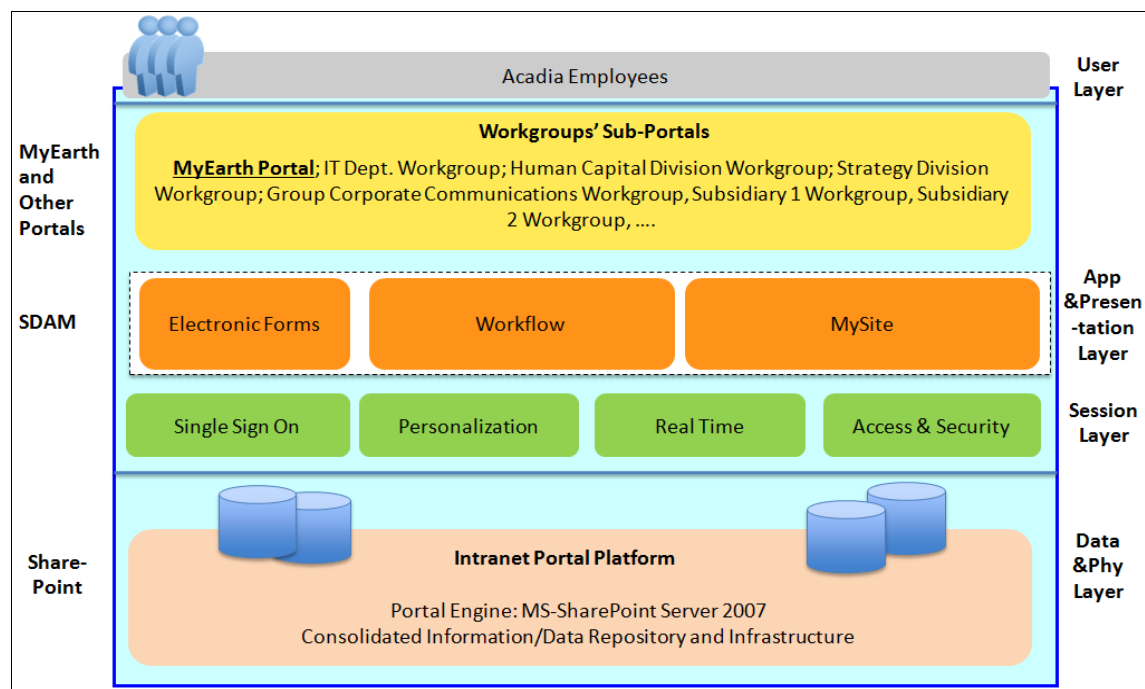


Figure 5.18 - SKMS System Components

(Source: Adapted from SKMS Project Document, SKMS01 supplied by the Group Corporate Communications Manager)

All the Acadia's staff members (*including non-executive or non-managerial such as technicians and clerical staff^d*) are able to log in to the SKMS using their staff ID and password. However, in practice, the SKMS are more useful for staff that can be classified as knowledge workers such as those who are holding an executive role (i.e., executive and managers).

^dAcadia outsources menial tasks such as cleaning of office spaces and general care of its office premises to contractors and hence, are not counted as Acadia staff

“Everyone (within the company) can actually access the portal. Anyone can create their own MySite on SDAM, share documents, create e-forms on it and thus, realised the green benefits,” (IT Manager 02)

All divisions and subsidiaries in Acadia are able to create a sub-portal under the main Intranet portal. These sub-portals are called Workgroups. The Workgroup is used as the platform to allow the divisions to share information related to the roles the division play in Acadia, the people and units within the division, the services provided, and in some cases, the documents shared by the division for consumption by others across the organisation. For example, Acadia’s Human Capital Division, their HC Workgroup is used to share information on their roles and responsibilities, as well as the shared documents that staff need to access from time to time such as HR manuals, policies, forms, procedures, and etc. The HC Workgroup is also used as a repository to keep training materials such as training notes in PDF formats, in which staff members are able to download and peruse after attending the trainings organised either by Human Capital Division or other divisions.

From the technical perspective, the SKMS runs on 4 servers (with 3 web front-end servers and 1 indexing server running the MS-SharePoint Server 2007), 2 switches and a storage area network (SAN) in order to support the SKMS operation. The cost of SKMS implementation was AUD\$320,000. As Acadia’s previous corporate portal was running on the older MS-SharePoint Server 2003 platform, Acadia continued to use Microsoft’s solution, the newer version of the portal engine called MS-SharePoint Server 2007. Hence, there was no development aspect to SKMS as the solution is purchased directly from Microsoft as the technology vendor. However, there was some customisation that needs to be made by the IT staff and webmasters due to the upgrading to the latest version of the MS-SharePoint software. These customisations include the redesigning of the existing portal with a “fresher” look and additional features such as online forums, online poll, CEO’s Blog, and Acadia’s live stock market price ticker.

Pertaining to the **general intent** with regards to values and goals underlying the SKMS innovation, the “**spirit**” of environmental sustainability was not given to the SDAM when it was conceived, prepared, implemented and used (refer Section 5.5.4.1). However, the

green benefits of the Intranet portal was only realised and enacted “during practice” when the portal was used as the MyEarth portal during the “Environmental Campaign Enablement” phase. This is described in detail in Section 5.5.4.2.

With regards to the **interpretive flexibility** of the SKMS, the evidence shows that both of the SKMS innovation (SDAM and MyEarth portal) was used as it was intended by the system owners (i.e., IT Department and the Group Corporate Communications Division). Therefore, the SKMS was faithfully appropriated by the users during its use during the “Document and Application Management” phase (see Section 5.5.4.1), and it was faithfully appropriated through its use extension during the “Environmental Campaign Enablement” phase (see Section 5.5.4.2).

From the perspective of the **Green information system type**, the SKMS innovation can be categorised as sustainability knowledge and learning management system for supporting staff engagement and education on environmental sustainability education (Boudreau, et al., 2007; Cooper & Molla, 2012; Hasan, et al., 2014; Mines, 2011). For the purpose of this thesis, this category of Green information system innovation is called information system for Sustainable Knowledge Management and Sharing System (SKMS).

The above discussion on the content of SKMS applications provides an overview of the information system used by Acadia for managing its knowledge management and sharing pertaining to environmental sustainability. The following section offers the detail discussion on the related process and mechanisms throughout the innovation process of the SKMS applications.

5.5.4 The Process and Mechanisms of SKMS Innovation at Acadia

There are two distinct phases can be identified in the process of SKMS innovation in Telecom Acadia: **(i) Document and Application Management** and, **(ii) Environmental Campaign Enablement Phase** as summarised in Table 5.12.

Descriptor	Document and Application Management	Environmental Campaign Enablement
When	Dec 2008---	October 2009--
What system	SDAM	MyEarth
Developers	Corporate IT Department implementing a Microsoft solution	Content developed and managed by Group Corporate Communications Division
Target users	Everyone within the company (Organisational users)	
Cost	AUD 320,000	---
Development environment	Intranet portal, MS-SharePoint Server 2007	Intranet Portal, MS-SharePoint Server 2007
Key operational challenges/problems	Lack of standard document and application management platform; unconsolidated servers and content, underutilisation of servers and poor knowledge management	Information dissemination
Key Environmental problems	N/A	Enabling corporate wide environmental sustainability campaign, developing green community of interest (CoI), cultivating sustainability knowledge sharing and culture
Functions	Sharing documents, developing small applications to automate business workflows	Dissemination and sharing of content related to environmental awareness and education
Key Benefits	Post-hoc realisation of potential energy saving from consolidated servers	Perception of better environmental sustainability knowledge management and sharing, and behavioral changes from environmental campaign

Table 5.12 - Sustainable Knowledge Management and Sharing Innovation Characteristics (Source: Developed based on interviews, Acadia's internal website AIW01, and SKMS Project Document, SKMS01 supplied by the GCC Manager)

5.5.4.1 The document and application management phase

The document and application management phase covers the periods from early 2009 onwards. It includes the conception, preparation and implementation, and use of the Sustainable Knowledge Management System (SKMS). It is influenced by internal leadership, capability, system, resource, and culture, as well as the vendor's influence. The following Figure 5.19 shows the pictorial depiction of how the innovation process is unfolded during the document and application management phase.

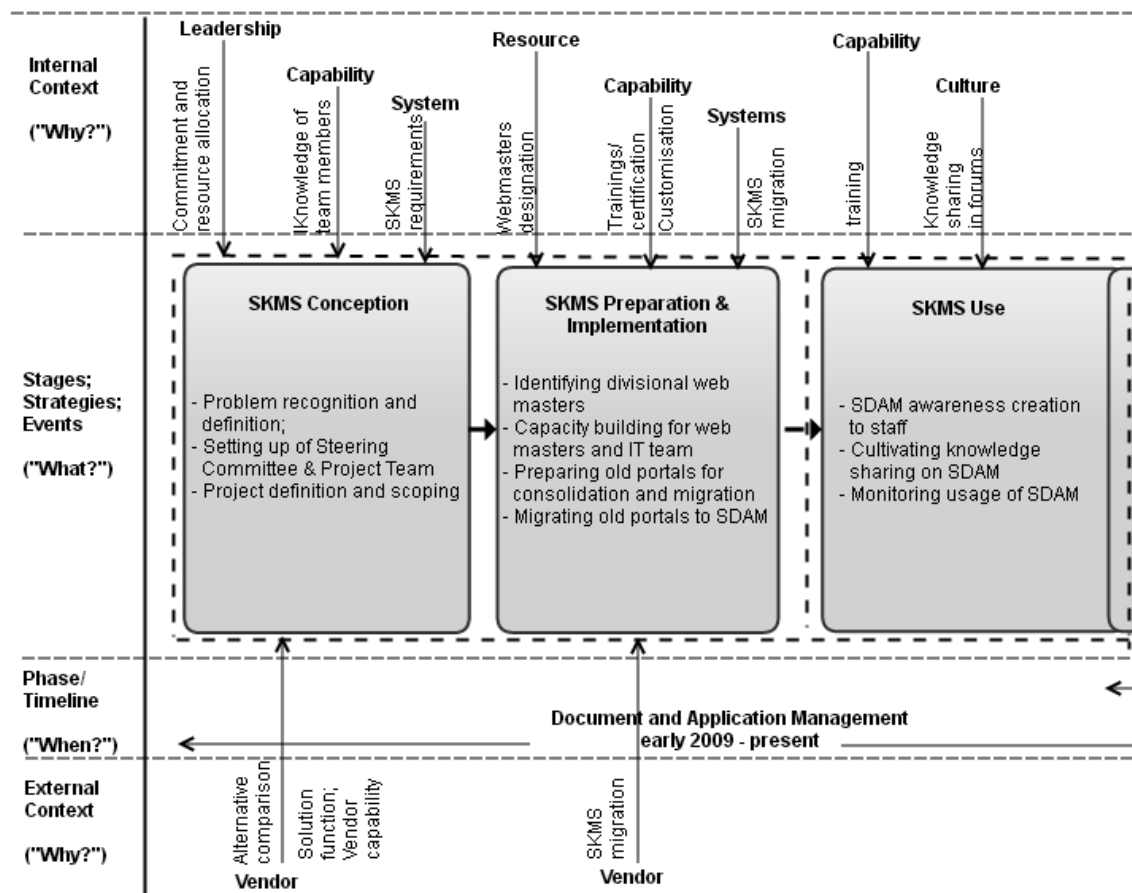


Figure 5.19 – Document and Application Management Phase of SKMS Innovation
(Source: Developed for the thesis)

The SKMS conception was influenced by three forces: (i) findings of IT Audit, (ii) the existing infrastructure to support SKMS; and (iii) an existing relationship with vendor.

The IT audit conducted by the IT Department in late 2008 has found a mushrooming and unmanageable number of servers, making the management of hardware and infrastructure

difficult. The audit also discovered the absence of standard hardware platforms to power up portals and applications. Further, the enterprise contents were not managed properly and existed in various places and on different servers. Therefore, there was a need to consolidate the content into a single repository on a single platform under a single Intranet portal.

The IT Department and the Group Corporate Communications Division raised these issues to the top management which led to the setting up of a SKMS Steering Committee. The SKMS Steering Committee comprised of the company's Group Chief Executive Officer (GCEO) and senior managers of Acadia. According to the Group Corporate Communications Manager:

“There was a project structure for the SKMS project. The GCEO is the project sponsor. There was also a steering committee ... the other members include the big bosses, the VPs from IT, Strategy, New Media, GCC and HR. The project director was a GM from IT Department. Then there was a PMO (Project Management Office) and a few other teams like governance and compliance; and project managers and workgroup webmaster, content manager.” (Group Corporate Communications Manager)

The composition of the steering committee demonstrated that the top management was committed in supporting the SKMS project by allocating resources that facilitated the SKMS innovation process. One of the tasks of the Steering Committee was to oversee the formalisation and the justification of the SKMS project and to conduct a more formal audit. The Steering Committee also formed a SKMS Project Team with members from cross-divisions including from the IT Department, Group Corporate Communications Division, and the vendor's representatives. The SKMS project team laid down the SKMS system's requirement definition, system selection, and vendor selection analysis. According to the SKMS Project Document (SKMS01) supplied by the Group Corporate Communications Manager, parts of the requirements from the SKMS include the ability to provide a single sign-on platform for all portal needs for Acadia, ability to integrate all portal services under one platform, offers the capability for messaging, personalisation, internal communication and feedback mechanism, and is accessible to all Acadia employees. Since Acadia had an MS-SharePoint Server 2003 infrastructure, the Project

Team decided that the SKMS should also run on the existing infrastructure provided by the vendor. Hence, the existing vendor (i.e., Microsoft) was selected as the infrastructure for SKMS.

There are four specific events occurred during the SKMS preparation and implementation: identifying divisional web masters; capacity building for webmasters and IT team; preparing old portals for consolidation and migration; and migrating old portals to the new SDAM platform which further hosts Acadia's main portal, MySite, e-Forms system, and e-Workflow system.

The SKMS Project Team, with the help of divisions with the company identified divisional web masters to be trained on the SKMS. This is because, the old divisional content and portals needed to be enhanced, redesigned or redeveloped to run on the new MS-SharePoint platform. According to the Group Corporate Communications Manager:

“A total of 106 webmasters for each division have been identified and appointed with the help of their respective Heads for consolidating this Intranet portal project.”
(Group Corporate Communications Manager)

To develop capacity, the IT Department staff and the divisional webmasters were sent for training on servers and content consolidation under the MS-SharePoint certification programme, conducted in conjunction with Microsoft. Upon returning from the training, the IT staff and divisional webmasters revisited and prepared old portals and applications for the planned migration. The actual migration of old portals to the single Intranet platform of SKSM was completed in June 2009. The vendor assisted in the migration process, and based on the knowledge transferred to the IT technical staff during the capacity building training, Acadia successfully managed to consolidate its contents and servers under SKMS. The SKMS Steering Committee and the Project Team were dissolved at the end of September 2009.

In July 2009, users were ready to use Acadia's new Intranet platform. In order to promote the SDAM portion of the SKMS, there were 3 specific events that occurred during this stage, namely SDAM awareness creation to staff, cultivating knowledge sharing on SDAM, and monitoring usage of SDAM.

To create awareness among staff and facilitate wider use of SDAM, in addition to training and information sessions, nationwide road shows were conducted by the Group Corporate Communications Division to staff in regional and state offices. During the awareness campaigns, the staff members were urged to use SDAM. In general, the SDAM (particularly the new Acadia Intranet portal) was promoted as a “vibrant” and “consolidated” platform to support Acadia’s knowledge sharing activities. The staff members were encouraged to share knowledge and ideas especially via the forum function in SDAM. This was to cultivate a general knowledge sharing culture and healthy discussion and engagement among the staff.

The IT Department, together with the Group Corporate Communications Division, monitored the usage of SDAM during this stage. However, according to the Corporate Communications Manager, this monitoring effort was not consistently conducted as both divisions were shifting their focus and efforts on other company projects.

“We actually do some tracking of usage... but not consistently done .. just during the earlier phase. In June 2009, the average number of access to SDAM was like 50,000 accesses² per day, and in July, it increased to 53,000 accesses. This data showed the increase and I believe now the usage is even more than before.” (Corporate Communications Manager)

5.5.4.2 The environmental campaign enablement phase

The environmental campaign enablement phase covers the periods from October 2009 onwards. It includes the use extension of SKMS. It is influenced by internal strategy, capability, and style. The following Figure 5.20 shows the pictorial depiction of how the innovation process is unfolded during the environmental campaign enablement phase.

²The number of times each staff accessing the SDAM. As there are 25,000 staff nationwide, it can be averaged out that each staff access and check the SDAM twice a day, and more thereafter.

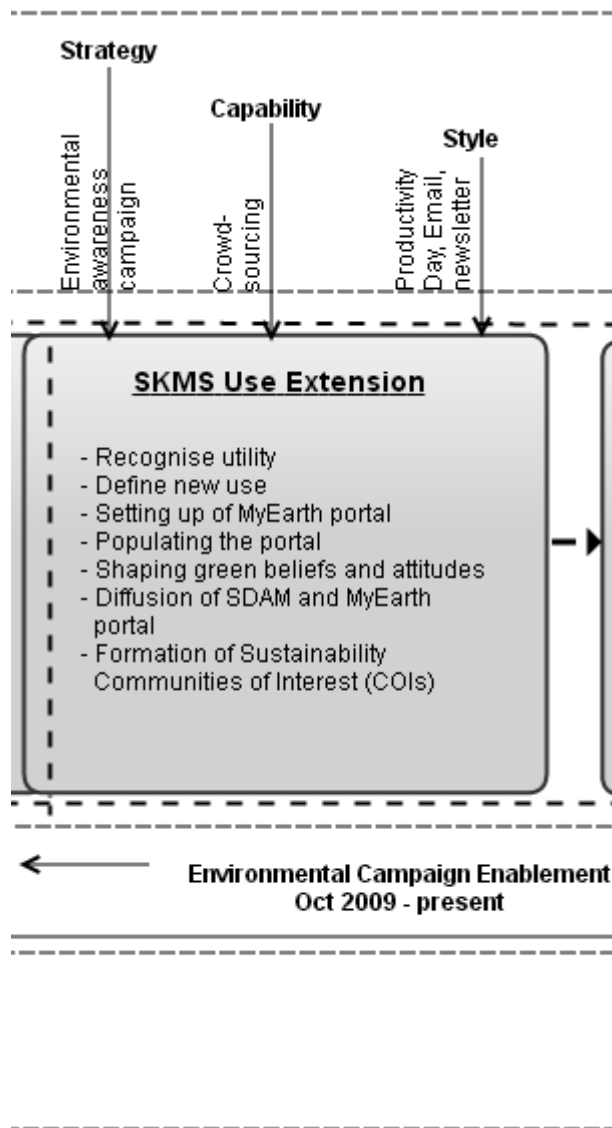


Figure 5.20 – Environmental Campaign Enablement Phase of SKMS Innovation
(Source: Developed for the thesis)

The environmental campaign enablement phase was unfolded when the SKMS use was extended to support Acadia’s environmental campaign by setting up a sub-portal focusing on environmental sustainability. This new portal was called the MyEarth portal. The main events that occurred during this phase were: recognising utility, defining new use, setting up the MyEarth portal; populating the portal; shaping and framing green attitudes; diffusion of SDAM and MyEarth portal; and formation of Sustainability Communities of Interest (COIs).

Towards the end of 2009, Acadia was planning to implement environmental sustainability awareness and education campaign for its staff. The Group Corporate Communications

Division through its Corporate Responsibility Unit decided to set up a sub-portal dedicated to enable the environmental awareness and education campaign to be shared online. The portal is called MyEarth portal. The MyEarth portal was intended to enable the cultivation of environmental sustainability culture among Acadia staff. According to the Group Corporate Communications Manager,

“Since we are in the midst of promoting environmental sustainability campaigns and building such sustainability culture in the company, we realised that we can use the existing Intranet portal technology to facilitate the campaign. With it, we can reach towards the wider population of Acadia, and provide the necessary information and education on environmental sustainability to our staff.” (Group Corporate Communications Manager)

Further, the environmental awareness and education campaign and the associated MyEarth portal were to support the Corporate Responsibility (CR) Strategy of Acadia as discussed in the earlier Case 2 (see Section 5.4.4.2). The Group Corporate Communications Division populated the MyEarth portal with content and knowledge pertaining to environmental sustainability using existing knowledge within the minds of Acadia staff. The strategy used was “crowd sourcing” whereby staff members were asked to share environmental sustainability tips with the rest of the staff. Initially, (prior to when the MyEarth portal went live), the interested staff were asked to send tips to the Group Corporate Communications Division via email. The Group Corporate Communications Manager said:

“Our environmental awareness and education campaign, it is obvious that the company is requesting for staff to participate. Like the Group Corporate Communications asking people to share their tips and tricks to be shared to the whole company via MyEarth portal. I think where we can follow and practice, we will practice. So I think it is a very good move.” (Group Corporate Communications Manager)

Through the MyEarth portal, the staff members were able to contribute their tips. The Group Corporate Communications Division compiled these tips and selected those suitable to be published and shared on the MyEarth portal. It was anticipated that the staff

who read the tips would practice the tips at their workplace and if possible, practice them at home too. The sharing of tips by individual staff, when accumulated into the MyEarth portal leads to the creation and strengthening of organisational knowledge on environmental sustainability. The practice of environmental sustainability tips either at workplace or at home cultivates not only the knowledge sharing culture but also the environmental sustainability culture among Acadia staff and their family members.

In addition to environmental sustainability tips sharing, to further shape and form green attitudes among the staff to use the MyEarth portal and SDAM, more awareness programmes sessions were held. To achieve this green culture as desired by the company's top management, the awareness programmes included email broadcasts, road tours held by the Group Corporate Communications Division from the headquarters and their counterparts from the regional offices. One of the biggest events to promote MyEarth portal and SDAM was "Productivity Day" held in 2011 whereby the use of MyEarth portal and SDAM for productivity and green behaviors was conducted (see also Section 5.4.4.2). The Productivity Day initiative was held in association with the vendor, Microsoft who helped in promoting the use of SDAM and MyEarth portal for both productivity and environmental sustainability benefits.

According to the Group Corporate Communications Manager:

"One of the reasons (for having awareness session) was to create excitement towards knowledge sharing culture and operational excellence by utilising SKMS with some of its Web 2.0 features (i.e., the MySite). The awareness besides educating was also meant to create buy-in and support of divisions to adopt the portal as their K-sharing platform." (Group Corporate Communications Manager)

To evaluate the widespread use of the SDAM and MyEarth portal among Acadia's staff, in November to December 2011, a survey (which is part of this research) was administered to 150 staff members across all levels in Acadia's nationwide operation.

The findings (see Table 5.13) regarding the extent of SDAM use suggest that the staff can be grouped into two types: (i) passive users (i.e., consumer of content), and (ii) active users (i.e., producer and consumer of content). Accordingly 94% use the SDAM to download company's documents such as procedures, manuals, work instructions, forms

and other documents. Ninety one percent (91%) of users are also accessing the company's online applications and other online services. A big percentage of eighty five percent (85%) use the SDAM to read the CEO's blog. It was also observed that many of the staff members are active users of the SDAM. For example, 76% of the staff claimed that they downloaded and used the documents shared by their colleagues while 72% of them were sharing their own documents with others.

Only a few staff created small applications and workflow systems. For example, only 51% of the staff created small applications such as e-forms to assist their daily work practices by converting manual, paper-based forms into electronic forms. However, a slightly higher percentage (59%) of the staff was using the SDAM to make booking or reservations of meeting rooms. From a social networking perspective, only 48% of the staff members were using the MySite to create and maintain the MySite in order to engage with their colleagues in an enterprise "social networking" environment. The above results can be attributed to the newness of the SDAM capabilities in Acadia (less than 2 years when the data collection was conducted).

Practice Use of SDAM ...	Using (%)	Not Using (%)
To download company's documents (such as procedures, manuals, work instructions, forms, and others for ISO9001 QMS; ISO14001 Environmental Management Systems; ISO18001 OHSAS, HR Policy, Staff's Terms and Conditions, training course materials, etc)	94	6
To access the company's online services/applications relevant to your work.	91	9
To read the messages written by the CEO on various topics including on eco sustainability related entries.	85	15
To download shared documents by your colleagues in Acadia.	76	24
To share documents with your colleagues in	72	28

Acadia.		
To book/reserve a meeting room.	59	41
To create small applications on your division's Workgroup (such as creating e-forms).	51	49
To create and maintain your personal MySite.	48	52

Table 5.13 -SDAM Diffusion Among Acadia Staff
(Survey conducted for the thesis)

As regards to the extent of use of the MyEarth portal (see Table 5.14), again, most of the users were passive users (i.e., consumer of content). This is because 85% of the staff members were just readers of the tips and opinions on environmental sustainability shared by their colleagues. This might be because of (i) their own environmental sustainability practices are low, or (ii) their knowledge and confidence in using the MyEarth portal for sharing environmental sustainability information is still not strong, (iii) their individual characteristics where people are more comfortable to be consumer of the content instead of producer of the content, and (iv) the awareness campaigns conducted by the company has yet to transform from the “belief formation” stage into an actual practice stage.

Fifty six percent (56%) of the users were using the MyEarth portal to download electronic calendar (e-calendar) and this indicates that about half of the company’s population are still preferring the manual calendars or not using any calendar at all to manage work practice.

Practice	Using (%)	Not Using (%)
Use of MyEarth Portal ..		
To read environmental sustainability tips and opinions shared by your colleagues within Acadia.	85	15
To download MyEarth e-Calendar.	56	44
To register yourself to become a volunteer in MyEarth related activities.	45	55
To register yourself to become a Nature Loving	43	57

Club member.		
To share environmental sustainability tips and opinions with your colleagues within Acadia.	35	65

Table 5.14- MyEarth Portal Diffusion Among Acadia Staff
(Survey conducted for the thesis)

However, it is interesting to note that Acadia’s staff are involving themselves in “Sustainability Communities of Interest” or COIs (albeit the membership is still low). For example, 45% of the survey participants claimed that they have registered themselves to become a volunteer in the MyEarth related activities that the company is organising. By registering themselves into the programme, whenever the Group Corporate Communications Division is planning to have any environmental sustainability related events in any locations in the country, the registered staff that lived within or close to where the events will be held would be communicated, engaged and expected to actively participate. Another 43% of the staff mentioned that they have registered themselves into the Nature Loving Club (NLC). The NLC arranges events such as Earth Camps in association with an external partner, a non-governmental organisation (NGO), which is the National Nature Loving Society. The members of NLC participate in camping and other outdoor activities with school children and with indigenous people with the aim of appreciating the natural environment and the importance of caring for the environment. For example, the Group Corporate Communications Manager stated the following:

“We formalise them (the Nature Loving Club) into an official club in Acadia. The members are able to conduct their own events besides joining the company- organised events. We also envisioned them to become the green champions at their own workplace.” (Group Corporate Communications Manager)

Thirty five percent (35%) of the surveyed staff claimed that they shared environmental sustainability tips with others. This indicates that only a small percentage of the staff members are willing to share their knowledge on environmental sustainability matters while the rest are still not used to do so. The above results might also be attributed to the

newness, and awareness of the MyEarth portal. However, based on the extended use of SKMS for MyEarth portal, the practices could be enhanced through more knowledge sharing and awareness sessions, continuously conducted by Acadia via its Group Corporate Communications Division.

When the use of SDAM and MyEarth portal are diffused widely within Acadia, and the use becomes extended into practice, a feedback loop is formed. Hence the SKMS as Green information system innovation drives a feedback loop that informs and reshapes the environmental awareness and education by enabling various other environmental programs and actions in Acadia.

5.5.5 The Outcomes of SKMS Innovation for Acadia

While there was no formal benefits evaluation conducted by Acadia, anecdotal evidence gathered during the data collection indicated that the SKMS, both the SDAM and the MyEarth portals have resulted in some benefits. These direct and indirect outcomes are summarised in Table 5.15 and is further discussed following the table.

Outcome Type	Category	Area	Benefit
Direct	Environmental	Emission	Emissions reductions from savings in electricity consumption.
		Engagement	Increase engagement with staff through their eco-participation in sustainability initiatives.
	Economic	Cost	Reduction in electricity consumption; reduction in paper consumption and hence, reducing operational costs.
	Operational	IT	Ease of server and content management.

Indirect	Social	Workplace	Creation of sustainable work practices.
		Shaping of green beliefs and awareness:	SDAM and MyEarth portal are used to shape green beliefs and increase environmental sustainability awareness among staff members.
	Rebound effect	E-Waste	Accumulation of abandoned, old servers.

Table 5.15 - Outcomes of Sustainable Knowledge Management and Sharing at Acadia

With regards to direct outcomes from the environmental and economic perspectives, emissions reduction and cost reduction were achieved from the use of the SKMS. In relation to the reduction in electricity consumption, the IT Manager claimed:

“In the past, we have so many applications and those are running on different machines and different software platforms. With the SKMS, we consolidated those hardware or server after migrating the application to SharePoint 2007. We have closed as many as 100 websites belonged to different workgroups (i.e., divisions, departments, units, etc) and now we only have 23. We are saving in terms of the energy consumption to power the electricity to so many machines to lesser servers now.” (IT Manager 01)

As elaborated in the MyEarth portal diffusion section, from the environmental engagement perspective, Acadia engaged its staff members through “Sustainability Communities of Interest” or COIs. The environmental engagement benefits can be seen when the staff members registered and involved as volunteers in events co-organised by Acadia’s Nature Loving Club (NLC) with the non-governmental organisation (NGO) such as the National Nature Loving Society.

From the operational perspective, the consolidation of servers and contents has resulted in a more efficient use of IT resources. The IT Manager 02 argued:

“Now, with SKMS, all applications are developed to run on the common platform and there is no more redundancy of hardware such as servers as all are now running on the SKMS and are hosted on the same data center. So we are able to manage our resources better.” (IT Manager 02)

Additionally, SDAM has enabled the document and application sharing as well as the unavailability of needs to print documents and forms on paper in most situations. The IT Manager claimed:

“When we use the Intranet to share documents in the function called MySite, I can just upload the documents there, set the permission level and let my colleagues know where to find the document. Similarly, some paper-based forms are now made it into e-forms using the capability of the Intranet to support simple workflow process management. So we see fewer forms and documents get printed or left uncollected at the printers these days. In another way, the use of the portal promotes paperless environment.” (IT Manager 02)

From the indirect outcome point of view, there are social benefits reaped by Acadia. The increased diffusion of both SDAM and MyEarth are contributing to the creation of sustainable work practices. The data also showed that the SKMS innovation had enabled the opportunity for Acadia to share information via the MyEarth portal, staff would find colleagues who live close to one another, and together register their intent to be part of the company’s car-poolers. News on recycling programmes held in association with the building tenants³ was also disseminated via the MyEarth portal. The shaping of green beliefs and awareness was also created through the use of the SDAM and MyEarth portal.

Another indirect outcome is the “rebound effect” from the accumulation of e-waste, mainly coming from the abandoned old servers. Due to the content and server consolidation under the SKMS initiative, many old servers (actual number was not available) were retired, kept in the corners of data centers and divisional offices. This situation created the accumulation of e-waste. During the data collection, IT Department

³ Acadia’s high-rise headquarters is also rented out to 3 big local and 5 multinational corporations.

was considering e-waste management under its Green IT initiative, however nothing was formalised on the action plans towards addressing the e-waste issue. Further, as mentioned by the IT Manager, the accumulation of e-waste gave Acadia an opportunity to reflect and to act upon the abandoned servers (as well as other equipments such as computers, monitors, printers, fax machines, and telephones). According to the IT Manager 01:

“The IT Application team is looking at this issue (e-waste). Now we are having what we call resource management planning ... we are relooking and is still planning on what to do with those old servers. Perhaps to salvage the components... memory storage, etc. This is a complicated issue and not a straight forward process.” (IT Manager 01)

5.5.6 The SKMS Innovation Process Model

The following Figure 5.21 illustrates the SKMS Innovation Process Model.

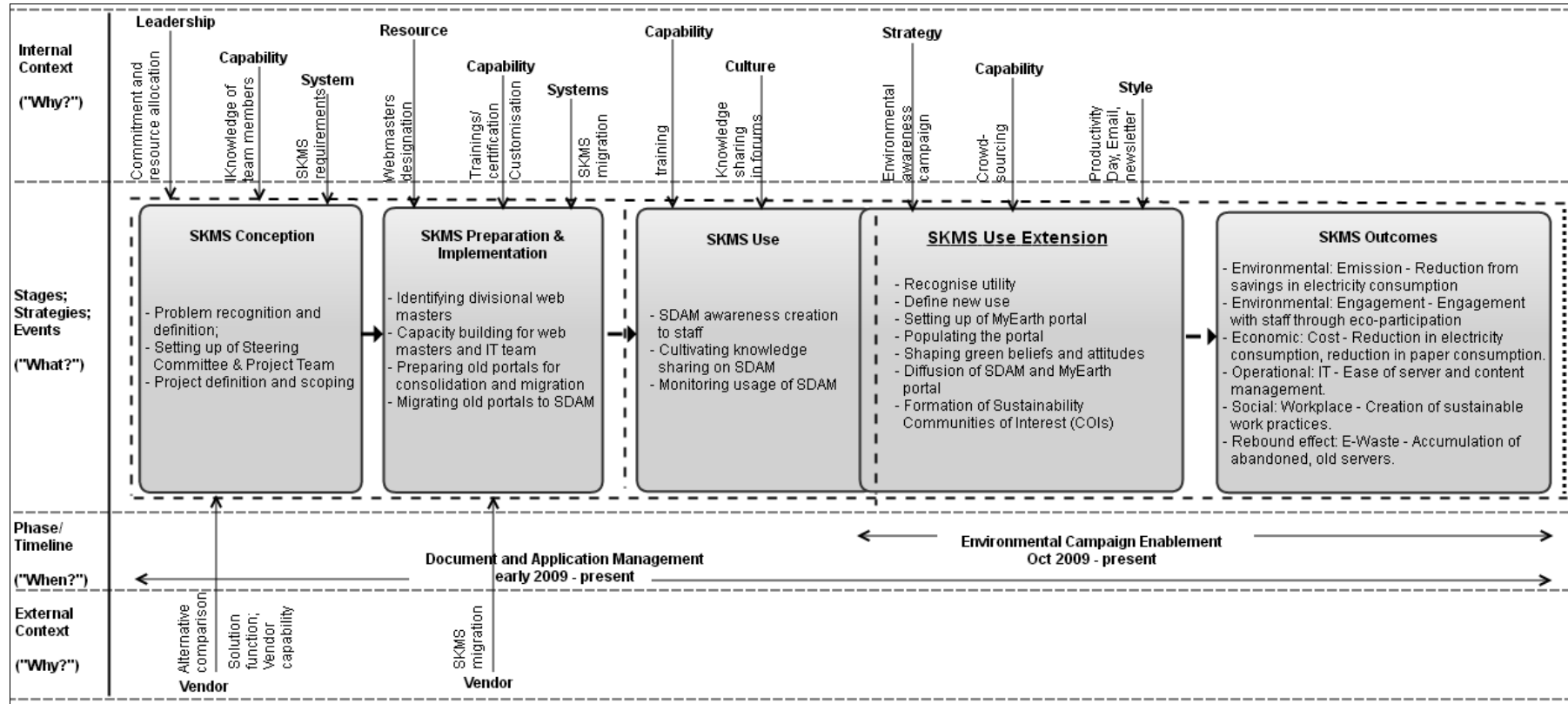


Figure 5.21 - SKMS Innovation Process Model

(Source: Developed for the thesis)

5.6 CASE 4: FLEET MANAGEMENT SYSTEM (FMS)

5.6.1 Introduction to the FMS Innovation

The academics (Steenwijk, 2011; Vaia, et al., 2012) and industry (Mallon, Johnston, Burton, & Cavanagh, 2007; Mines, 2011; Pamlin, 2008) have discussed the adoption of Fleet Management Systems including telematics for environmental sustainability. This chapter focuses on the innovation process of a Fleet Management Systems (FMS) used in Acadia to manage and track its fleet of vehicles.

From the academic perspective, Watson et al (2010) discuss the use of telematics at UPS to manage large fleet of trucks, and how telematics fits an Energy Informatics Framework to increase profitability and reduce carbon emissions. In an implementation of a telematics system in the insurance industry, Vaia et al., (2012) claim the environmental benefits of having a fleet management system include improving traffic flow and conditions through changing driver behaviour. These benefits were realised through the provision of real-time information that enabled drivers to make better choices about their route and thus spend less time on the road, reducing fuel consumption and pollution. Additionally, the fleet management system data can optimise vehicle maintenance programs, which means fewer replacement parts and automotive breakdowns leading to longer lifespan of vehicles (Vaia, et al, 2012; Steenwijk, 2011).

From the industry perspective, Mines (2011) discusses the use of smart infrastructure management system for managing facilities and improving utilisation of hard assets such as buildings and vehicles. An example of such utilisation is also captured in Mallon et al., (2007) when describing Telstra's fleet initiative that utilises information system to enable fuel-efficient travel patterns. For example, Telstra had installed GPS-enabled equipments in more than 4,500 or 27% of its vehicles, and was committed to achieve a 5% reduction in fuel consumption while increasing productivity by 15% in 2006 (Mallon, et al, 2007). Relating to the benefits of fleet management system, Pamlin (2008) argues that such system is important particularly for large logistic companies and corporations in maintaining a huge number of fleet to track the vehicles and the associated emissions.

Further, inefficient route planning without proper FMS may add to unnecessary kilometres to each delivery and the consequent GHG emissions (Pamlin, 2008).

Acadia's FMS is comparable to systems previously investigated from the academic and industry perspectives above and is considered as an appropriate example of a Green information system innovation.

5.6.2 The Context of the FMS Innovation in Acadia

The fleet management systems emerged from the needs driven and influenced by **internal** and **external** factors.

Internally, from the **business imperatives** perspective, Acadia's Fleet Management Department is responsible for ensuring all its vehicles are roadworthy, in compliance with government's regulations, utilised optimally, and available at all times for business operations and supports across the seven zone offices and thirty service outlets nationwide. In 2011, the Fleet Management Department managed 5,500 vehicles with 75% of the vehicles (mostly vans, lorries and four-wheel drives) running on diesel while the remaining 25% are small vehicles. According to the Fleet Manager 01, on average, Acadia spends nearly AUD\$500,000 a month (or AUD\$6,000,000 a year) on fuel and the volume of fuel consumed averages 510,000 litres a month. An Assistant General Manager of Support Business explained the following:

“Actually, our fuel consumption is quite significant. On average, we spent almost AUD\$20million on fuel alone for the past 3 years. But we cannot avoid it as our staff in the field need to carry out their duties for installation, maintenance, servicing customers, and etc. We cannot reduce the number of such jobs because those are our business. What we can do is just by monitoring, tracking every usage, like why certain jobs see a sudden decrease, and other jobs see a sudden increase. But still, they (the drivers) could have their own reasons.” (Assistant General Manager of Support Business)

The need to monitor and manage fleets has also evolved from fuel spending control to interest in lowering the company's carbon emissions as stated by the Fleet Manager 2.

“The fleet system, especially the Automatic Vehicle Location System (AVLS) could indirectly contribute towards lowering CO₂ emissions. We can monitor whenever events such as harsh braking or harsh speeding happens. These events contribute to higher fuel usage, along with carbon emissions.” (Fleet Manager 02)

The need for Acadia to manage its vehicles effectively has driven the Fleet Management Department to develop and use a Fleet Management Information Systems.

Externally, from 2000 to 2011, the country where Acadia is operating experienced at least five fuel price hikes as indicated in Figure 5.22.

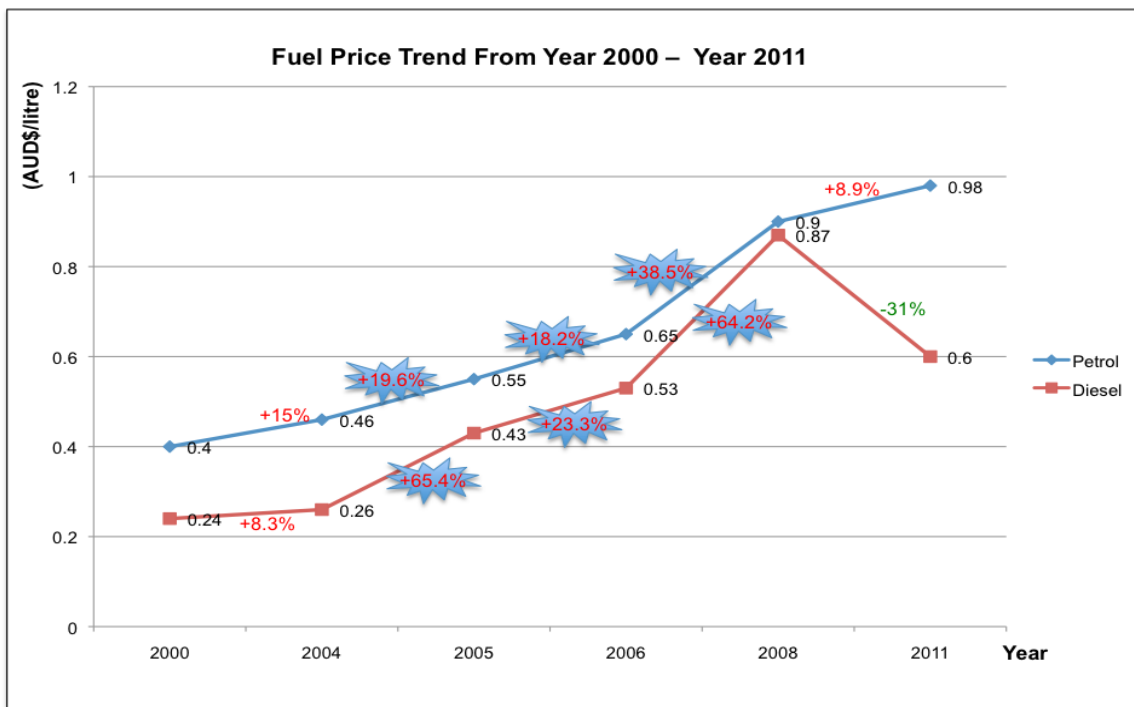


Figure 5.22 - Fuel Price Trend from 2000 to 2011

(Source: Researcher’s analysis based on publicly available data from local dailies)

While fuel hikes have driven Acadia to embark on fuel conservation initiatives, these hikes have been less influential than electricity hikes (refer also Case 1 – Energy Informatics) because: (a) the overall cost of fuel is much lower (i.e., on average AUD\$500,000 per month) as opposed to the cost of electricity (i.e., on average AUD\$6.5 million per month in 2010); and (b) the lack of mandate in developing and enforcing policy on fuel reduction. Additionally, prior to 2012, the business model of the Fleet

Management Department hindered it from developing an enforceable policy on fuel consumption. According to the Assistant General Manager of Support Business:

“Fleet Management Department is just a service provider or a leaser for fleet in Acadia. They don’t have the rights to go to the users because the users are from different groups (i.e., the regional network offices, RNOs). Only the vehicle owners such as the General Managers of the RNOs can do something. We can only report and advise them like, ‘you must monitor with your log book’. But from fuel saving aspect, they need to monitor themselves. In short, Fleet Management Department has no power to enforce any policy on reducing fuel consumption.” (Assistant General Manager of Support Business)

The Assistant General Manager added:

“The fleet owner would say that it was their rights to use the vehicles because they are paying for using those vehicles. So that is why Fleet Management Department has no power to enforce any fuel saving policy. They (Fleet Management) have the details for average travelling for certain region based on historical record from the Auto Leasing and Servicing System (ALSS). So, it should not exceed that average excessively. Fleet Management Department are monitoring it.”(Assistant General Manager of Support Business)

From the **coercive pressure** point of view, as Acadia is a member of the country’s government-linked corporations (GLCs), the GLC’s Corporate Sustainability Circle had encouraged GLC members to develop their own carbon management program. As a result, towards the end of 2011, Acadia had launched a Carbon Management Plan (CMP) for implementation in 2012. One of the initiatives within the CMP was tracking and reducing fuel consumption, and subsequently, reducing carbon emission. As stated by the Group Corporate Communications Manager:

“For the record, we are going to have Carbon Management Plan (CMP) to streamline and consolidate all the green efforts and basically to align with the government’s aim to reduce national carbon reduction target as per Copenhagen Climate Change Conference (COP 15) in 2009. Not much can be revealed now

because this is a new initiative in this company.” (Group Corporate Communications Manager)

5.6.3 The Content of the FMS Innovation at Acadia

The Acadia’s Fleet Management Systems are composed of five inter-related components:

1. Auto Leasing and Servicing System (ALSS)
2. Supplier Invoice Management Online (SIMO)
3. Automatic Vehicle Location System (AVLS)
4. Customer Service Module and e-Log Book
5. MS-Excel

Table 5.16 summarises the five components of the FMS and Figure 5.23 depicts the researcher’s depiction of the relationship among the FMS components. The figure should not be interpreted as architectural diagram as these systems were not fully integrated as implied in the diagram. The detailed description of the Fleet Management Systems is in Appendix 5.1.

Component	Year Developed and By	Users	Nature of system	Information stored/displayed
ALSS	2002 (Internal)	Departmental: Fleet Management Department staff only.	Online website for asset management.	Fleet asset database of all vehicles in Acadia from acquisition until disposal.
SIMO	2002 (Internal)	Departmental: Finance Division, Fleet Management Department managers, and fleet supervisors.	Supplier payment system for fuel. Data on fuel consumption from SIMO are generated into an Excel report.	Information on refuelling from the fuel vendors.
AVLS	2006 (Partnership)		Secure website, reading data transmitted and retransmitted from hardware onboard vehicles to the satellite (GPS), and onto the mapping system.	Tracking vehicles' locations and other usage details; assist in running a more efficient fleet.
CSM and e-Log Book	2008 (Internal)		Online website (a sub-system to ALSS) – Using the same database from ALSS, with capability to edit the database information.	Displaying vehicle information and updating trips made using the vehicles.
MS-Excel	2008 (by Microsoft, customised by Fleet Management Department)	Departmental: Fleet Management Department managers.	Customised report generation based on users' needs.	Extracting data for analysis from ALSS, SIMO, CSM e-Logbook, and AVLS

Table 5.16- Summary of Acadia's Fleet Management Systems

(Source: Developed based on interviews with the Fleet Managers, Customer Service Module (CSM01) and e-Log Book (ELB01) websites, and document (AVLS Brochure, AVLS01) supplied by Fleet Manager 01)

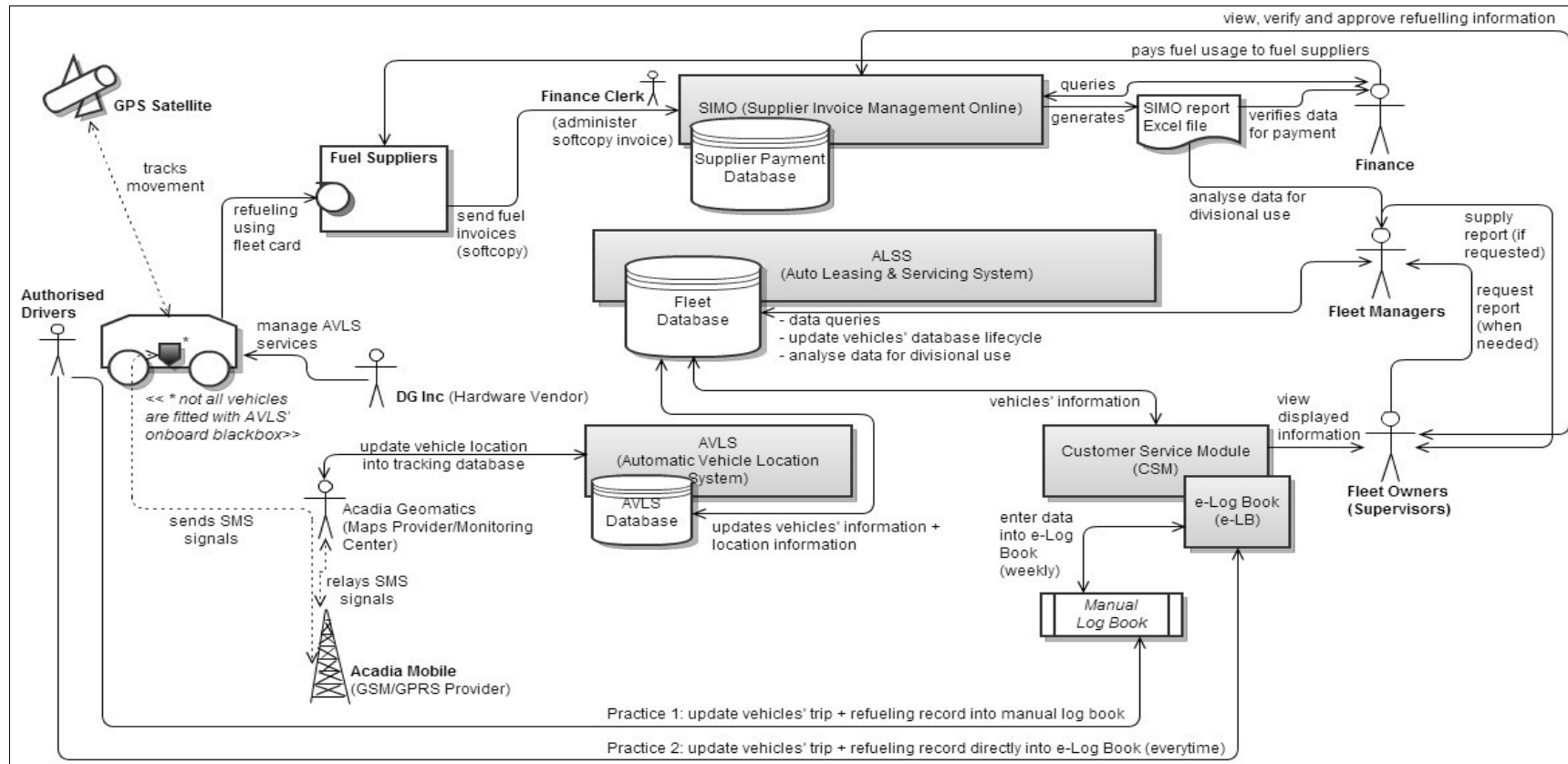


Figure 5.23 - Fleet Management System and Relationships Among its Components

(Source: Developed based on interviews with the Fleet Managers, Finance Manager, Assistant General Manager of Support Business)

Pertaining to the **general intent** with regards to values and goals underlying the FMS innovation, the “**spirit**” of environmental sustainability was not given to the ALSS and SIMO when they were conceived, developed, implemented and used (refer Section 5.6.4.1). The same situation occurred when the AVLS was conceived, developed, implemented and used (refer Section 5.6.4.2) when there was arguably lacked of green spirit being fully inscribed during the development of the AVLS. However, when the FMS entered the “Use Management” phase (refer Section 5.6.3), the system owner (i.e., the Fleet Management Department) and the Group Corporate Communications Division realised that the FMS can have its green benefits realised and enacted “during practice”, particularly for the purpose of capturing, tracking, and reporting Acadia’s carbon emissions as part of the company’s Carbon Management Plan (see details in Section 5.6.4.3).

With regards to the **interpretive flexibility** of the FMS, the evidence shows that all of the FMS components (i.e., ALSS, SIMO, AVLS, CSM and e-Log Book) were used as they were intended by the system owners (i.e., Fleet Management Department) and system users (i.e., Fleet owners and drivers). Therefore, the FMS was faithfully appropriated by the users during its use stage, during the “Asset and Cost Management” phase (see Section 5.6.4.1), during the “Behaviour Management” phase (see Section 5.6.4.2) and during the “User Management” phase (see Section 5.6.4.3).

From the perspective of the **Green information system type**, the FMS innovation can be categorised as information system for carbon management for helping organisations monitor, manage and report corporate carbon footprint and resource consumption (Butler, 2011; Mines, 2011; The Climate Group, 2008; Watson, Boudreau, & Chen, 2010).

The above discussion on the content of FMS applications provides an overview of the information system used by Acadia for managing its fleet assets, cost management, behaviour management of fleet users as well as for carbon management. The following section offers the detail discussion on the related process and mechanisms throughout the innovation process of the FMS applications.

5.6.4 The Process and Mechanisms of FMS Innovation at Acadia

Acadia's Fleet Management Systems innovation process could be grouped into three distinct phases. The phases are **Asset and Cost Management Phase**, **Behaviour Management Phase** and **Use Management Phase** as summarised in Table 5.17.

Descriptor	Asset and Cost Management	Behaviour Management	Use Management
When	2002---	2006-2010	2008--
What system	Auto Leasing and Servicing System (ALSS) and Supplier Invoice Management Online (SIMO)	Automatic Vehicle Location System (AVLS)	Customer Service Module (CSM), e-Log Book and Excel
Developers	Fleet Management Department, IT Department (with inputs from Finance Division and representatives of the fuel suppliers)	Acadia Geomatics, DG Inc	Fleet Management Department
Target users	Departmental: Fleet Management Department staff; Finance staff	Departmental: Managers of Fleet Management Department, Fleet owners; Drivers	Departmental: Fleet owners; Drivers
Cost	N/A	AUD186,700	N/A
Development environment	Lotus Notes/Domino; ASP.Net, MS-SQL	N/A	ASP.Net, MS-SQL
Key operational challenges/problems	Lack of operational systems to manage fleet asset and fuel cost and payment reconciliation	Lack of real-time system to track the fleet and behaviours of the drivers	Use management of vehicle via manual log book and inability to view vehicle records by fleet owners
Key Environmental problems	N/A	N/A	N/A
Functions	Vehicles records from purchase until disposal, history of fuel purchase records for each vehicle based on cost centres and fuel suppliers	Vehicle's location, speed, direction, time and date, distance travelled, estimation of fuel consumption, idling behaviour, after hour use	Viewing of vehicles records from purchase until disposal; updating vehicle movement and use record

Key Benefits	Post-hoc realisation of fuel reduction from the tracked fuel consumption data.	Post-hoc realisation of fuel reduction from the tracked fuel consumption data and user behaviour management.	Post-hoc realisation of fuel and carbon emission reduction from the tracked fuel consumption data and use management.
--------------	--	--	---

Table 5.17- Fleet Management System Characteristics

(Source: Developed based on interviews with Fleet Managers and Assistant General Manager of Support Business; Customer Service Module (CSM01) and e-Log Book (ELB01) websites, and document (AVLS Brochure, AVLS01) supplied by Fleet Manager 01)

5.6.4.1 Asset and cost management phase

This phase started in 2002 and covers the conception, development and implementation, and use of two fleet management systems, that is the Auto Leasing and Servicing System (ALSS) and the Supplier Invoice Management Online (SIMO). These processes were influenced by the internal strategy, resource and capability as well as the fuel suppliers' need. The following Figure 5.24 shows the pictorial depiction of how the innovation process is unfolded during the asset and management phase.

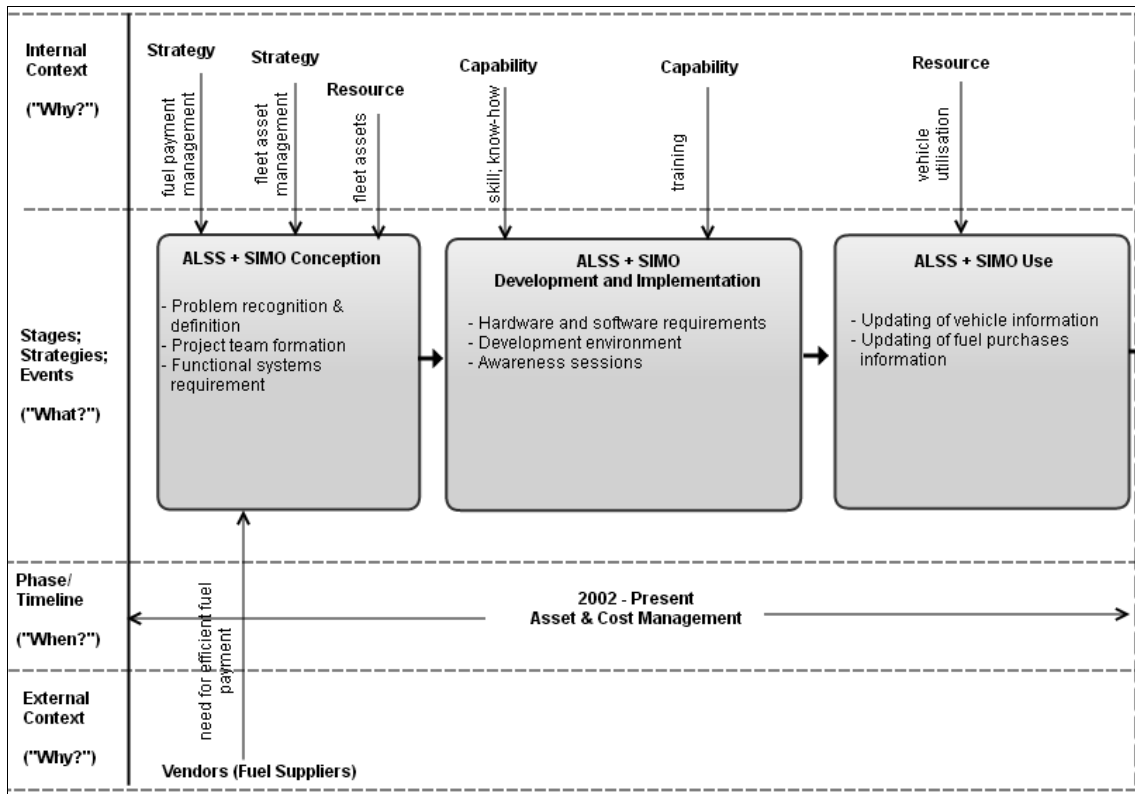


Figure 5.24 – Asset and Cost Management Phase of FMS Innovation

(Source: Developed for the thesis)

The ALSS and SIMO were conceived in 2002. As stated in the Context discussion (see Section 5.6.2), in 2002, Acadia signed a fuel supply contract with three vendors (fuel suppliers) for all its fleets nationwide. In order to manage the fleets and the cost of fuel, two systems were developed, namely ALSS and SIMO. The aim of ALSS was to manage the fleet asset while the aim of the SIMO was to facilitate payment to fuel suppliers. According to the Fleet Manager:

“These systems, well, mainly to manage our fleet operations. We are mandated to ensure our vehicles are roadworthy and in compliance with the government regulations. We hope the system enable us to provide optimal service to Acadia and its customers in servicing their needs. So, whenever we need the vehicles, they are available at all times, especially during work hours. As we have so many vehicles, now around 5,500, we need a system to manage these vehicles. So surely we need a system to manage that.” (Fleet Manager 01)

The three events occurred during the conception stage of ALSS and SIMO were: problem recognition and definition, project team formation, and functional systems requirements for ALSS and SIMO. In the problem recognition and definition, the Fleet Department managers along with the people in the Finance Division considered that it was necessary to have a computerised system to manage Acadia's fleet assets as well as to facilitate fuel payment to the fuel suppliers. Due to this realisation, they then formed a team comprised of people from the Fleet Management Department, IT Department, Finance Division and representatives from the fuel suppliers in conceptualising of the new system. The project team identified the functional requirements that needed to be developed for ALSS and SIMO. However, no green elements were considered during the conception of ALSS and SIMO as Acadia did not have any energy efficiency strategy or environmental management system ISO14001. The Fleet Manager said:

“For ALSS and SIMO, they are mainly operational. We want to just have better management and inventory of our vehicles. All vehicles' information are kept in the database, and it contains information pertaining to their acquisitions until their disposals (as used cars or scrapped in the events of accidents).” (Fleet Manager 01)

The ALSS and SIMO were developed in early 2002 and implemented towards the end of 2002. In terms of the hardware and software requirements, and the development environment, the Fleet Management Department worked in collaboration with the IT Department to develop the ALSS which composed of the ALSS web site developed using Microsoft's ASP.Net (to provide the user interface for interaction with the system). The vehicles database was built using MS-SQL. The Finance Division developed the SIMO system together with the IT Department using Lotus Notes/Domino client server environment. The SIMO has its own database of vehicles and was not integrated with ALSS or any other FMS. There were no green elements such as tracking CO₂ emissions inscribed or even considered by the ALSS and SIMO developers during the development of the systems. Their use of ASP.net and Lotus Notes/Domino are based on client-server technology unlike the UCC (refer Case 2 in Section 5.4) which was developed with peer-to-peer technology in mind, hence enhancing energy efficiency.

During the implementation of the systems, the Fleet Management Department conducted a series of awareness sessions to its own staff, the authorised drivers and the fleet

supervisors on the functionalities of ALSS and SIMO. However, the messages conveyed were mostly about the effective management of vehicles recorded into the log book, keeping the invoice for verification if needed and proper use of the fleet card. This indicates that environmental element was not given any consideration during the implementation of ALSS and SIMO.

In terms of the use of ALSS and SIMO, ALSS is used by the Fleet Management Department staff to update vehicles information whenever a new vehicle is acquired. Once the vehicle is purchased, its data are stored and maintained in the ALSS' vehicle database until the vehicle is disposed from the fleet's operation (i.e., scrapped, or sold/auctioned as second hand vehicle). As regards to SIMO,

“SIMO is the supplier payment system for fuel. It interfaces with data from fuel vendors that make claims from our fuel purchases. It is used by Finance to generate a report in Excel format and share the file with us. Fleet Management check the report for our own purposes while fleet owners use it to approve the purchases for the payment by Finance.” (Fleet Manager 01)

One interesting area where the data from SIMO and ALSS were used was for analysing and deciding resource utilisation. The Assistant General Manager of Support Business claimed that:

“We (the management of Support Business) use petrol consumption data from the report to look at resource efficiency. If we think it is not efficient, we would rather not invest in vehicles, because using own vehicle could probably be more efficient compared to us buying the vehicle and staff use it. Let say, if they use less than 500km/month, we track in terms of that. They need to return the car. Meaning, using the vehicle just for a 500km trip a month is too little. So we might as well give the car to other divisions or RNOs needing it. We also track how many vehicles being used less than 1000km/month. That is considered underuse too.” (Assistant General Manager of Support Business)

While ALSS and SIMO are still being used, the Green IT initiative (see Section 5.4.4.1 and Section 5.4.4.2) that was started in 2010 by the IT Department missed the opportunity

to recognise these two information systems as “low hanging fruits” to green the company. The reports generated from SIMO on fuel consumption, particularly during the fuel price hikes in 2004, 2006 and 2008 (refer Section 5.6.2) could be used as the main argument for Acadia to reduce or at least manage both its spending on fuel as well as the related environmental footprint.

Similarly, when the Property Operations Division was working on its ISO14001 Environmental Management System (pilot and actual implementation), and the Energy Efficiency Program (EEP), they have not included fleet management as the “top of mind” agenda. The Manager of Support Business claimed that there was no strong leadership to prioritise fleet management at the higher level despite the middle managers’ efforts in reporting their findings to their top management.

“We at the working level have all that intention (helping the company to support the Carbon Management Plan (CMP) in a more comprehensive manner). But the management is not looking that far yet despite what we reported to them. They ask us to prioritise first, business-wise. There are so many things to do. We try to start with small initiatives as long as cost savings are supported.” (Manager of Support Business)

The same view was reiterated by the Assistant General Manager of Support Business.

“Most of what we have are initiatives from the bottom (by the divisions). Not someone with a real leadership, power and budget to orchestrate all things sustainability from the top.” (Assistant General Manager of Support Business)

5.6.4.2 Behaviour management phase

This phase covered the periods from 2006 - 2010 when the Automatic Vehicle Location System (AVLS) was conceived, developed, implemented, used and discontinued as a result of a number of internal and external factors, namely structure, strategy, capability, resource, style, and system, as well as external business partner. Figure 5.25 shows a pictorial summary of how the phase is unfolded.

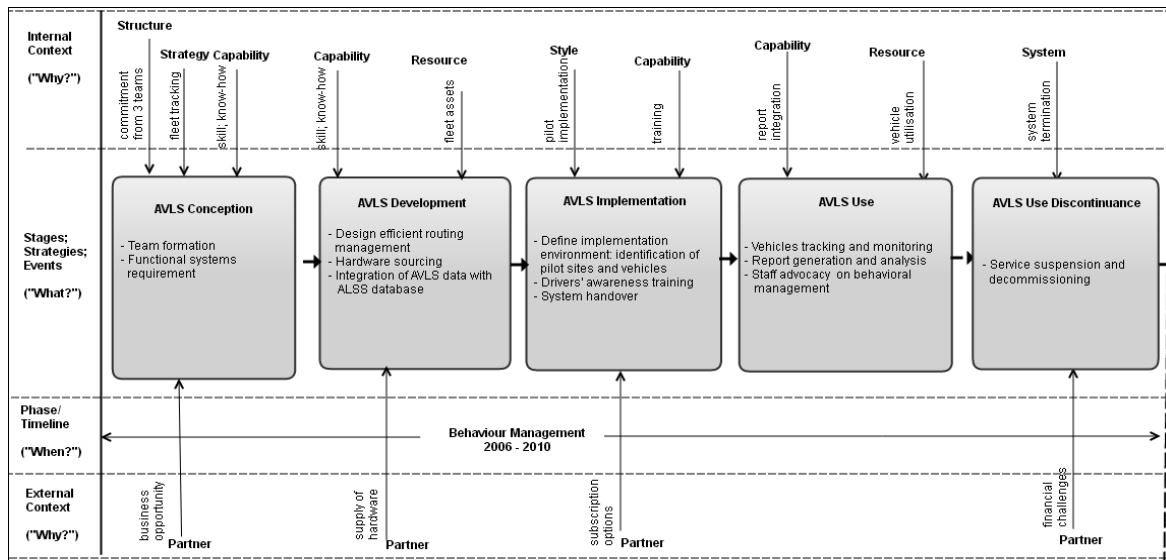


Figure 5.25 – Behaviour Management Phase of FMS Innovation

(Source: Developed for the thesis)

There are two systems events which occurred during the stage of AVLS conception: project team formation; and specifications for AVLS' functional requirements. The AVLS was a large system that drew expertise or know-how from three teams, namely the Fleet Management Department, Acadia Geomatics (a division of Acadia that develops geo-spatial mapping systems), and DG Inc., an external partner company who found business opportunity in supplying the hardware for the AVLS. In terms of functional systems requirement, the AVLS's functional requirement was defined to locate the vehicles in near real-time (between 3-5 minutes) and to track fuel consumption.

According to Fleet Manager 02:

“AVLS is a web-based system using GPS to track our vehicles. The user can see the distance travelled, as well as the vehicle's position according to day and time. The automatic alarm system would be triggered if the driver over sped causing the alarm to beep. Using the installed sensor, the system is able to give report such as how many times the driver was over speeding.” (Fleet Manager 02)

During the conception of AVLS, there was one green functional requirement that is, tracking of fuel consumption. However, while this feature was included during the development, it has a problem because of the lack of integration with SIMO making the

user unable to gauge fuel information directly from the AVLS interface. Therefore, the tracking of the actual fuel consumption while the vehicle was on the field operation was unable to be carried out. For fuel information, the Fleet Managers still had to go back to the data from SIMO and ALSS, instead of getting it direct from AVLS.

There were three events unfolded during this AVLS development, namely design of efficient routing management, hardware sourcing, and integration of AVLS data with the ALSS database.

In order to ensure efficient routing, the geospatial maps developed by Acadia Geomatics include Acadia's network exchange buildings into the mapping software as the points-of-interest (POIs). The reason for putting these specific POIs was to ease the authorised drivers in navigating directly to their destinations (i.e., mostly the network buildings under their care). For relaying the positions of the vehicles to the control centre located at the DG Inc premises (and also accessible via website for the Fleet Managers), subscription to Acadia Mobile's GSM services was made. In terms of sourcing for the hardware, DG Inc was selected to supply the black box device and RFID tags, as well as to integrate the hardware with the geo-spatial mapping systems developed by Acadia Geomatics. According to the Fleet Manager 02:

"We started the AVLS project in 2006/2007. We bought it from DG Inc, a local company. It has business relation with Acadia Geomatics. Geomatics provides the platform for AVLS. It is more like "mapping system" detail with Exchanges as point-of-interests POIs for whole country. Geomatics develops the mapping system and DG Inc takes the map service." (Fleet Manager 02)

During the integration for product trials, all developed modules were tied up together into one system and tested internally by the three teams with a small number of vehicles. During the development stage, no known green development options were practiced by the system developers.

In July 2007, the AVLS went live as a pilot implementation with 352 vehicles. The events during the implementation stage were: defining the implementation environment, drivers' awareness trainings; and system handover. The implementation environment entailed

identification of vehicles and sites for pilot implementation whereby the project teams chose the implementation to be conducted in seven zones as pilot sites. The identified vehicles were then fitted with the AVLS black box hardware and RFID tags. Further, the Fleet Management Department and DG Inc entered into a business agreement on the subscription package over the AVLS services. As of July 2007, a total of AUD\$186,700 was spent by the Fleet Management Department on the installation of the AVLS and initial package subscription to DG Inc. The Fleet Manager 02 said:

“We have over 350 units installed on our vehicles. On lorries, vans, cars and mostly for Regional Network Office (RNO)'s vehicles. We selected the 7 zones because we have operation in all those zones. We want to see the system running on nationwide-operation and that was why we need to have the system installed in vehicles in all seven zones.” (Fleet Manager 02)

Before and during the pilot implementation took place, a series of awareness trainings were conducted in the seven zones with the drivers whose vehicles were selected for installation with the AVLS. While drivers have no interaction with the AVLS other than starting and stopping the vehicle, information on AVLS were shared with them and their fleet supervisors. Drivers were informed of the objective of the AVLS and how their driving practice (i.e., location, vehicle speed, speed violation, direction, etc) of the vehicles under their care would always be monitored remotely via satellite. According the Fleet Manager 02:

“We explained to them the objective of AVLS. They also agreed to participate in the project whereby their vehicles are to be fitted with AVLS. We then fit the black box and RFID into the vehicles. After that, we provided some briefings about the system to the fleet owners and drivers. Especially the fleet owners on what they would be able to do with AVLS, and how to use AVLS website.” (Fleet Manager 02)

The AVLS was handed over to the Fleet Management Department for daily operation of the piloted vehicles.

During AVLS use, three events were observed: vehicles tracking and monitoring; report generation and analysis; and staff advocacy. When AVLS was used by the drivers, they

have no interaction with the AVLS hardware and RFID tag. The movement of the vehicles including its locations were tracked and captured automatically and remotely monitored by AVLS and the GPS. The staff members at the Fleet Management Department were able to track the vehicles and record whatever events the vehicle (and driver) were performing in terms of the driving practice using the AVLS website. The fleet managers and fleet supervisors on the other hand were able to control the AVLS devices installed on the vehicles by sending triggers (i.e., beeping alarm) in the event the driver was going beyond the “boundary fence” allowed to them or in the case of over-speeding. According to the Fleet Manager 02:

“Using AVLS, we can see the location of our vehicles at all times. We can see whether they are really in the field doing work. It will ease our monitoring and management of the vehicles. We want our fleets are optimally used. Otherwise, we may need to rationalise and justify the vehicles to be used for other purpose or sell it because it is underutilised. We can see their busy hour, when they are stationary (idle), distance travelled.” (Fleet Manager 02)

The fleet managers generate reports based on request by the fleet supervisors located at the zone offices, or on monthly basis for their analysis. For example, fleet supervisors may request for report on a particular vehicle in order to see the irregularities in utilisation of the vehicle such as the use of vehicles outside work hours. By pulling data from the AVLS and ALSS databases, detail information on the movement of the vehicles including the location of the vehicle can be reported. Similarly, reports can be generated and analysed pertaining to the number of vehicles underutilised for possible reallocation to the needing location in another zone. Reports can also be generated to analyse the pattern in speed violations made by the drivers. These reports were brought together to a monthly meeting with the Support Business management to rectify situations such as misbehaviours by the drivers. The drivers and their fleet supervisors who use the vehicles for personal use, or too frequently violating the speed rules or involved in harsh breaking were called to the Fleet Management Department’s office for further investigation and action as a measure of advocacy with the concerning drivers. According to the Fleet Manager 02:

“There are also people using the vehicles after work hours as if it is their own personal vehicles. This is not right. We can see the data using AVLS. Except when there is a business need for that like over time (OT), normally our vehicles are stationary or parked at night. We can see people using our vans to night markets or something. We normally don’t really care much but when it becomes a habit, we raise the issue with the supervisors to warn the authorised drivers involved. We can also see how much fuel being used because the AVLS have that function. We just make estimation actually, as the real data comes from SIMO anyways.” (Fleet Manager 02)

Despite the use of AVLS the Fleet Management Department missed the opportunity to highlight the use of AVLS for greening Acadia. According to the Fleet Manager:

“Reporting-wise, what we normally report in the annual reports are just the number of fleets, how much new vehicles acquired, disposed, or sold. It was not to the extent of how much fuel consumption or CO₂ emission. No. They (Corporate Communications Division) never asked for such information to be reported. So we never report it. Sure, in the future, if they want us to help and provide data, like for their MyEarth campaign, we are more than willing to help where possible.” (Fleet Manager 01)

The AVLS use was discontinued in 2010 when the partner company, DG Inc faced financial challenges and was forced to close down its business. The Fleet Manager said:

“We have all the intention to go on bigger scale with AVLS as we can do many good things with it. Tracking the vehicles in near real-time, the utilisation of our assets, and overseeing the behaviours of our drivers on the ground. But we cannot do much because it happened quite suddenly when DG Inc announced that it is going out of business. We were caught off guard and our plan to move forward was stalled.” (Fleet Manager 01)

Following this, the AVLS service was suspended and decommissioned.

5.6.4.3 Use management phase

The Use Management Phase started in 2008 when the Customer Service Module and e-Log Book were developed. The systems remain in operation until today to complement ALSS and SIMO. This phase is called the use management because CSM and e-Log Book are used to manage the use of the vehicles. The innovation stages of CSM and e-Log Book include conception, development and implementation, and use as a result of a number of internal and external factors, namely the strategy, capability, resource, system, and practice, as well as the government. Figure 5.26 shows a pictorial summary of how the phase is unfolded.

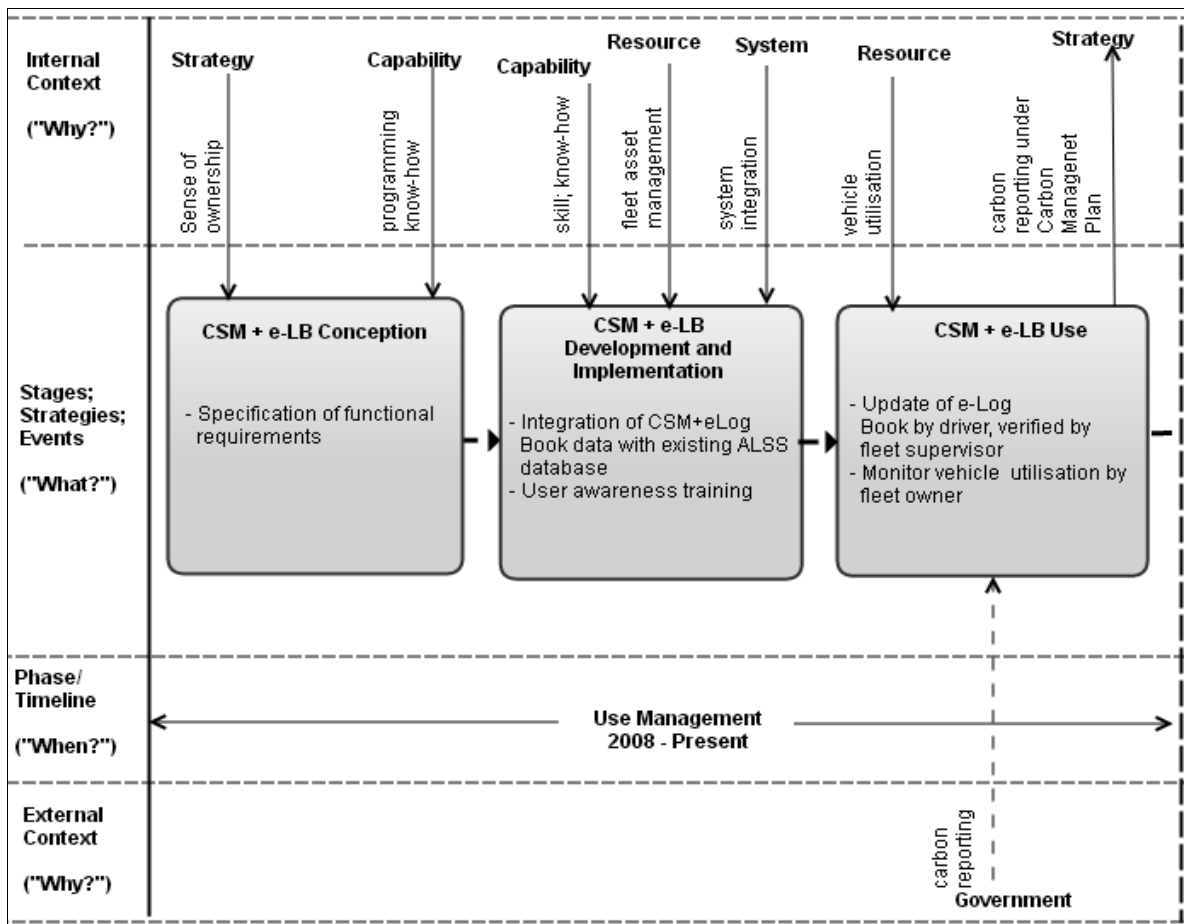


Figure 5.26 - Use Management Phase of FMS Innovation
(Source: Developed for the thesis)

The CSM and e-Log Book project were conceived and started in 2008. One event occurred during this stage: specification of functional requirements for CSM and e-Log Book.

The strategy driving the conception of CSM and e-Log Book was to increase the sense of ownership of the fleet assets by the fleet owners and drivers. During the conception stage, the Fleet Management Department decided to develop the system internally as it had staff members that were knowledgeable in IT and understood the fleet utilisation processes. The Fleet Management managers were also not keen to outsource the project to external parties to avoid unnecessary time spent to learn about the processes of fleet operations.

The functional system requirements for CSM include “displaying” vehicle information (vehicle profile and its licensing), service or maintenance information, summon information, and fuel use information. The e-Log Book was defined to enable users to update journey data (detailing the trips information and fuel consumption), and viewing the history of the vehicle’s journey. Further, the requirement was defined to address the limitations of SIMO and ALSS and included online access to enable users to manage their own vehicle utilisation. With the introduction of CSM and e-Log Book, users were able to monitor their vehicles operation and were empowered to get more detail on vehicles owned (or leased) by them. As indicated by the Fleet Manager:

“The CSM and the e-Log Book “added value” to our (internal) customers. We digitise the old manual log book into e-Log Book now. In a way, CMS and e-Log Book can be seen as an extension of ALSS.” (Fleet Manager 01)

During the development of CSM and e-Log Book, the developers ensure the integration of the new CSM and e-Log Book data with the existing ALSS database. Once the systems were completed, both CSM and e-Log Book systems were put into implementation. A link to the CSM and e-Log Book was placed in the Fleet Management Department’s portal for users to access and log into the systems. In order to create user awareness, the Fleet Management Department conducted a series of awareness sessions to the authorised drivers and the fleet supervisors on the functionalities of CSM and e-Log Book. During the awareness training, there was no specific sustainability message conveyed to the users besides promoting the transition from using manual log book towards the use of e-Log

Book. The green functional requirements of monitoring fuel consumption did not take center stage.

In terms of CSM and E-Log Book use, the systems empower the users of Acadia's fleet in managing their vehicle's utilisation. Before and after each trip, the authorised drivers were expected to update the e-Log Book. Information such as the odometer reading before and after, the destination and purpose of the trip, fuel used (refuelling activities) and other activities that are happening during the trip are reported. Notably, the fuel consumption data was treated as any other data and was not used to develop greener work practices. The CSM and e-Log Book systems enabled the fleet supervisors and drivers to generate their own report of vehicle utilisation for further planning such as to schedule maintenance. The Fleet Management Department managers are using and extracting data from CSM for further analysis. In order to do this, MS-Excel is used because the existing CSM was not developed with a detail number crunching and advanced data analytics capabilities. According to the Fleet Manager:

“Both systems the CSM and e-Log Book help the users actually. On our end, we already have the ALSS. When we introduce CSM and e-Log Book, we want the users to make record, update the record of their vehicle use.” (Fleet Manager 01)

As stated in Section 5.2.4, in 2011, Acadia had introduced a Carbon Management Plan (CMP) which intended to reduce the company's Scope One (through fleet management), Scope Two (through electricity management) and Scope Three (through behavioural management) emission. While the Fleet Managers did not specifically mentioned the potentials of the FMS (particularly CSM and e-Log Book) in keeping track of Acadia's fuel consumption and carbon emissions for the CMP, it can be indirectly deduced (represented by dotted line in Figure 5.26) that the Group Corporate Communications Division is able to harvest the information from the FMS for the Acadia's CMP carbon reporting strategy.

5.6.5 The Outcomes of the FMS Innovation for Acadia

While there was no formal benefits evaluation conducted by Acadia, anecdotal evidence gathered during the data collection indicated that the FMS have resulted in some benefits. These direct and indirect outcomes are summarised in Table 5.18.

Outcome Type	Category	Area	Benefit
Direct	Environmental	Emission	Reduction in carbon emission from reduction in fuel consumption.
	Economic	Cost	Reduction in fuel cost from better tracking of fuel consumption.
	Operational	Efficiency	Improved fleet management asset process. Better tracking of fleets and drivers' driving behaviours. Improved fuel payment process to fuel suppliers.
Indirect	Social	Workplace	Better sense of ownership of the fleets.
	Rebound effect	E-Waste	Unused black boxes and RFID tags from the discontinued AVLS project.

Table 5.18- Outcomes of Fleet Management Systems at Acadia

As stated in the above sections, hard evidence of quantifiable and/or explicitly reported FMS benefits was not available due to the lack of attention from the top management on the potentials of the FMS to support Acadia's environmental sustainability initiatives. The Fleet Manager 01 claimed:

“We don’t really evaluate much about the benefits of AVLIS and the other components of the fleet systems. We did not do proper documentation or formal reporting to the Group Corporate Communications for sustainability report. They never asked us for that kind of information,” (Fleet Manager 01)

However, based on the researcher’s check on Acadia’s progress on its Carbon Management Plan as reported in its Sustainability Report 2012, the company had started reporting the fuel consumption data from the GHG emissions standpoint (refer Figure 5.27). It was shown that Acadia’s CO₂ emission for petrol was decreasing by around 2% from 15,215.41kgCO₂e in 2011 to 14,934.50kgCO₂e in 2012. Yet, there was an increase of 0.8% for diesel consumption from 5,847.72kgCO₂e in 2011 to 5,895.83kgCO₂e in 2012. The increase can be attributed to more business and field operations in order to cater the high demand on the company’s high-speed broadband services which require more diesel-engine vehicles to be utilised.

Thus, it can be argued that, to some degree, the Acadia’s Fleet Management Systems have helped Acadia to keep track and report its fuel consumption, and hence improve the richness of the sustainability report.

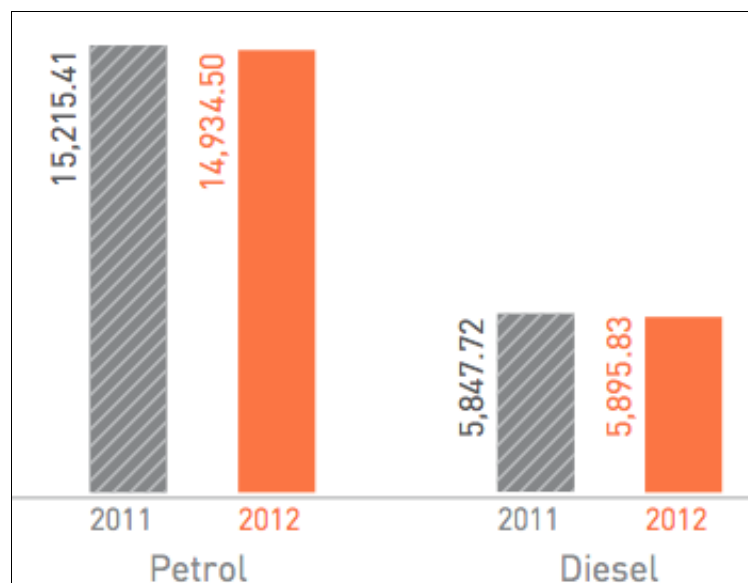


Figure 5.27 - GHG emissions from company-owned vehicles from fuel purchases (Source: Acadia Sustainability Report 2012)

From the behavioural management benefit perspective, the Fleet Manager also claimed:

“We have used the information from our systems for a few cases, like three suspicious cases. The use of vehicles outside work hours, which is unethical, can be misused for personal gain. With report from the systems especially AVLS, we can trace such unhealthy behaviours and act accordingly.” (Fleet Manager 01)

5.6.6 The FMS Innovation Process Model

Figure 5.28 shows the FMS Innovation Process Model. Due to the space constraint, the process model requires cross-referencing with the figures highlighted preceding the discussion of the FMS innovation phases, namely the asset and cost management phase (Section 5.6.4.1); behaviour management phase (Section 5.6.4.2); and use management phase (Section 5.6.4.3).

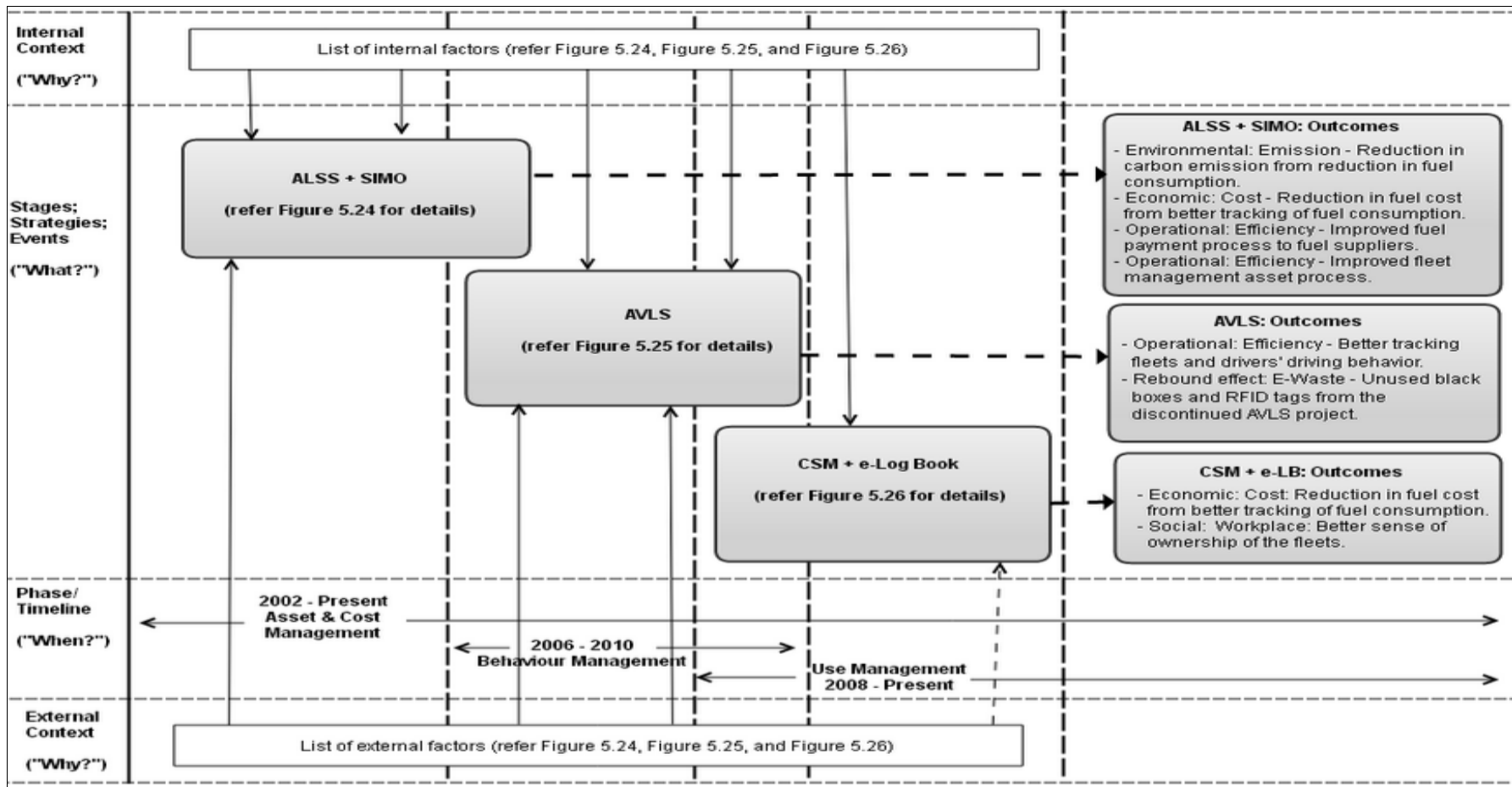


Figure 5.28- Fleet Management System (FMS) Innovation Process Model

(Source: Developed for the thesis)

5.7 CHAPTER SUMMARY

This chapter has presented the findings based on the four Green information system innovation cases of Energy Informatics, Unified Communication and Collaboration, Sustainable Knowledge Management and Sharing, and Fleet Management System. In the following chapter, a cross-case analysis based on the individual Green information system innovation process shown in this chapter will be compared and cross-analysed. Then, it will be followed by the overall discussion based on the findings of the four Green information system innovation cases.

CHAPTER 6 : CROSS-CASE ANALYSIS AND DISCUSSION

6.1 INTRODUCTION

This chapter presents the cross-case analysis for the four Green information system innovation cases covered in Chapter 5. The cross-case analysis includes discussion about the content, context, process, and outcomes from the four Green information system innovations studied (Section 6.2). The chapter then proceeds to introduce the two Green Information System Innovation Process Models, namely the Green Information System in Practice Innovation Process Model and the Green Information System in Spirit Innovation Process Model (see Section 6.3). Theoretical propositions based on both innovation process models are proposed and followed by the depiction of the innovation models before the chapter ends with the chapter summary (Section 6.4).

6.2 CROSS-CASE ANALYSIS

In order to facilitate a deeper understanding of the cases and highlight the differences between them, it is important to consolidate the findings of the within-case analyses presented in Chapter 5 with a cross-case analysis. The objective of the cross-case analysis is to derive conclusions which go beyond the separate and individual impressions of each case. Key findings across cases are discussed within the context of the conceptual framework covered in Chapter 3 and the thematic coding based on the data analysis discussed in Chapter 4. In the following sections, the cross-case analyses are presented based on the **content**, **context**, **process**, and **outcomes** of Green information system innovation.

6.2.1 The Content of Green Information System Innovation

The **content** of Green information system innovation, as discussed in the conceptual framework discussion (see Section 3.3.1 in Chapter 3) and drawn from the literature can be seen from the following three themes: **spirit** (DeSanctis & Poole, 1994), **interpretive**

flexibility (Orlikowski, 1992), and the **types of Green information system** (Mines, 2011). In addition to the three themes identified from the existing literature, there are five new and emergent themes related to the content of Green information system innovations drawn from the data which include **components, year developed and by whom it was developed, users, nature of systems, and information stored/displayed** (see Table 6.1 for the cross-case summary).

The “**spirit**” of greenness (Ijab et al., 2010) was inscribed in the Energy Informatics (Case 1) as it was developed to address the increased need for measurement and visibility of electricity use in Acadia, to improve energy efficiency and reduce electricity cost, and for compliance to ISO14001 standards and certification and in response to increasing national electricity tariffs.

However, for the Unified Communications and Collaboration (Case 2) and the Sustainable Knowledge Management and Sharing (Case 3), the green functional affordance became apparent through three variations of **interpretive flexibility** during the use of the systems, namely the *metastructuring* and the *expansion of functional affordance* (for the Unified Communications and Collaboration - Case 2), and *use extension* (for the Sustainable Knowledge Management and Sharing - Case 3). For the fourth innovation, the Fleet Management System, the innovation was appropriated faithfully as it was intended so by the system developers.

In terms of the **types of Green information system**, the four innovations are examples of the different types of Green information system discussed in Section 3.3.1.3 in Chapter 3. The types of Green information system innovations in Acadia can be categorised as **Smart infrastructure management software (Case 1), Sustainable communications and collaboration systems (Case 2), Sustainability knowledge and learning management system (Case 3) and Software for carbon and energy management (Case 4)** as shown in Table 6.1.

In terms of the **components** of the Green information system innovations, except the Unified Communications and Collaboration (Case 2), the other Green information system innovations are comprised of two or more components (Table 6.1). This indicates that Green information system innovations are not always a single innovation, but can be

formed by many related innovations to achieve the goals as intended by the system owners.

The innovations started as early as 1996 (Case 1) and covered the period until 2011 (Case 2 and Case 3). They were developed both internally and externally. The Fleet Management System was mostly developed internally by the IT Department team and the Fleet Management Department staff. The Unified Communications and Collaboration (Case 2) was a relatively recent innovation developed only in 2006 by the Acadia R&D, and the Sustainable Knowledge Management and Sharing was implemented in 2008 through a purchase from an external vendor, Microsoft.

In terms of the **users** of the Green information system innovation, there were two types of users for Acadia's Green information system innovation: (a) organisational; and (b) departmental users. The Unified Communications and Collaboration (Case 2) and the Sustainable Knowledge Management and Sharing (Case 3) are used by all Acadia staff. However, the Energy Informatics (Case 1) and the Fleet Management System (Case 4) are for department-specific users as the systems are mainly used by the staff of the Property Operations Department and the Fleet Management Department, respectively.

From the perspectives of **nature of system** and **information stored/displayed**, each of the Green information system innovations has their own specific characteristics from managing electricity consumption of chill water pumps (Case 1), through facilitating less carbon intensive collaboration and communication (Case 2) and assisting staff to exchange sustainability information (Case 3) to managing fleet-related carbon (Case 4). As a result, the types of information stored and displayed are building operational data (Case 1), instances of the communications and collaboration taking place, the information of the users and the activities undertaken by the users during their interactions (Case 2), shared documents and workflow applications (Case 3) and data related to fleet assets including fuel consumption and other details (Case 4). The summary of the cross-case analysis for the content of Green information system innovations is shown in Table 6.1.

Category	Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
Content	Spirit	ES2 inscribed with greenness during the conception stage.	-	-	-
	Interpretive flexibility	Faithful appropriation.	(i) Metastructuring and (ii) Expansion of functional affordance.	Use extension.	Faithful appropriation.
	Types of Green information system	Smart infrastructure management software.	Sustainable communications and collaboration systems.	Sustainability knowledge and learning management system.	Software for carbon and energy management.
	Components	Building Automation System (BAS); Integrated Building Management System (IBMS); ES2; MS-Excel	Unified Communications and Collaboration (UCC)	Sustainable Document and Application Management (SDAM); MyEarth portal	Auto Leasing and Servicing System (ALSS); Supplier Invoice Management Online (SIMO); Automatic Vehicle Location System (AVLS); Customer Service Module (CSM) and e-Log Book; MS-Excel
	Year developed and by	1996-2006 from different vendors (BAS); 1996 by Acadia R&D (IBMS); 2006 by Acadia R&D (ES2)	Late 2006 by Acadia R&D	Dec 2008 by IT Department & Microsoft (SDAM); Oct 2009 by IT Dept, Microsoft &GCC (MyEarth portal)	2002 by internal (ALSS&SIMO); 2006 by partnership (AVLS); 2008 by internal (CSM and e-Log Book)
	Users	Departmental: Property Operations staff.	Organisational: Acadia staff.	Organisational: Acadia staff.	Departmental: Fleet Management staff, Fleet supervisors, Finance Division staff.
	Nature of system	Building automation; integrated building management; Chilled Water Pump (CWP) controlling; Report generation.	Online communications and collaboration among staff members.	Handling the sharing of documents and applications; dissemination of environmental awareness information.	Management of fleet asset; fuel supplier management; fuel consumption tracking; report generations.

Category	Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
	Information stored/displayed	Building automation control; integrated building information; speed of CWP; data analysed from ES2.	Communications and collaborated information.	Shared documents, forms, environmental news and campaign information, etc.	Fleet asset database; fuel vendor information; vehicles location and other vehicle details.

Table 6.1 - Cross-Case Summary for the Content of Green Information System Innovations Category across the Four Cases

6.2.2 The Context of Green Information System Innovation

The context of Green information system innovation can be seen from the themes of **external** and **internal** contexts, as discussed in the conceptual framework (refer Section 3.3.2 in Chapter 3) and the data coding section (refer Section 4.5.2.1 in Chapter 4). It needs to be highlighted that while there is no specific ordering of the lower-level or the higher-level factors pertaining to the contextual forces affecting the Green information system innovation in Acadia, this research recognises two differentiators. Firstly, factors derived from the **internal context** are considered as the **strong-order reasons** which motivate the desire of Acadia to go green via its Green information system innovations. These motivations include the desire: (i) for greater IT efficiency and cost savings; (ii) to pursue regulatory legitimacy; and (iii) to pursue socially responsible business practices and corporate citizenship. Secondly, factors originating from the **external context** are considered as the **second-order facilitators** which regulate and/or influence Acadia's innovation in Green information system. The examples of the external motivations include: (i) government's regulations for low carbon economy and operations; and (ii) industry and market influences. The following sub-sections provide a cross-analysis of the external and internal factors driving the Green information system innovations in Acadia.

6.2.2.1 External factors

Table 6.2 summarises the cross-case analysis based on the external context of Green information system innovations. As indicated in Table 6.2, normative and coercive forces have played a role in either influencing the conception of the Green information system or in influencing the metastructuring, expanding the functional affordance, or extending the use of the Green information system innovations in Acadia. From the empirical findings discussed in Chapter 5, there was no evidence of Acadia mimicking other organisations' adoption of Green information system innovations.

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
Context	External context	Mimetic	-	-	-	-
		Normative	<u>IT market:</u> Price structure. <u>Oil and Gas Market:</u> Fuel price. <u>Energy bodies:</u> Energy consumption norm.	<u>Vendors:</u> Vendor's pressure. <u>Consultant:</u> Green IS/IT knowledge.	-	-
		Coercive	<u>Government:</u> Increase tariff; Follow government's environmental reporting (disclosure).	-	-	<u>Government:</u> Carbon reporting.

Table 6.2 - Cross-Case Summary for the External Context of Green Information System Innovations Category across the Four Cases

Two out of the four systems were influenced by **normative pressures**. In the Energy Informatics (Case 1), normative pressures were felt from market sources particularly the IT market's high price structure if Acadia were to purchase the Integrated Building Management Systems from the external IT market (i.e., the commercial IBMS developers); and price hikes in the global oil and gas market around 2006 - 2010. Another source of normative pressure was industry sources such as the United Nation's Industrial Energy Efficiency Improvement Project (IEEIP) that set energy consumption norms so that organisations were to conduct energy audits and identify the most significant contributors of their electricity consumption. In the Unified Communications and Collaboration (Case 2), normative pressure took the form of vendors pushing and promoting their UCC solutions to Acadia as well as IT consultants in defining Green IT as the latest technology trend and identifying feasible solutions. The empirical data collection and subsequent data analysis showed lack of evidence of normative pressures influencing Acadia's innovations in the Sustainable Knowledge Management and Sharing (Case 3) and the Fleet Management System (Case 4).

The influence of **coercive** pressure was evident in Cases 1 and 4 where the conception and use of the systems were affected to some degree due to the government's intervention by increasing national electricity tariffs in response to energy price hikes and enforcing environmental sustainability performance disclosure, respectively.

6.2.2.2 Internal factors

The cross-case analysis of the internal context across the four Green information system innovation cases shows that a number of internal factors played a role in driving or motivating the conception, or use of the Green information system cases as summarised in Table 6.3. The ensuing discussion will highlight the main internal factors influencing the innovations of the four Green information systems.

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
Context	Internal context	Top management	<u>Leadership:</u> Electricity as top of mind.	<u>Leadership:</u> Norm setting CEO; Norm setting champion.	<u>Leadership:</u> Commitment; Resource allocation.	-
		Business imperatives	<u>Strategy:</u> Construct new building; Develop own capability; ISO14001; R&D Tech Roadmap; Sustainability Report.	<u>Strategy:</u> R&D Tech Roadmap; Green IT Framework.	<u>Strategy:</u> Environmental Awareness Campaign.	<u>Strategy:</u> Carbon reporting on Carbon Management Plan (CMP).
			<u>Resource:</u> Building asset.	<u>Resource:</u> IT budget; Knowledge; Existing application; Stock Green IT/IS knowledge.	<u>Resource:</u> Existing Intranet platform.	<u>Resource:</u> Fleet assets.
			<u>System:</u> Feature enhancement from Integrated Building Management System (IBMS).	-	<u>System:</u> SKMS requirements; SKMS migration.	<u>System:</u> System termination; System integration.
			-	<u>Style:</u> Reminders; Encouragement from superiors.	<u>Style:</u> Productivity Day; Email; Newsletter.	<u>Style:</u> Pilot implementation.
			<u>Technology:</u> Integration of Building Automation System (BAS); Tool for electricity monitoring and measurement.	<u>Technology:</u> Integration of TelePresence features.	-	-

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
			<u>Policy & Practice:</u> Building control; Energy audit; Informing down; Informing up.	<u>Policy & Practice:</u> Energy efficiency norms.	-	-
			-	<u>Staff:</u> Environmental disposition; Task structure; Working condition.	-	-
		Environmental sustainability culture	-	<u>Culture:</u> Adoption of UCC for sustainability practices.	<u>Culture:</u> Knowledge sharing in forums.	-
		Innovation climate	<u>Capability:</u> R&D know- how and experiences.	<u>Capability:</u> IT development and commercialisation.	<u>Capability:</u> Functional department know-how and experience.	<u>Capability:</u> Functional department know-how and experience.

Table 6.3 - Cross-Case Summary for the Internal Context of Green Information System Innovations Category across the Four Cases

From the **top management** perspective, three out of the four Green information system cases were directly influenced by the leadership of Acadia where the top management had set the agenda for Green information system action (Case 1), champion the implementation of a Green information system and set the norm for the adoption of Green information system (Case 2) and allocate the required resources for the implementation of a Green information system project (Case 3). However, for the Fleet Management System (Case 4), there is lack of evidence to indicate the element of top management in driving the innovation of the FMS.

All four Green information system cases were driven by several factors of the **business imperative** internal context as summarised in Table 6.3. In particular, the *strategy* and *resource* factors affected and influenced all of the four Green information system innovations. For example, in the Energy Informatics (Case 1), the *strategy* to support the expanding business of Acadia had driven the company to construct a newer and larger building to cater for its business expansion. The larger building required an integrated building management system (IBMS) which led to the Energy Informatics (Case 1) innovation. Other internal strategies playing roles in the conception and development of the Energy Informatics include the implementation of ISO14001, alignment to the R&D Technology Roadmap's green solutions, as well as the need for electricity consumption reporting in the Sustainability Report of the company. The Unified Communications and Collaboration (Case 2) was realised due to the Green IT strategy of the IT Department. The *strategy* to facilitate the environmental awareness campaign among staff members has led to the use extension of the Intranet portal into the MyEarth portal under the Sustainable Knowledge Management and Sharing system (Case 3). Acadia's Carbon Management Plan (CMP) strategy has contributed to the upgrade of the FMS for tracking fuel consumption and carbon emission.

The other main factor from the **business imperatives** perspective is *resource*, both in terms of availability of IT (Cases 2 and 3) and non-IT assets (Cases 1 and 4) to be used and managed respectively, the financial constraints to invest in new Green information system solutions (Case 2), and the know-how of system developers and IT managers in making technological choices (Cases 1 and 2).

As regards to *system* in the Energy Informatics (Case 1), the ES2 component was developed with a specific *system* feature to enhance an existing Integrated Building Management System (IBMS) in enabling the variable control of the chilled water pump fan speed. In the Sustainable Knowledge Management and Sharing (Case 3), the *system* factor influenced in the requirements setting of the project, as well as in the migration of the system when it was ready for implementation. In the Fleet Management System (FMS), the *system* factor had been influential in affecting the termination of the AVLS use. *Style* relates to the approaches taken to encourage use of the systems enterprise wide. This included sending reminders via email, getting senior managers in departments or divisions to encourage their subordinates to use the innovations, running campaigns such as Productivity Day (Cases 2 and 3) and pilot implementation to try out the Green information system innovation (Case 4).

The *technology, policy and practice, and staff* were the least common business imperatives. *Technology*, that is, the lack of integration of the 11 building automation sub-systems (BAS) was one of the main reasons for the conception of the Integrated Building Management System (IBMS). On the other hand, the integration of the TelePresence features into the Sustainable Communications and Collaboration (SCC 2.0) was facilitated by the *technology* readiness (Case 2) factor having played a role in enabling this Green information system innovation. In terms of *practice*, the Energy Informatics (Case 1) showed that the *practice* of conducting an energy audit had driven the innovation of ES2, which was later used to informate down the electricity consumption data to the operational staff, and to informate up the electricity consumption data to the decision makers and stakeholders. In the Unified Communications and Collaboration (Case 2), *the practice* selected by the UCC system developers to adopt energy-efficient servers and equipment shaped the development environment. Lastly, the *staff's* environmental disposition factor had driven the adoption of the metastructured UCC as Sustainable Communications and Collaboration (SCC). Improving the task structure and the working condition was promoted to be the benefits from using the UCC for environmental sustainability, and hence influenced the staff's diffusion of the UCC in Acadia.

From the perspective of **environmental sustainability culture**, while the importance of the environmental attitudes of employees to adopt and continue to use Green information

system was evident in the Unified Communications and Collaboration (Case 2), the *culture* of knowledge sharing using e-forums, especially on environmental sustainability matters, was relevant to the use continuance of the Sustainable Knowledge Management and Sharing system (Case 3). From the **innovation climate** perspective, the innovativeness of Acadia is prevalent when all four Green information system innovation cases showed evidence of the staff *capability* to create and/or apply information systems for environmental sustainability. This include Acadia's R&D subsidiary (Cases 1 and 2) and functional departments' (Cases 3 and 4) know-how and experiences. Table 6.3 summarises the cross-case analysis based on the internal context of the Green information system innovations.

6.2.3 The Process of Green Information System Innovation

The process of Green information system innovation can be described from the identified themes of **phases, stages, events, and key people** (see Section 3.3.3 in Chapter 3 and Section 4.5.2.1). In Table 6.4, these are summarised and in the following sub-sections, the phases, stages, events and key people across the four Green information system innovation cases are cross-analysed.

The **phases** of Green information system innovations are different for all four cases. Most of the innovations were divided into three phases while only one was divided into two phases (see Table 6.4). Each phase of the Green information system innovation is further divided into several **stages** of Green information system innovations which include conception, development, implementation, use, metastructuring, expansion of functional affordance, use extension, use discontinuance, and evaluation. As indicated in Table 6.4, not all innovations followed the nine stages. For example, based on the cross-case analysis, the Energy Informatics system (Case 1) followed the stages from conception, development, implementation, use, and evaluation. However, the other three cases took slight variations (refer Table 6.4). From the cross-case analysis, it can be deduced that the four Green information system innovations generally show two different paths – one for those information systems that were intentionally created to address environmental sustainability and another path for those information systems that were appropriated later to be used to enable and support environmental sustainability.

The **events** in the Green information system innovation process are intricately woven into the innovation stages of conception, development, implementation, and evaluation. However, based on the cross-case analysis of the four Green information system cases, while the events that took place in each of the innovation stages were almost similar, however, they address different issues (i.e., problems or needs). For example, the Energy Informatics (Case 1) was conceived when Acadia *recognised the need* for electricity use, measurement and management. On the other hand, the Unified Communications and Collaboration (Case 2) was conceived when Acadia *recognised the problems* of establishing an effective electronic communications and collaboration due to various reasons (see Table 6.4). The Sustainable Knowledge Management and Sharing (Case 3) was conceived when the company *recognised the problems* of managing and controlling the mushrooming of contents and servers and to cultivate knowledge sharing culture among staff (see Table 6.4). In the Fleet Management System (Case 4), the system was conceived when the Fleet Management Department *recognised the problems* of effectively managing the large number of fleet assets as well as in effectively reimbursing fuel costs to fuel suppliers (see Table 6.4).

In the Energy Informatics (Case 1), the Unified Communications and Collaboration (Case 2), and the Fleet Management System (Case 4), the event of defining a development environment was an important event (Table 6.4). However, in the Sustainable Knowledge Management and Sharing (Case 3), no development environment was needed as the platform for the SKMS was purchased outright from the vendor, Microsoft. Furthermore, two of the Green information system innovations were “*faithfully appropriated*” (Cases 1 and 4) while Cases 2 and 3 underwent variations in their appropriations that include utility recognition, functional affordance expansion and metastructuring (see Table 6.4). Only the Energy Informatics innovation (Case 1) was formally evaluated in terms of the outcomes and one of the Fleet Management Systems components was discontinued.

Several **people** were involved in the innovation processes in various capacities. These include the top management, system owners and system developers, IS managers and professionals, technology consultants, vendors and partners, clients and competitors, as well as change agents or environmental champions (Table 6.4). Two of the Green information system innovations have benefited from direct commitments from the *top*

management. In the Unified Communications and Collaboration (Case 2), the Chief Technology and Innovation Officer (CTIO) was instrumental in instructing the “expansion of functional affordance” of the UCC with the TelePresence feature, resulting in a new project named the Sustainable Communications and Collaboration (SCC 2.0). In the Sustainable Knowledge Management and Sharing (Case 3), the Group Chief Executive Officer headed the SKMS Steering Committee to ensure the successful undertaking of the SKMS project. Although the other two cases, namely the Energy Informatics (Case 1) and the Fleet Management System (Case 4) showed lack of direct participation from the top management, however, evidence showed that the top management was concerned with escalating electricity costs. This had led the senior management of the Property Operations Department to embark on the ES2 project (Case 1).

In all Green information system innovation cases, the *system owners and system developers* were responsible for shaping how the innovation process unfolded (see Table 6.4). These range from management and technicians of the Property Operations Department (Case 1), the IT Department managers (Case 2 and 4), the Group Corporate Communications (Case 3), the Fleet Management Department (Case 4) and Acadia R&D (Case 1). Other people involved in the innovations include *vendors, consultants, partners* and Acadia’s staff from other departments or divisions who facilitated in the innovation process (see Table 6.4).

Category	Themes	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
Process	Phases	Building Measurement Capability → Energy Measurement & Monitoring → Energy Management.	Unified Communication & Collaboration → Metastructuring of UCC → Sustainable Communication & Collaboration.	Document and Application Management → Environmental Campaign Enablement.	Asset & Cost management → Behaviour Management → Use Management.
	Stages	Conception; Development; Implementation; Use; Evaluation.	Conception; Development; Implementation; Use; Metastructuring; Expand Functional Affordance.	Conception; Preparation, Implementation; Use; Use Extension.	Conception; Development; Implementation; Use; Use Discontinuance.
	Events	<u>Conception:</u> Recognise need for electricity use, measurement and management; Intent to use EI; Project definition and scoping.	<u>Conception:</u> Problem recognition and definition; Recognise the need, Intent to incubate UCC; Project definition and scoping.	<u>Conception:</u> Problem recognition and definition; Setting up of steering committee and project team; Requirement definition.	<u>Conception:</u> Problem recognition and definition; Project team formation; Functional systems requirement.
		<u>Development and Implementation:</u> Defining functional requirements; Decide development environment; Define implementation environment; Evaluate and decide sourcing options; System integration; Developing the IS; Develop users' capability.	<u>Development and Implementation:</u> Evaluate and decide sourcing; Define functional/customer requirements; Specify hardware requirements; Define development environment; Developing the IS; Define implementation environment; Awareness creation; Developing users' capacity.	<u>Preparation and Implementation:</u> Identifying divisional web masters; Capacity building for web masters and IT team; Preparing old portals for consolidation and migration; Migrating old portals to SDAM.	<u>Development and Implementation:</u> Hardware and software requirements; Development environment; Awareness sessions; Design efficient routing management Hardware sourcing; Integration of AVLS data with ALSS database; Define implementation environment; Drivers' awareness training; System handover; Integration of CSM +

Category	Themes	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
					e-Log Book.
		<u>Use:</u> Appropriation; Reappropriation; Cultivation of practice; Monitoring of practice; Electricity data collection; Data retrieval and reporting; Electricity performance indicator disclosure.	<u>Use:</u> Appropriation; Cultivating the practice; Monitoring use; Diffusion of practice.	<u>Use:</u> SDAM awareness creation; Cultivating knowledge sharing on SDAM; Monitoring usage of SDAM.	<u>Use:</u> Updating vehicle information; Updating fuel purchases information; Define implementation environment Awareness sessions/training; Vehicles tracking and monitoring; Report generation and analysis; Staff advocacy on behavioural management; Updating of vehicle information; Updating of fuel purchases information; System handover; Updating e-Log Book; Monitor vehicle utilisation.
		-	<u>Metastructuring:</u> Recognise UCC utility; Redefine the use and context of use; Shape green beliefs and attitudes.	-	-
		-	-	<u>Use Extension:</u> Recognise utility; Define new use; Setting up MyEarth portal; Populating the portal; Shaping green beliefs and attitudes; Diffusion of SDAM and MyEarth portal; Formation of Cols.	-

Category	Themes	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
		-	<u>Expand Functional Affordance:</u> Recognise utility of system to be expanded; Define new use; Shape green beliefs and attitudes.	-	-
		<u>Evaluation:</u> Intent to monitor and measure energy.	-	-	-
		-	-	-	<u>Use Discontinuance:</u> Service suspension and decommissioning.
	People	<u>Top management:</u> Indirect involvement from top management due to concerns on rising electricity costs.	<u>Top management:</u> Chief Technology and Innovation Officer (CTIO).	<u>Top management:</u> Group Chief Executive Officer (GCEO).	-
		<u>System owners:</u> Property Operations Department senior managers, managers and technicians.	<u>System owners:</u> IT Department senior managers and managers.	<u>System owners:</u> Group Corporate Communications managers; IT Department senior managers and managers.	<u>System owners:</u> Fleet Management Department senior managers and managers.
		<u>System developers:</u> Acadia R&D system developers.	<u>System developers:</u> Acadia R&D system developers.	-	<u>System developers:</u> Fleet Management Department developers, IT Department system developer; Finance managers; Acadia Geomatics system developers.
		<u>Vendors:</u> Building automation system vendors.	<u>Vendors:</u> UCC vendors.	<u>Vendors:</u> Microsoft.	<u>Vendors:</u> Fuel suppliers.

Category	Themes	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
		-	<u>Consultant:</u> Gartner.	-	-
		-	-	-	<u>Partner:</u> DG, Inc.
		<u>Environmental champions:</u> The system owners, the system developers.	<u>Environmental champions:</u> The system owners; the system developers, Green IT team members, Top management: Chief Technology and Innovation Officer (CTIO).	<u>Environmental champions:</u> The system owners, Top management: Group Chief Executive Officer (GCEO).	-
		<u>Other people:</u> Group Corporate Communications managers; Finance managers; Strategy managers; Quality managers.	<u>Other people:</u> Group Corporate Communications managers, UCC end users.	<u>Other people:</u> Sustainable Document and Application Management users; MyEarth portal users.	<u>Other people:</u> Fleet owners and drivers, Finance managers; Group Corporate Communications managers.

Table 6.4 - Cross-Case Summary for Innovation Process across the Four Green Information System Cases

6.2.4 The Outcome of Green Information System Innovation

The **outcome** of Green information system innovation, as identified in the Conceptual Framework discussion (refer Section 3.3.4 in Chapter 3), includes the themes of **eco-efficiency, eco-equity, and eco-effectiveness**. However, based on the data analysis of the empirical evidence, the outcomes of Green information system innovations are described from the emerging themes of **direct** and **indirect** outcomes. Direct outcomes include **environmental, economic, and operational** benefits, while indirect outcomes include **social** benefits and the **rebound effect**. According to Brandel (2006), direct benefits include observable measures like reduced head count or increased sales, and indirect benefits include returns that cannot be directly observed but are nonetheless realised - such as worker productivity.

The main *direct benefits* across the four Green information system innovations in Acadia were the *environmental, economic and operational* benefits. From the *environmental* benefits perspective, the Energy Informatics (Case 1) was found to have helped Acadia save electricity consumption and associated carbon emissions. However, for the other three innovations, the environmental benefits were not formally evaluated, hence, they are considered perceived benefits. These perceived environmental benefits include reductions in business travels and the associated carbon emissions (Case 2), savings in electricity consumption due to consolidation of contents and servers (Case 3), and reduction in carbon emissions from reduction in fuel consumption and related emissions (Case 4). Other benefits are summarised in Table 6.5.

Based on the cross-case analysis, the following section proposes two process models.

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
Outcomes	Direct	Environmental	<u>Emission:</u> Savings in electricity consumption and associated carbon emissions.	<u>Emission:</u> Savings from reductions in business travels and associated carbon emissions.	<u>Emission:</u> Emissions reductions from savings in electricity consumption.	<u>Emission:</u> Reduction in carbon emission from reduction in fuel consumption.
			<u>Strategy:</u> Showcases an eco-efficiency eco-goal, which is, being green and efficient, is possible. Acadia, in its 2010 and 2011 annual reports and in its 2009 and 2010 sustainability reports features ES2 as one of the main enablers in its cost savings and sustainability initiatives.	-	-	-
			<u>Engagement:</u> Using graphical data to illustrate high electricity consumption pattern, soliciting feedback and persuading employees to react accordingly was much easier compared to when no such data was available.	-	<u>Engagement:</u> Increase engagement with staff through their eco-participation in sustainability initiatives.	-

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmnt & Sharing System	Case 4 Fleet Management System
		Economic	<u>Cost:</u> Better estimation of the cost of electricity consumption for budgeting purpose.	<u>Cost:</u> Savings from reductions in business travels.	<u>Cost:</u> Reduction in electricity consumption; reduction in paper consumption and hence, reducing operational costs.	<u>Cost:</u> Reduction in fuel cost from better tracking of fuel consumption.
		Operational	<u>Technical:</u> Improved the control, monitoring and management of the building's air-conditioning system.	-	-	-
			-	-	-	<u>Efficiency:</u> Improved fleet management asset process; Better tracking of fleets and drivers' driving behaviours; Improved fuel payment process to fuel suppliers.
			<u>Informational:</u> Ease of access to electricity consumption data for preparing sustainability and annual reports.	-	-	-
			<u>IT:</u> Developing energy informatics systems development capacity.	-	<u>IT:</u> Ease of server and content management.	-

Category	Theme	Sub-Theme	Case 1 Energy Informatics	Case 2 Unified Communication & Collaboration	Case 3 Sust. Knowledge M'gmt & Sharing System	Case 4 Fleet Management System
	Indirect	Social	<u>Workplace:</u> Energy informatics used to maintain acceptable thermal comfort and conduciveness of the workplace.	<u>Workplace:</u> UCC is used to motivate change in daily work practice into more sustainable ones.	<u>Workplace:</u> Creation of sustainable work practices.	<u>Workplace:</u> Better sense of ownership of the fleets.
-			<u>Shaping of green beliefs and awareness:</u> UCC is used to shape green beliefs and increase environmental sustainability awareness among staff members.	<u>Shaping of green beliefs and awareness:</u> SDAM and MyEarth portal are used to shape green beliefs and increase environmental sustainability awareness among staff members.	-	
		Rebound Effect	-	-	<u>E-Waste:</u> Accumulation of abandoned, old servers.	<u>E-Waste:</u> Unused black boxes and RFID tags from the discontinued AVLS project.

Table 6.5 - Cross-Case Summary for Innovation Outcome across the Four Green Information System Cases

6.3 GREEN INFORMATION SYSTEM INNOVATION PROCESS MODELS

It is important that the linkage between the empirical results of a study and prior studies be established in order to improve internal validity, generalisability as well as to construct theories in any case study research (Eisenhardt, 1989). Furthermore, according to Lee and Baskerville (2003, p. 221), generalisability refers to “the validity of a theory in a setting different from the one where it was empirically tested and confirmed.” Therefore, when the findings support an emerging theory, confidence in its validity is enhanced, giving it wider generalisability and a higher conceptual level.

Based on the cross-case analysis discussed in Section 6.2, in order to enhance the validity of the findings and to generalise the findings to theory, two new and unique Green information system innovation process models have been developed: (a) Green Information System in Practice Innovation Process Model and (b) Green Information System in Spirit Innovation Process Model. Both of the models illustrate the complex relationships between contextual factors (internal and external), the innovation process (the phases, stages, events, and people) and the innovation outcomes. The main characteristics of the two models are presented in Table 6.6.

Characteristic	Green Information System in Practice	Green Information System in Spirit
Strategy	Exploit	Explore
Focus	Metastructure and/or extend use and/or expand functional affordance of existing information system	Develop new information system
Typical innovation stages	Recognise utility, Metastructure, Extend use, Expand functional affordance, continuous use, green benefit realisation.	Green intention, functional specification, development and implementation environment, faithful appropriation, continuous use, green benefit realisation.
Case Examples	Unified Communication and Collaboration; Sustainable Knowledge Management & Learning System; Fleet Management System	Energy Informatics

Table 6.6 - The main characteristics of Green Information System in Spirit and Green Information System in Practice Innovation Models

The following sub-sections theorise in greater detail the new innovation process models.

6.3.1 Green Information System in Practice Innovation Process Model

Although information systems have a relevant role in facilitating the transformation of organisations into more sustainable businesses, there are relatively few organisations that innovate information systems for environmental sustainability (Elliot, 2011; Melville, 2010). It was also argued that organisations do not fully exploit ICT's potential in their efforts to achieve environmental sustainability (Pernici, et al., 2012), although some organisations such as Telecom Acadia, as exemplified in this research, are using their existing information system to achieve environmental sustainability. Thus, since the existing information system was not conceived with environmental considerations, or “green spirit”, the point of emergence of the green consideration occurs during technology in use (DeSanctis & Poole, 1994; Ijab, et al., 2010; Orlikowski, 1992).

For information system innovations with these characteristics, we called this innovation model as the **Green Information System in Practice Innovation Process Model**. This process model is based on the information system exploitation strategy. Information system exploitation deals with efficient employment of current assets and capabilities (March, 1991; Nooteboom, 2004). According to March (1991), the concept of exploitation includes terms such as refinement, choice, production, efficiency, selection, implementation, and execution. The idea of exploitation is also aligned with Orlikowski (1996), who argues that individuals and organisations often use IT systems and technologies different from the intentions or goals of their designers.

The Green Information System in Practice Innovation Process Model consists of the following innovation stages:(a) recognising the potential “green” utility of the system; (b) metastructuring; (c) extending use; (d) expanding functional affordance; (e) continuous use; and (f) green benefit realisation as shown in Figure 6.1.

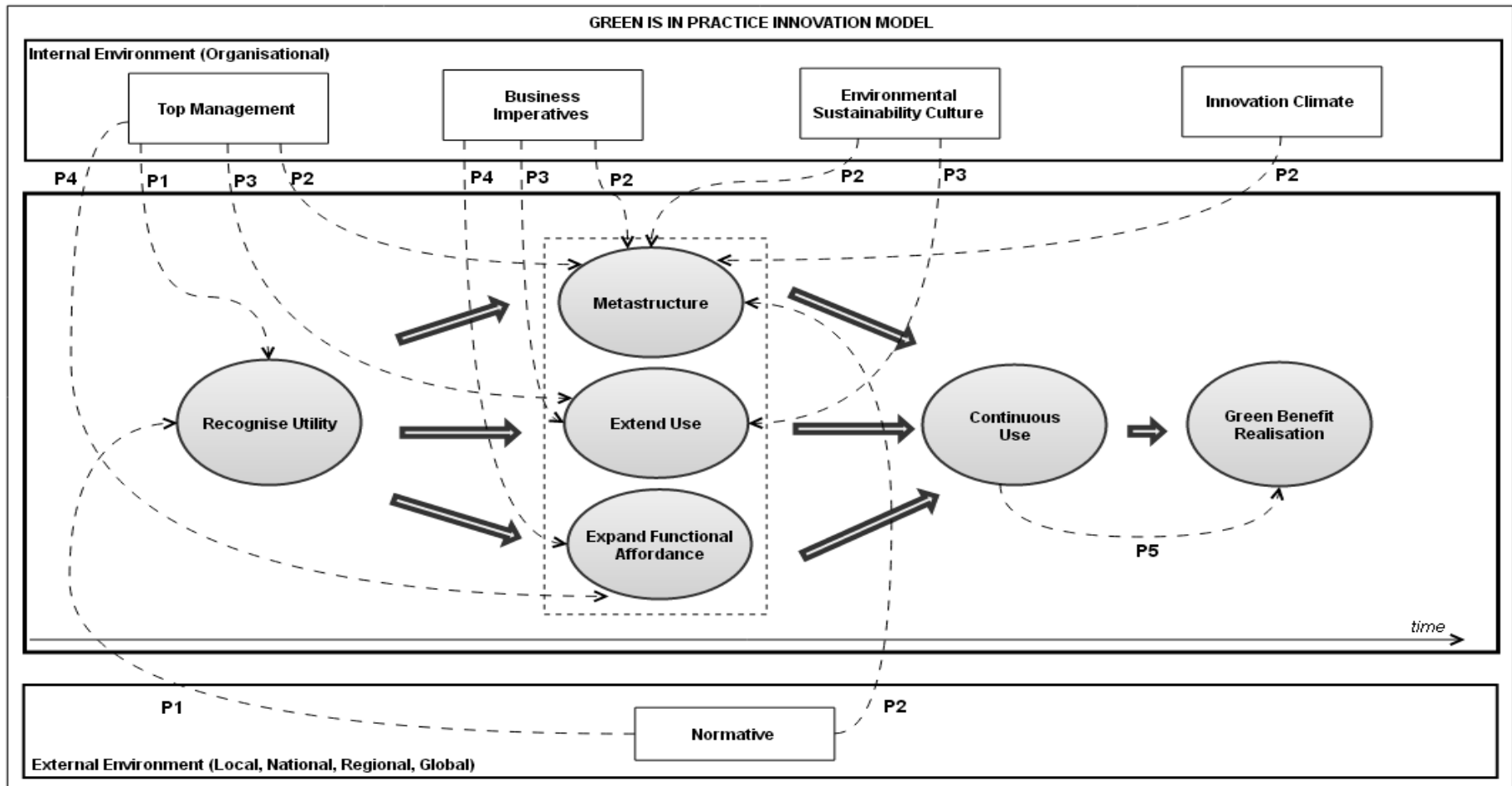


Figure 6.1- Green Information System in Practice Innovation Process Model

6.3.1.1 Recognition of the utility

Recognition of the utility of the information system takes place when organisations recognise the usefulness of an existing system for other benefits beyond what the system was initially intended for (Dey, Abowd, & Wood, 1998; Sharman, 2007; Vanier, 2004; Watson, Boudreau, Li, et al., 2010). The importance of recognising the utility of the existing information system has been discussed and supported in the IS literature, such as in the works of Dey et al. (1998) who applied the utility recognition of self-integrating software driven by the use context. In their research, CyberDesk, a framework for self-integrating the behaviour of a number of software applications, was proposed. The CyberDesk framework relieved the burden on programmers by removing the necessity to predict how software should be integrated, as well as relieved the burden on users by removing the need to understand how to make different software components work together. Vanier (2004), who studied Geographic Information Systems (GIS), argued that GIS was not a new innovation as it has a long history of usage in civil engineering applications. GIS was used mainly as a visualisation tool and not as an integrated component of the engineering solution. Vanier (2004) discovered that municipalities in Canada were recognising the utility and benefits of spatially related data (i.e., the GIS innovations) to manage their municipal infrastructure asset management beyond the original uses of GIS.

Sharman (2007), on the other hand, opined that while nurses recognise the utility of clinical technologies in the field of medical informatics, they perceive them differently from their administrative counterparts. The nurses were found to consider technology as a good tool but it cannot be the only tool. It was claimed that the strongest tools are the nurses' own embodied knowledge and their personal capabilities (i.e., skills and caring ability). In the case of telematics at UPS, according to Watson et al. (2010, p. 10), "UPS's Roswell team recognised that there was an untapped digital data set - the data collected everyday by each truck's built-in automotive bus. The team could envisage some potential uses of this data and decided to build a system to capture it." This demonstrated how the top management and system owners of UPS have created and exploited opportunities (i.e., by recognising the utility of the existing system or untapped digital data set) for environmental sustainability purposes.

Recognising the utility of an existing information system for environmental sustainability is also influenced by **external normative** influence exerted by the external consultant engaged by the IT Department of Acadia who introduced the Green information system and Green information technology solutions to Acadia's IT managers. At the same time, an internal factor such as **top management** is also driving the recognition of the utility of the information system. In the Unified Communications and Collaboration (Case 2), the norm setting top managers and environmental sustainability champion have driven the identification and recognition of the UCC for supporting Acadia's environmental sustainability purposes. This finding is consistent with Meyer (2000), Nedbal et al. (2011) and Bose and Luo (2011) who claimed that any innovation (in this case including Green IT/IS initiatives) requires support from the organisation's top management and champions who recognise the usefulness of the existing system to the organisation, then leads authority and resources for the re-appropriation of the identified system for sustainability uses. Beath (1991) and Bose and Luo (2011) also found that champion support can facilitate the recognition of the utility of existing information systems by providing the necessary drive and effort to initiate this utility recognition process.

Based on the above discussion, the following proposition is put forward:

Proposition 1: The recognition of the utility of the existing information system for environmental sustainability purposes are more likely to be driven by both external and internal factors such as the normative influence from the external consultants and the top management's leadership.

6.3.1.2 Metastructuring, use extension, and expansion of functional affordance

Once the organisation recognises the utility of their existing information systems for environmental sustainability, the new utilisation (or appropriation) can be in the forms of **(i) metastructuring; (ii) use extension; or (iii) expansion of functional affordance.**

Metastructuring in the context of this thesis involves re-contextualising and redefining the meaning of information system innovations for supporting environmental sustainability without having to develop or to purchase new systems as demonstrated in

the Unified Communications and Collaboration innovation (Case 2). According to Pozzebon (2000), metastructuring existing systems entails the appropriation of the same technology in diverse ways and coming up with different meanings and effects for different users. It was also argued that other users (besides end users) act as mediators as they modify the technology and the institutional environment through their explicit (and sanctioned) actions, and thus influence the technical and institutional contexts in which individual-level structuring occurs (Orlikowski, et al., 1995). Foster and Heeks (2013b, p. 15) named this concept as “domestication” where changes are not just the practical but also the “symbolic” and cognitive dimensions in the selection, deployment, and adaptation of new technologies. In this research, Acadia metastructured the Unified Communications and Collaboration (Case 2) to support Acadia’s internal need for sustainable communications and collaboration. As discussed in Chapter 5 (Section 5.4.4.2), the metastructuring of the UCC was influenced by **business imperatives** (i.e., internal strategy, resource, and staff), **top management** (i.e., leadership), **environmental sustainability culture** (i.e., the culture of adopting the UCC for sustainability practices) and **innovation climate** (i.e., capability to create), as well as the **normative** pressures exerted through the vendor and consultant’s influences. The case of UCC metastructuring in Acadia is consistent with Orlikowski et al.’s (1995) metastructuring concept which was used to explain how users re-contextualise general purpose computer-mediated communication technologies (CMCs) and how their actions can result in institutional changes in practices. The work of Scheepers (2003) on the metastructuring of the Intranet as an electronic messaging system and the dynamic roles of various key people, namely the technology champion, organisational sponsor, Intranet coordinator, Intranet developer and content provider in the metastructuring process, provided additional literature support to our theorisation of the metastructuring process of UCC in Acadia.

Based on the above discussion, the following proposition is put forward:

Proposition 2: The metastructuring of the existing information system for environmental sustainability is more likely to be driven by internal factors such as top management, business imperatives, environmental sustainability culture, and innovation climate as well as the external factor of normative pressure.

The second option that organisation can have to exploit an existing information system for environmental sustainability is through **use extension**. **Use extension** refers to how an existing system is extended to cover new potentials that are not recognised earlier by system developers or the organisation (Barley, 1986; Green, 2003; Lassen & Simonsen, 2014; Orlikowski, 1992). Under use extension, the technology remains the same, however, its uses are extended to cover new potential (such as managing and sharing sustainability information) instead of just for operational uses. Foster and Heeks (2013) called this situation “use variations” because the system provides variations from the anticipated uses of the technology. In this research, the Group Corporate Communications Division together with the IT Department and the vendor extended the existing Intranet portal platform (Case 3) by creating a sub-portal called MyEarth portal. This is in fact a creative way of using an existing technology platform to disseminate and share as well as engage the staff members on environmental sustainability. Acadia’s use extension of their Intranet portal for the sustainability purpose were driven by mostly internal drivers, namely **top management** (i.e., leadership), **business imperatives** (strategy, resource, system, style) and **environmental sustainability culture** (i.e., the culture of environmental knowledge sharing via forums). For example, the strategy of enabling environmental awareness and education campaigns had driven the use extension and the use of crowdsourcing for sustainability materials was used to increase the green shaping capability. The style used to propagate green culture was through awareness programmes such as via email broadcasts, road tours held by the Group Corporate Communications Division and an event called “Productivity Day”.

The use extension in Acadia is consistent with the practical examples of use extension exemplified in the works of Green (2003) and Lassen and Simonsen (2014). Green (2003) investigated the adoption rationale and post-adoption activity of Electronic Data Interchange (EDI) in ten organisations. The study found that organisations extended their EDI use and activity to cover customers’ activities as well. The reasons for the use extension were found to be internally and strategically driven as to reduce transaction handling and personnel requirements (Green, 2003). Meanwhile, in the work of Lassen and Simonsen (2014), they investigated the use extension of the electronic whiteboard (EW) system in a hospital setting. The EW system had originally been developed for the emergency department but had later been extended to be used in the entire hospital. The study highlighted the internal needs for the coordination of inter-departmental ordering of

surgical operations via the EW system. The results showed that the EW system had been configured and its use was organised in a manner that facilitated the support of inter-departmental coordination of work (Lassen & Simonsen, 2014).

Based on the above discussion, the following proposition is suggested:

Proposition 3: The use extension of the existing information system for environmental sustainability is more likely to be driven by internal factors such as top management, business imperatives, and environmental sustainability culture.

Organisations may also **expand the functional affordance** of an existing information system for supporting any environmental sustainability initiative. Expanding functional affordance refers to the addition of extra functional affordance (i.e., features) to an existing software to make the information system more meaningful and more effective in achieving the intended goals (Markus & Silver, 2008). According to Green IS researchers, identifying functional affordances of information system innovations that relate to the goal of establishing environmentally sustainable work practices assists in understanding how Green information system can be designed to aid tackling sustainability challenges such as energy consumption, waste reduction, resource utilisation, or emission management (Dedrick, 2010; Melville, 2010; Seidel, et al., 2013; Watson, Boudreau, & Chen, 2010).

Based on Acadia's evidence, the expansion of the functional affordance of an existing information system to create and/or apply Green information system innovations can be influenced by internal factors namely **top management** (i.e., leadership), and **business imperatives** (i.e., resource, and technology). It was revealed that Acadia, via one of its key champions (i.e., the Chief Technology and Innovation Officer, CTIO), was proposing for the SCC to be expanded by introducing new feature (i.e., high-definition TelePresence service). While the existing SCC does have a desktop video conferencing capability, it was argued that a full featured TelePresence would provide a more appealing video conferencing experience, one that is seamless and fully interactive. The expansion is also to provide an alternative experience and ultimately to replace conventional face-to-face meetings (a common practice in Acadia). Moreover, as claimed by Hasan et al., (2014, p.

103), “the use of collaboration tools and teleconferencing systems will further demonstrate the viability, effectiveness and environmental footprint of such activities, particularly in reducing the reliance on travel.” The above discussion shows that the internal motivation by a single champion (i.e., the CTIO) who has the power and ability to set norms, along with the availability of resources (IT managers with stock Green IT knowledge) and technology (the existing application) are able to drive and shape an organisational environmental sustainability initiative.

Based on the above discussion, the following proposition is put forward:

Proposition 4: The expansion of functional affordance of the existing information system for environmental sustainability is more likely to be driven by internal factors such as top management and business imperatives.

6.3.1.3 Continuous use and green benefit realisation

After having accepted and used the innovation over a certain period of time, individuals evaluate the innovation and begin forming beliefs about the innovation’s advantages, taking into account technological, organisational and environmental factors that represent antecedent and contextual factors of the information system adoption (Hameed, Counsell, & Swift, 2012; Rogers, 1983; Sorgenfrei, et al., 2014). Saga and Zmud (1994) operationalised behaviour during the acceptance stage as frequency and duration of use, which in this research is called “**continuous use**”. Additionally, Rogers (1983) posited that in the post-acceptance stage, users seek confirmation about their initial acceptance decisions and may either reverse their initial adoption decisions or **continue to use and derive benefits** from an innovation. In order to use the innovation effectively, users integrate and deeply embed the technology as part of their work processes (Saga & Zmud, 1994). The continuous use of the telematics project at UPS, for instance, had illustrated the realised green benefits which fall under three areas: social, environmental, and financial (Watson et al., 2010). From the social benefit perspective, the use of the telematics system had increased the safety of truck drivers through the monitoring of their safe driving habits, environmental benefits from the reduction of mileage, fuel consumption, and replacement parts; and the financial benefit was from the overall

reduction in energy consumption (Watson et al., 2010). Besides that, Melville and Whisnant (2012) also reported that the continuous use of an environmental ERP at SunGard had resulted in a better environmental strategy in shaping beliefs, shifting cultures, and enabling new environmental objectives.

The above literature and the findings of this research supported the claim made by Seidel et al. (2013, p. 1293), who argued that “... positive consequences in terms of more environmentally sustainability practices emerge when individuals interpret information systems as providing sense-making and sustainable practicing affordances, and then realise them.”

Based on the above discussion, the following proposition is put forward:

Proposition 5: The realisation of green benefits in the organisation is directly affected by the continuous use of Green information system innovation by the system users.

The next subsection discusses and theorises the Green Information System in Spirit Innovation Process Model.

6.3.2 Green Information System in Spirit Innovation Process Model

Green information system innovations created under a “Green Information System in Spirit” approach are generally based on an information system exploration strategy as stated in Table 6.6 (Section 6.3). Exploration is concerned with the development of new assets and capabilities (March, 1991) and is emergent in nature (Galliers, 2011). It includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, and discovery. In a nutshell, Green information system innovations in spirit are new systems and conceived with the green “spirit” (Ijab et al., 2010). Typically, they follow the stages of (a) green intention and belief formation; (b) green functional specification; (c) green development environment; (d) green implementation environment; (e) faithful appropriation; (f) continuous use; and (g) green benefit realisation. The depiction of the Green Information System in Spirit Innovation Process model is shown in Figure 6.2.

6.3.2.1 Green intention and belief formation

Green intention and belief formation is the first stage in the conception of the Green Information System innovation proposed in the Green Information System in Spirit Innovation Process Model. Datschefski (2001) asserted that sustainability can be achieved partly through design and this view is supported by other researchers including Murugesan (2008), Brooks et al. (2012), and Jena (2013). Therefore, in ensuring that technologies are **intentionally designed** with green” “spirit”, environmental concerns should be given during the design and development processes (Huang, 2009; Ijab et al., 2010; Zhang et al., 2011). Hence, the way designers or system developers view their tasks, particularly when designing and developing information systems for today’s organisations, needs to be reoriented towards designing environmentally sustainable systems (Watson et al., 2010).

In the context of Acadia’s Energy Informatics (Case 1) innovation, the green intention and belief formation was formed during the conception stage. Internally, when the ES2 was conceived, the main intention of the **top management** was to address the electricity issue as the top agenda among the company’s leadership. From the **business imperatives**

perspective (i.e., the strategy-aspect), the Property Operations managers put forth a strategy to reduce Acadia's electricity consumption from the air-conditioning, which was claimed to consume 60% of the company's total electricity bill. The other internal factor was the **innovation climate** whereby Acadia R&D was recognised as having the capability, know-how and experience in developing integrated building management systems.

Also, the green intent and belief formation was influenced by the external factors in the forms of **normative** and **coercive** pressures (Butler, 2011; Scott, 1994, 2010) exerted from external institutions such as the government, IT market, and consultant which was evidenced in Acadia's Energy Informatics (Case 1), the Unified Communications and Collaboration (Case 2) and the Fleet Management System (Case 3) innovations. The findings of this research supported Berrone, Gelabert, and Fosfuri (2007) who claimed that coercive and normative forces influence the companies' propensity to innovate in environmental-related projects. Furthermore, it was argued that this relationship (i.e., institutional pressures and environmental innovation) is contingent on the availability and specificity of the companies' resources (Berrone et al., 2007). Other researchers in the Green IT/IS field such as Daly and Butler (2009), Kuo and Dick (2010), Molla and Abareshi (2012) and Brooks et al. (2012) also found that factors such as the influence of top management, business imperatives (or called bottom line considerations), and normative and coercive legitimation pressures influenced the extent of Green information system adoption in organisations. Thus, the above discussion lends support to Seidel et al. (2013), who posited that sustainability transformations are not purely motivated by economic imperatives only, but also driven by a complex net of normative, and coercive pressures. This led us to the next proposition:

Proposition 6: The normative and coercive pressures from the external, combined with the internal factors of top management, business imperatives, and innovation climate are the triggers that shape the Green intention and belief formation of the Green information system.

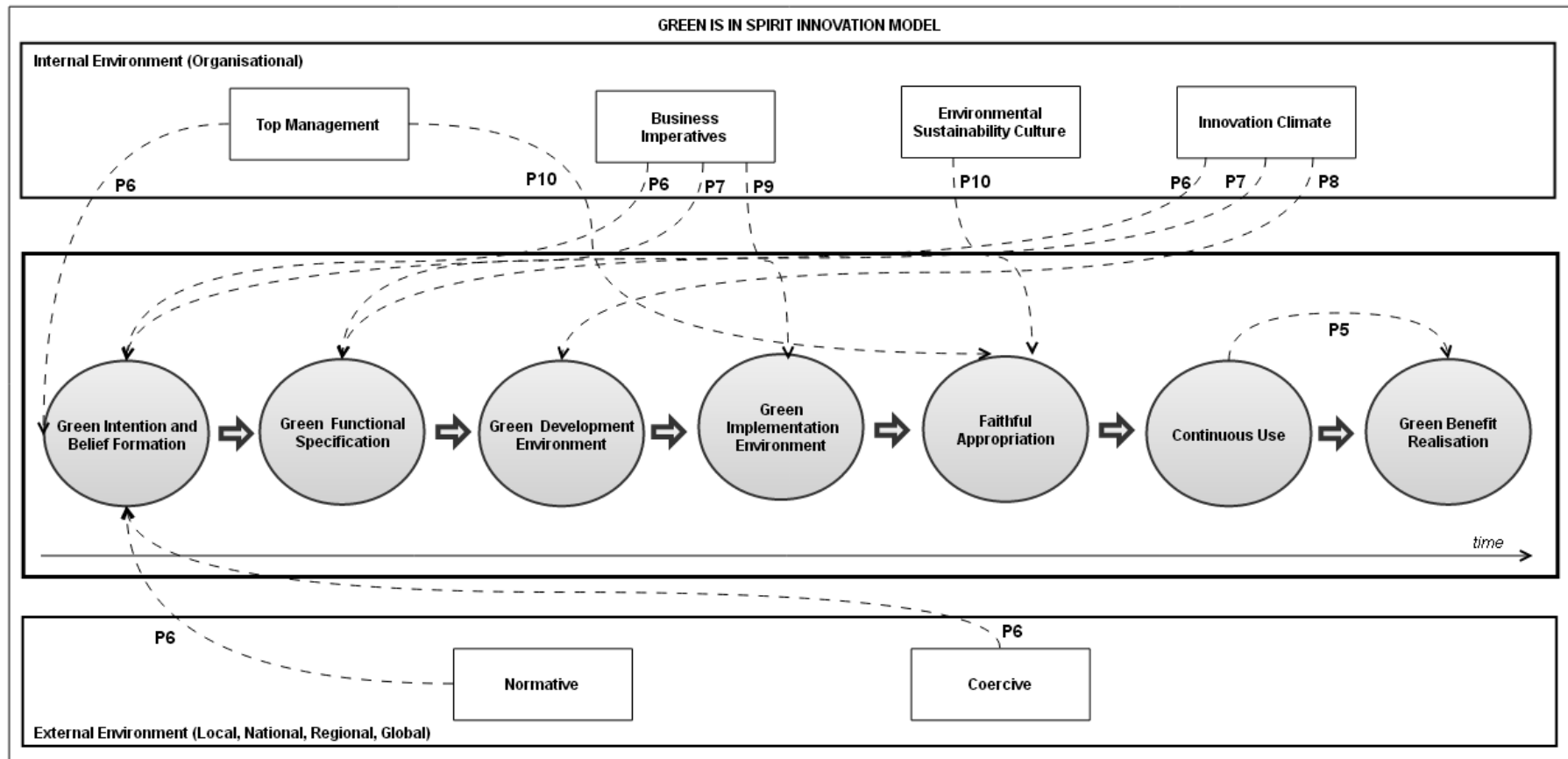


Figure 6.2 - Green Information System in Spirit Innovation Model

6.3.2.2 Green functional specification

The next stage in the Green Information System in Spirit Innovation Process Model is the **green functional specification**. Green functional specification refers to an explicit green specification or the expected software feature to be built on the information system artefact (Zhang et al., 2011). For managers and system developers who already have a positive belief in the natural environment, one of the first actions from the belief formation comes in the form of specifying and including the green functional specifications for the software being developed. In the Energy Informatics (Case 1), the system developers for ES2 had a specific functional goal to reduce the Chilled Water Pump (CWP) motor speed to half of its original speed without compromising on the thermal comfort level. Moreover, the configuration of the CWP motor speed can be done from the computer screen and mobile device connected to the secure Internet website. The goal of reducing the CWP motor speed thus leads towards the achievement of “lower electricity consumption” achieved in Case 1. This is consistent with Zhang et al.’s (2011) idea of soft goals in information system functional specifications. The examples of soft goals inscribed in a new system supporting environmental sustainability are “Low GHG Emissions” and “Low Electricity Consumption” (see Zhang et al., 2011 for details). Zhang et al. (2011) also argue that environmental objectives should be handled, particularly as non-functional requirements in the development phase of information system artefacts.

In addition, according to Capra, Francalanci, and Slaughter (2012), although software does not directly consume energy, by specifying green functional requirements, a small reduction of Central Processing Unit (CPU) usage can be obtained by running greener software and hence, provide energy savings. Based on the findings in the Energy Informatics (Case 1), the **business imperatives**’ strategy (i.e., the alignment of the Energy Informatics innovation with the R&D Technology Roadmap strategy) and the **innovation climate** (i.e., the capability of the Acadia R&D system developers in terms of knowledge or know-how) gained through reading technical reports or journals, attending trainings, seminars and technology exhibitions lead them in embedding these sustainability aspects in the functional specifications. The above discussion thus brought us to the next proposition:

Proposition 7: The inclusion of Green functional specification into the Green information system is more likely to be driven by business imperatives and the innovation climate exerted through the capability of system developers who are knowledgeable on the topics of sustainable information system development.

6.3.2.3 Green development environment

During the system development, system developers are able to introduce various ways to ensure the information system is developed within the **green development environment**. For example, developers can consciously write energy efficient codes, reuse existing codes and write reusable codes as part of their **sustainable system development practices** (Huang, 2009). Within the development environment, in order to minimise electricity consumption, the developer team is able to use energy-efficient equipment such as LCD monitors instead of CRT monitors, or the use of laptops instead of desktop computers are able to reduce electricity consumption during system development (Huang, 2009).

In the Energy Informatics (Case 1), the **system developers** were using their **knowledge** on open source development tools such as Java and PHP, web-based delivery of the ES2 system, and the data is stored on a free database solution, MySQL. The practice of the ES2 system developers is consistent with the potential of open source use in system development to reduce dependency on proprietary system development environment (Boudreau, et al., 2007; Sissa, 2013). Open source also provides the agility to the system development, resulting in faster time project completion. Furthermore, IS researchers argue that open source development provides an example of Green IS Development (Green ISD), whereby physical boundaries are transcended, tangible resources are replaced with electronic resources, and eco-effectiveness is embedded throughout the product lifecycle (Hasan, et al., 2014; Watson, Boudreau, York, Greiner, & Wynn, 2008). Therefore, similar to the green functional specification discussed in Section 6.3.2.2 above, the green development environment is also internally motivated by the organisational **innovation climate**.

Based on the above discussion, the following proposition is put forward:

Proposition 8: The internal innovation climate affected system developers' extent of knowledge on sustainable system development practices and influenced how the Green development environment is defined.

6.3.2.4 Green implementation environment

The next stage in the Green Information System in Spirit Innovation Process Model is the **green implementation environment**. This stage involves activities that can be instilled with sustainability values during the testing, installation, system migration and user training (Huang, 2009). While the Energy Informatics (Case 1) did not mention the types of system testing conducted, yet, tests related to sustainable systems should include an energy consumption test, response time test, and other tests of efficiency (Huang, 2009). Additionally, Huang (2009) argued that although the information system is developed for sustainability, if it is not properly installed, the objective would not be achieved.

For instance, in the Energy Informatics case, while the ES2 is able to help reduce electricity consumption, if the system is not properly installed and configured, the existing Air-Conditioning and Ventilation System (ACVS) would take over and run the system as normal (i.e., without the capability of setting a configurable CWP motor speed). User training is another aspect of green implementation environment. Within the systems training to users, the users need to be provided with the background information on the importance of energy (both electricity and fuel) conservation, and foster habits that save energy such as by turning off the equipment when the system is not used at the end of the work day (Huang, 2009). Acadia's IT Department in its Green IT initiative was in the process of devising a Green Procurement Policy which will enforce green buying practices. For example, for the purchase of new computers and network equipment, consideration must be taken on buying products that are Energy Star compliant. The new procurement policy will also make use of EPEAT audit checklists throughout the procurement practice to ensure the equipment purchased is made from non-toxic materials, are energy efficient in use, and have after-life support programmes such as take-back support from the vendors or manufacturers (Butler, 2011; Ijab, et al., 2012; Zhang, et al., 2011). The points of discussion above indicate that the internal **business imperatives** play a crucial role in influencing the system developers and system owners to adopt a green implementation environment. Hence, the next proposition is put forward:

Proposition 9: Green implementation environment is more likely to take place if internal business imperatives exist, such as a green purchasing policy and system implementation guidelines that focus on the deployment of energy efficient hardware such as servers and network equipment.

6.3.2.5 Faithful appropriation

Based on the evidence from the Green information system innovation cases, all Green information system innovations were **faithfully appropriated** by the system users as intended by the system developers and system owners. The idea of faithful appropriation is consistent with DeSanctis and Poole's (1994) analysis of technology appropriation. They suggest three constructs that indicate the levels of appropriation, namely (i) faithfulness (in relation to the structure's design principles); (ii) the group's attitudes towards the structures; and (iii) level of consensus. Faithful appropriation of the Green information system innovations can lead to competence in using the Green information system for achieving environmental sustainability goals (de Medeiros, Riberio, & Cortimiglia, 2014). According to Chen (2007) and de Medeiros et al. (2014), proactive managers and staff members with a contingency view of the business that are able to create products and processes, gained through various means. Examples of the means are awareness of the existence of the created information systems through user training and demonstrations of the functionality and usefulness of the systems in supporting environmental goals, which were also evidenced to have occurred in Acadia. This indicates that the internal **environmental sustainability culture** is inculcated and encouraged among staff members, thus leading to the faithful appropriation of the Green information system innovations.

Other researchers such as Hallstedt, Ny, Robert, and Broman (2011) claimed that faithful appropriation of green innovation requires the complete incorporation of an environmentally sustainable vision in all areas of the organisation, as well as the internal availability of incentives for this approach. While there was no evidence of incentive giving occurring in Acadia for the staff members to use the information system for environmental sustainability purposes, evidence showed that the **top management** who

provide green leadership encouraged their subordinates to use the UCC (Case 2) in supporting their daily work. This leads us to the final proposition:

Proposition 10: Users' faithful appropriation of the Green information system is affected by the environmental sustainability culture, as well as the extent of the top management's green leadership.

The **continuous use** and the **green benefit realisation** stages in the Green Information System in Spirit Innovation Model follow the fifth proposition (see Section 6.3.1) as these two stages are similar and applicable for both Green information system innovation process models proposed in this thesis.

6.4 CHAPTER SUMMARY

This chapter has presented the discussion about the overall findings of the research. It discusses the two Green information system innovation process models in organisation – namely the Green Information System in Practice Innovation Process Model and the Green Information System in Spirit Innovation Process Model. Emphasis was given to the strategy, focus, typical stages, facilitating factors and case example(s) for each of the innovation models. In the theory-building process undertaken in this research, theoretical propositions were made based on whatever emerged from the data. These propositions are able to be tested and verified in another qualitative research, or tested statistically in quantitative-based research undertakings. In the next chapter, the overall conclusion to this research is offered.

CHAPTER 7 : CONCLUSION

7.1 INTRODUCTION

IS researchers and practitioners must consider process-related concepts when examining the role of information systems in the transformation towards sustainable organisations (Seidel, et al., 2012). This allows not only a better understanding of the transformative power of technological systems in the context of sustainable development (Elliot, 2011; Melville, 2010), but also progress towards more prescriptive and normative advice that can aid and guide the implementation of sustainable, IT-enabled business processes (Seidel, et al., 2012). In line with the arguments by Seidel et al. (2012), this research has taken a process perspective to explain Green information system innovations.

The purpose of this chapter is to provide a summary of the key findings by revisiting the research questions and the conceptual framework. The chapter also covers the contributions and limitations of the research, and areas for further research, along with final concluding remarks. The remaining part of the chapter is organised into five other sections. Section 7.2 offers a high level summary of the research. Section 7.3 revisits the three research questions formulated in this thesis. Following that, the theoretical and practical contributions of this thesis are presented in Section 7.4. In Section 7.5, the limitations of this study are described and avenues for future research are suggested. The chapter is summed up with concluding remarks in Section 7.6.

7.2 OVERVIEW OF THE RESEARCH

The premise of this research is based on the fact that (i) there is limited clarity in terms of the motivations for pursuing Green information system innovation; (ii) lack of understanding about the detailed Green information system innovation process; and (iii) limited understanding of the benefits or outcomes of Green information system use for environmental sustainability. Thus, it is important to identify the motivating, driving, and

influencing factors from the internal and external forces' point of view, to understand the detailed innovation process and what the process entails, as well as to explore the outcomes from Green information system innovation.

The study was carried out to address three questions. It was conducted based on a literature review of IS, Green IS, organisational innovation and sustainability areas. The conceptual framework was developed based on Pettigrew's (1990) contextualist and processual theory of organisation change. The theory is relevant for analysing the innovation process in organisations as it provides the tools to focus on the "*what, why and how*" of change such as information system evaluation (Stockdale & Standing, 2006). Empirically, a qualitative research design involving 44 semi-structured interviews, 30 organisational documents and a descriptive survey of 150 respondents was followed. It was implemented in two phases, in one organisational setting investigating four Green information system innovation cases. Data was analysed using thematic coding as per Boyatzis (1998) and Braun and Clarke (2006).

7.3 REVISITING THE RESEARCH QUESTIONS

Green information systems can enable and enhance organisations' transitions towards sustainable practices. While the innovation process is widely discussed in the management and IS fields, there is limited research on how Green information systems are being created and/or applied from a process perspective. Particularly, an analysis of what is Green information system innovation and how organisations create and/or apply Green information system innovation, the factors and forces that affect the process of innovation as well as the outcome of innovation are lacking from current IS and Green IS literature. Such a study is important for advancing IS-enabled environmental sustainability strategies, processes and practices, and is therefore identified as one of the goals for IS researchers. This thesis set out to contribute to the Green information system innovation process literature by answering three research questions:

Question 1: What is Green information system innovation and why do organisations create and/or apply Green information system innovation?

The question was raised to understand the real motivations for organisations to create and/or apply information systems that have the capabilities to minimise environmental sustainability impacts. Initially, based on the conceptual framework (refer Section 3.3.2 in Chapter 3) and drawing from institutional and organisational innovation theories, we anticipated that external mimetic, normative and coercive pressures as well as internal factors of top management, business imperatives, environmental sustainability culture, and innovation climate are driving organisational Green information system innovations.

The findings of this research **confirmed** that organisations are indeed under different institutional pressures when innovating new systems (i.e., exploring new systems) or making use of existing innovations (i.e., exploiting the readily available information systems) for environmental sustainability. These pressures are the normative and coercive forces exerted by various external entities such as the government, IT market, vendors and partners, as well as technology consultants. There also exist internal drivers including the top management's leadership, business imperatives (i.e., strategy, resource, systems and technology, policy and practice, and staff), environmental sustainability culture as well as innovation climate within the organisation. These points are further emphasised in our proposed Green Information System in Practice Innovation Model and Green Information System in Spirit Innovation Model along with ten theoretical propositions made in Section 6.3 of Chapter 6.

However the findings **did not support** the existence of mimetic pressure in the context of Acadia. This is probably a localised situation and specific to Acadia's case only. Based on the experience of the researcher, the reason behind this circumstance can be attributed to the lack of large organisations within the same industry as Acadia (i.e., the competitors) who are innovating in Green information systems. Therefore, there are limited numbers of local organisations for Acadia to mimic as to ensure the mimetic forces were taking place during the study of Acadia's Green information system innovations. In addition, as Acadia did not carry out any benchmarking studies of Green information system undertakings by regional and international telecommunication firms, the mimetic forces were evidently absent in this research.

Question 2: How does the Green information system innovation process take place in organisations?

This question was raised as there was limited understanding from the current literature regarding the process of Green information system innovation. To address the question, we draw from the process theory of innovation which implied a thorough investigation of stages, critical events, key people, and time as stated in the conceptual framework discussion in Section 3.3.3 of Chapter 3.

The findings of this research are **consistent** with the literature in terms of understanding the process of innovation from the perspectives of phases, stages, events and key people. This research also **extended** the literature by discovering the various dimensions to comprehensively explain the process of Green information system innovation. For example, in discussing the phases of Green information system innovation, we found that the phases are more representative when seen from the dimensions of “When”, “What system”, “Developers”, “Target users”, “Cost”, “Development environment”, “Key operational challenges/problems”, “Key environmental problems”, “Functions”, and “Key benefits”.

Furthermore, it is found that the stages of Green information system innovation are not necessarily following the linearity of typical innovation stages of conception, development, implementation, and evaluation as earlier identified. However, the innovation stages in Green information systems are more varied due to the consideration of the content of the Green information system, discussed in this research from the perspectives of “spirit”, “interpretive flexibility” and “types of Green information system” (see Section 3.3.1 in Chapter 3). This research **discovered** that the innovation stages can be further seen from the “metastructuring”, “expansion of functional affordance”, and “use extension” stages. These use variations transpired depending on how the users consider and use the Green information system innovations during their daily practices of using these systems.

In terms of the “events” taking place in a Green information system innovation process, the research **extended** and **offered new insights** into the Green information system innovation literature by identifying the various events taking place during the innovation

process, namely (i) problem recognition and definition; (ii) intention to adopt information system; (iii) intention to incubate information system; (iv) recognise utility; (v) project scoping; (vi) define functional requirements; (vii) decide development environment; (viii) evaluate sourcing option; (ix) decide sourcing option; (x) decide implementation environment; and (xi) develop the information system. While these innovation events are considerably applicable to all information systems, when they are adopted in the context of Green information system innovations, the detailed activities within the events would be different. For example, during the development of a new Green information system innovation, the event of “define functional requirements” would be turned into “define green functional requirements” as to provide emphasis on the infusion or inscription of the green “spirit” into the information system. Lastly, in this study, the “people” perspective of the Green information system innovation process is more comprehensively seen from the many roles the key people play during the innovation process, namely top management, managers, system developers, system owners, system users (departmental and/or organisational), consultants, vendors and partners.

Next, this research **extended** the literature on the Green information system innovation process by offering **new insights** on how the Green information system innovation process can be modelled and explained using ten theoretical propositions discussed in Section 6.3.1 and Section 6.3.2. The two new and unique Green information system innovation process models proposed in this research are (i) the Green Information System in Practice Innovation Process Model; and (ii) the Green Information System in Spirit Innovation Process Model. For the Green Information System in Practice Innovation Process Model, it provides a unique classification of innovation stages consisting of (a) recognising the potential “green” utility of the system; (b) meta-structuring; (c) extending use; (d) expanding functional affordance; (e) continuous use; and (f) green benefit realisation. For the Green Information System in Spirit Innovation Process Model, the unique classifications of the innovation stages are identified as (a) “green intention and belief formation”; (b) “green functional specification”; (c) “green development environment”; (d) “faithful appropriation”; (e) “continuous use”; and (f) “green benefit realisation”. The accompanying theoretical propositions are used to explain how the Green information system innovation, either in practice or in spirit, is more likely to take place in the real context of an organisation.

Question 3: What are the outcomes from the Green information system innovation process?

This research question was raised because the relationship between the use of technology and the broader eco-sustainability goals is not well understood (Berkhout & Hertin, 2004). Many studies focus on the adoption and diffusion of information systems without differentiating their environmental impact (Chen et al., 2008). To address the question, we draw from the outcomes of innovation literature which implied that the outcomes of innovation are commonly captured as eco-effectiveness, eco-equity, and eco-efficiency, mentioned in the conceptual framework discussion in Section 3.3.4 of Chapter 3.

Based on the findings of this research, although hard quantitative data is not available, anecdotal evidence shows that the Green information system innovations made ISO 14001 compliance easier; increased the quality of data for sustainability reporting; maintained acceptable thermal comfort, enabled sustainable work practices, shaped green beliefs, enhanced eco-participation among staff and reduced electricity consumption and carbon emission. The attainment of Green information system innovation outcomes is important in providing clearer motivations and justifications for organisations to invest in information systems for environmental sustainability, as well as to embark on a complex and complicated Green information system innovation journey.

Thus, the findings **did not support** the typically reported outcomes of Green information system innovation in the Green IS literature, namely the eco-effectiveness, eco-equity, and eco-efficiency goals. Rather, the findings identified **new insights** about the outcomes of the Green information system. These are the much simpler identifications of Green information system outcomes from the perspectives of direct and indirect outcomes. The direct outcomes are seen from the economic, environmental, and operational perspectives. The environmental benefits from Green information system innovation may include carbon emissions reduction, energy efficiency, and/or waste minimisation. On the other hand, the economic benefits from Green information system innovation are usually seen in terms of reduction in energy, water, and/or other natural resources costs while the operational benefits may include reduction in business travels, resource utilisation, better productivity and IT efficiency. The indirect outcomes are framed around social benefits and the rebound effect. The social benefits identified in this research include positive

changes in attitudes and behaviours of individuals while the rebound effect from the Green information system innovations is the side impact from sustainability practices such as accumulation of e-waste from server consolidation practice. In both the Green information system innovation process models proposed in this research, the Green information system innovation outcomes are captured in the “Green benefit realisation” stage of the innovation process. Overall, the findings to this research question are **consistent**, and **supported** the argument by Seidel, Szekely, and vom Brocke (2015) who claimed that most organisations are still thinking in mere economic imperatives instead of striving for eco-effectiveness as the ultimate goal of information systems when they are embarking on any information system endeavours for environmental protection.

7.4 RESEARCH CONTRIBUTIONS

The theoretical and practical contributions are elaborated in the following sub-sections.

7.4.1 Theoretical Contributions

The followings are the **theoretical contributions** made by this research, and will be useful for researchers within the research domains of Green IS, IS, and Organisational Innovation.

First, the study produced two types of Green Information System Innovation Process Models: (a) Green Information System in Practice Innovation Process Model; and (b) Green Information System in Spirit Innovation Process Model as discussed in detail in Section 6.3. Moreover, based on the two new innovation process models, we offer a set of ten testable theoretical propositions for future empirical research by IS researchers who are keen to understand and explain Green information system innovations from the process perspective.

Second, the study enriches the Green IS literature and body of knowledge by adopting the processual approach instead of the commonly used variance or functional approach. The process approach allows deep understanding of the process, how the process unfolds over

time, and the complex factors and interactions surrounding the innovation process. The investigation covers the whole spectrum of the innovation process starting with the conception, development, implementation, use, appropriations of the technology (i.e., variations of use of metastructuring, expansion of functional affordance, and use extension, diffusion of use, use continuance, discontinuance), evaluation, and outcome. Most Green IS studies look at certain stages only such as adoption, implementation, or use only.

Third, the study provides a description of the concept of “Green information system” beyond the current understanding or nomenclature or taxonomy by clearly explaining the intricate innovation process of Green information system for energy efficiency, Green information system for communications and collaboration, Green information system for knowledge management and sharing, and Green information system for energy and carbon management. The comprehensive discussion on the Green information system innovations by looking deeper into the “content” of the Green information system from the lens of “spirit”, “interpretive flexibility”, “types of Green information system” and a number of other dimensions offer a deeper comprehension about what entails a Green information system innovation.

Fourth, the study presents new understanding by applying the contextualist approach to explain the interactions between the vertical and horizontal levels. The vertical levels saw dynamic and complex interaction between the internal environment and external environment, resulting in events undertaken in stages or phases over a period of time in order to achieve the outcomes. To the knowledge of the researcher, this is the first time a contextualist approach is used to explain the complex Green information system innovation process. In addition, the study of the external environment’s coercive, normative and mimetic pressures enriches understanding on how these external forces are being acted upon by organisations. The study posits that organisations respond to the pressure depending on the internal environment’s situation such as the responsiveness of the leadership, the norms set by managers, the environmental disposition of staff, or the availability of resource or staff capability to take action. Different organisations may also respond differently to the institutional forces due to the structure, culture, strategy or even priority of the firm.

7.4.2 Practical Contributions

The following are the **practical contributions** of this research:

First, this research describes the use of information systems for energy efficiency, communications and collaboration, knowledge management and sharing, and carbon management for green outcomes. The characteristics, technical descriptions and innovation processes presented in this research will help managers to exploit existing information systems or explore new information systems for environmental sustainability. The proposed Green Information System in Practice Innovation Process Model and the Green Information System in Spirit Innovation Process Model facilitate these actions.

Second, the potential for information systems to improve organisational energy efficiency (electricity and fuel) was highlighted as not widely understood by senior managers in the property management and fleet management, and the IT managers in this study. Developing management awareness and deep understanding of information systems for environmental sustainability is highlighted as a critical building block for a comprehensive environmental sustainability capability.

Third, information systems for energy management are different from conventional work related information systems and organisations need to define metrics and indicators for measuring energy consumption. In conventional work related information systems, the issue of measurement is handled by accounting systems. In energy informatics, the measurement systems may have to be built from scratch. Additionally, performance indicators around electricity and fuel reduction and/or electricity conservation that involve everyone within the organisation need to be defined, tracked, communicated and compared against benchmarks and baselines.

Fourth, organisations, especially ICT firms, need to extend their capabilities in new areas and develop internal capability in order to reduce the risk of delaying the benefits of information systems for environmental sustainability. This is because the benefits of using information systems for environmental sustainability can be seen not only from its direct environmental benefits, but also on economic, organisational, social, and

technological outcomes as well. The quantification of outcomes has to be done with proper undertakings under the “green benefit realisation” innovation stage by the IS managers and green champions.

Fifth, this study provides understanding on the complexities surrounding the Green information system innovation process. By having this understanding, managers are able to allocate time, resources and staff, and subsequently provide them with sufficient capability to embark on any type of Green information system innovation model. Managers are also able to provide clear, aligned and targeted strategies (both business and environmental) that should underpin and guide the Green information system innovation process.

Sixth, managers are able to understand the types of pressures exerted from and by the external environment. The managers are then able to plan to effectively respond to these influences or regulations imposed by the external environment, and react by initiating appropriate course of actions (i.e., innovation events).

7.5 RESEARCH LIMITATIONS AND FUTURE STUDIES

The limitations of this research stem mainly from its investigation of a single organisation setting. A similar study could be conducted using a broad and diverse sample from other organisations to extend and enhance the findings made in this research. For instance, a quantitative research could be carried out to investigate and test the validity of the two Green information system innovation models and the theoretical propositions.

7.5.1 Limited Generalisability

Qualitative research is inductive and seeks to understand either culture, process, events, meanings or experiences within particular social contexts such as a society, or an organisation (Denzin & Lincoln, 1998). The selected organisation in this study, Telecom Acadia, represents a single organisation in a single industry: telecommunications. Bennett (2004) argued that bias in a qualitative research study can occur when the number of

cases that represent a sample is not large enough to claim that the findings are applicable to the population from which the sample was taken. In addition, one of the most common criticisms of the case study method is that the method is prone to selection bias. Because of the small number of case studies conducted, the findings of this study are not generalisable in the statistical sense, yet the results are generalisable into theory (Lee & Baskerville, 2003). Therefore, the case study approach can be applied and extended to examine the Green information system innovation process in different types of businesses or industries including commercial and non-profit organisations. Conducting a similar study using a broad and diverse sample to further extend and enhance the thesis findings would not only provide a new perspective on the area of study, but it might also help to promote better understanding of the Green information system innovation process, the factors driving Green information system innovations, and the outcome from Green information system innovations in different organisations and environments.

7.5.2 Limited Study on the Actual Practice of Green Information System Users

In order to provide deeper understanding of how Green information system innovation could be turned into green outcomes, a research towards understanding the daily practice of Green information system innovation users would be useful. However, this current research has a restricted scope in understanding the “practice” aspect of Green information system innovation. Future research could address this issue by conducting a longitudinal and ethnographical kind of study towards understanding the practice of using Green information system innovations for green benefits realisation.

7.5.3 Limited Testing of the Theoretical Propositions

This research was designed and executed under qualitative research, hence, a formal proposition (or hypothesis) testing was not compatible with the subjective intent of this research. Thus, to address this issue, future research could either statistically test the propositions, or other longitudinal qualitative research could also be carried out for deeper investigation and validation of the propositions made in this thesis.

7.6 CONCLUDING REMARKS

In closing, this research is novel as it investigates the process of Green information system innovation from the conception stage until the evaluation of green benefits in the context of organisation. For business organisations, learning from the lessons highlighted in this thesis would enable them to create and/or apply Green information system innovations with conscientious mind-sets and judicious considerations. Furthermore, innovating Green information system is a way forward for any businesses that wishes to embark on an environmental sustainability journey facilitated by information systems.

IS researchers such as Brooks et al. (2012) and Lin, Yang and Hsu (2013) claimed that research in Green IS is still in its infancy and there is a noticeable level of uncertainty about what should be examined with respect to Green information system, and hence, it requires research direction. Other renowned Green IS researchers such as vom Brocke, Watson, Dwyer, Elliot, and Melville (2013, p. 520) argued that “while significant achievements have been made in shaping Green IS as a subfield in the IS discipline, the emergence of Green IS is still by far too slow.” Next, Grant and Marshburn (2014) highlighted that the benefits of Green information system are still unclear. Loeser (2013) reminded us that there is a lack of empirical evidence to date to support Green IS/IT. Despite the claims of Watson et al. (2008) that Green information system is more efficient, and that better efficiency leads to more profit, it is not clear whether the costs associated with Green information system will in fact help the bottom line or help the environment (Dedrick, 2010; Elliot, 2011). Even the most recent literature by Seidel, Szekely, and vom Brocke (2015) also argued that there is still little awareness of the potential of information systems in fundamentally transforming business processes towards environmental protection. This study is therefore an important addition to the Green IS body of knowledge to address some, if not all, of the challenges of advancing the Green IS field.

REFERENCES

- Abdul Rahim, R. E., & Abdul Rahman, A. (2013). *Resource-based Framework of Green IT Capability Toward Firms' Competitive Advantage*. Paper presented at the Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2013), 18 - 22 June, Jeju Island, Korea.
- Abukhader, S. M. (2008). Eco-efficiency in the era of electronic commerce - should 'Eco-Effectiveness' approach be adopted? *Journal of Cleaner Production*, 16(7), pp. 801-808.
- Agius, H. W., & Angelides, M. C. (1997). Desktop video conferencing in the organisation. *Information & Management*, 31(6), pp. 291-302.
- Alaraifi, A., Molla, A., & Deng, H. (2011). *Information Systems for Data Centres: Description and Operational Characteristics*. Paper presented at the Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2011), 29 June - 2 July, Brisbane, Australia.
- Ali, A., & Yusof, H. (2011). Quality in Qualitative Studies: The Case of Validity, Reliability and Generalisability. *Issues in Social and Environmental Accounting*, 5(1), pp. 25-64.
- Allan, M., & Thorns, D. (2008). *A Methodological Quest for Studying Interactions in Advanced Video Conferencing Environments*. Paper presented at the 4th International Conference on e-Social Science, 18 - 20 June, Manchester.
- Allenby, B. R., & Richards, D. J. (1999). Applying the triple bottom line: telework and the environment. *Environmental Quality Management*, 8(4), pp. 3-10.
- Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and qualitative research in the built environment: application of "mixed" research approach. *Work Study*, 51(1), pp. 117-131.
- Andersson, L. M., & Bateman, T. S. (2000). Individual environmental initiative: championing natural environment issues in US business organizations *Academy of Management Review*, 43, pp. 548-570.
- Andrade, A. D. (2009). Interpretive Research Aiming at Theory Building: Adopting and Adapting the Case Study Design. *The Qualitative Report*, 14(1), pp. 42-60.
- Aoun, C., Vatanasakdakul, S., & Cecez-Kecmanovic, D. (2011). *Can IS Save the World? Collaborative Technologies for Eco-Mobilisation*. Paper presented at the Australasian Conference on Information Systems (ACIS 2011), 30 November - 2 December, Sydney, Australia.
- Attewell, P. (1992). Technology diffusion and organisational learning: the case of business computing. *Organisation Science*, 3, pp. 1-19.

- Avgerou, C. (2001). The significance of context in information systems and organizational change *Information Systems Journal*, 11(1), pp. 43-63.
- Ayande, A., Sabourin, V., & Moreno, R. C. (2015). Fostering Corporate Social Responsibility and Sustainable Development: A Critical Analysis and Perspective on the Organisational Strategies Implemented by Corporations *Advances in Social Sciences Research Journal*, 2(7), pp. 176-196.
- Babin, R., & Nicholson, B. (2009). *How Green is my Outsourcer - Environmental Responsibility in Global IT Outsourcing*. Paper presented at the International Conference on Information Systems (ICIS), 15 - 18 December, Phoenix, AZ.
- Bailey, D. E., & Kurland, N. B. (2002). A review of telework research: findings, new directions, and lessons for the study of modern work. *Journal of Organizational Behavior*, 23, pp. 383-400.
- Barley, S. R. (1986). Technology as an occasion for structuring: evidence from observations of CT scanners and the social order of radiology departments. *Administrative Science Quarterly*, 31, pp. 78-108.
- Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), pp. 99-120.
- Baruch, Y. (2001). The status of research on teleworking and the agenda for future research. *International Journal of Management Reviews*, 3(2), pp. 113-129.
- Baumgartner, R. J. (2009). Organisational Culture and Leadership: Preconditions for the Development of a Sustainable Corporation. *Sustainable Development*, 17(2), pp. 102-113.
- Baunsgaard, V. V., & Clegg, S. R. (2015). Innovation: A Critical Assessment of the Concept and Scope of Literature. In R. Agarwal, W. Selen, G. Roos & R. Green (Eds.), *The Handbook of Service Innovation* (pp. pp. 5-25). London, UK: Springer London.
- Beath, C. M. (1991). Supporting the Information Technology Champion. *MIS Quarterly*, 15(3), pp. 355-372.
- Becker, S. W., & Whisler, T. L. (1967). The innovative organisation: A selective view of current theory and research. *The Journal of Business*, 40(4), pp. 462-469.
- Beirne, G., Moore, G., & Riesenbach, R. (2007). Facts, Lies and Videoconferencing: A Guide to Video Communication. Retrieved from <http://www.telepres.com/documents/Facts,Lies&Videoconferencing%28WhitePaper%29final%28reissued.2007%29.pdf>
- Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly*, 11(3), pp. 369-386.

- Bengtsson, F., & Agerfalk, P. J. (2011). Information technology as a change actant in sustainability innovation: Insights from Uppsala. *Journal of Strategic Information Systems*, 20(1), pp. 96-112.
- Benitez-Alamo, J., Perez-Arostegui, M. N., & Javier, T. T. (2010). Information Technology-Enabled Innovativeness and Green Capabilities. *Journal of Computer Information Systems*, 51(2), pp. 87-96.
- Bennett, A. (2004). Case study methods: Design, use, and comparative advantages. In D. F. Sprinz & Y. Wolinsky-Nahmias (Eds.), *Models, numbers, and cases: Methods for studying international relations* (pp. pp. 19-55): University of Michigan Press.
- Berkhout, F., & Hertin, J. (2004). De-materialising and re-materialising: digital technologies and the environment. *Futures*, 36(8), pp. 903-920.
- Berrone, P., Gelabert, L., & Fosfuri, A., Gomez Mejia, L., (2007). *Can Institutional Forces Create Competitive Advantage? Empirical Examination of Environmental Innovation*: IESE Business School - University of Navarra.
- Berthon, P., Hulbert, J. M., & Pitt, L. F. (1999). To Serve or Create? Strategic Orientations Toward Customers and Innovation. *California Management Review*, 42(1), pp. 37-58.
- Bibri, M. (2009). *ICT Design Unsustainability & the Path toward Environmentally Sustainable Technologies*. Blekinge Institute of Technology, Karlskrona.
- Blake, B. F., Neuendorf, K. A., & Valdiserri, C. M. (2003). Innovativeness and variety of internet shopping. *Internet Research: Electronic Networking Applications and Policy*, 13(3), pp. 156-169.
- Bocken, N. M. P., Farracho, M., Bosworth, R., & Kemp, R. (2014). The Front-End of Eco-Innovation for Eco-Innovative Small and Medium Sized Companies, 31, pp. 43-57.
- Bose, R., & Luo, X. (2011). Integrative framework for assessing firms' potential to undertake Green IT initiatives via virtualisation - A theoretical perspective. *Journal of Strategic Information Systems*, 20(1), pp. 38-54.
- Boudreau, M.-C., Chen, A. J., & Huber, M. (2007). Green IS: Building Sustainable Business Practices. In R. T. Watson (Eds.), *Information Systems: A Global Text* Available from <http://globaltext.terry.uga.edu/node/21>
- Bouwen, R. (1998). Relational construction of meaning in emerging organisation contexts. *European Journal of Work and Organisation Psychology*, 7(3), pp. 299-319.
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.
- Bradshaw, R., & Donnellan, B. (2013). *Optimising Flow Network Design With A Green IS Framework: An Exploration of the Bikeshare Domain*. Paper presented at the European Conference on Information Systems, 6 - 8 June, Utrecht, The Netherlands.

- Brandel, M. (2006). Sidebar: Indirect Benefits. *Computerworld*. Retrieved from <http://www.computerworld.com/article/2561178/it-management/sidebar--indirect-benefits.html>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), pp. 77-101.
- Broder, J. (2009). Climate Change Seen as Threat to U.S. Security. *The New York Times*. Retrieved 2 January 2010, from http://www.nytimes.com/2009/08/09/science/earth/09climate.html?_r=0
- Brooks, S., Wang, X., & Sarker, S. (2012). Unpacking Green IS: A review of the existing literature and directions for the future. In J. vom Brocke, S. Seidel & J. Recker (Eds.), *Green Business Process Management* (pp. pp 15-37). Berlin: Springer Berlin Heidelberg.
- Brown, D., Dillard, J., & Marshall, R. (2005). Strategically informed, environmentally conscious information requirements for accounting information systems. *Journal of Information Systems*, 19(2), pp. 79-103.
- Brundtland, G. H. (1987). *Our Common Future: The Report of the World Commission on Environment and Development*: Oxford University Press, Oxford.
- Bryman, A., & Bell, E. (2007). *Business Research Methods (2nd Edition)*. Oxford University Press, Oxford.
- Bughin, J., & Chui, M. (2010). The rise of the networked enterprise: Social media finds its payday. *McKinsey Quarterly*, December.
- Bullock, K. L., & Davis, C. K. (2011). *Unified Communication and Collaboration*. Paper presented at the Southwest Decision Sciences Institute Conference, Houston, Texas.
- Butler, T. (2011). Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS. *Journal of Strategic Information Systems*, 20(1), pp. 6-26.
- Cameron, R. (2011). *Quality Frameworks and Procedural Checklists for Mixed Methods Research*. Paper presented at the The 14th Australian Vocational Education and Training Research Association (AVETRA), 28 - 29 April, Melbourne, Australia.
- Capra, E., Francalanci, C., & Slaughter, S. A. (2012). Is software “green”? Application development environments and energy efficiency in open source applications. *Information and Software Technology*, 54(1), pp. 60-71.
- Chen, A. J., Boudreau, M.-C., & Watson, R. T. (2008). Information systems and ecological sustainability. *Journal of Systems and Information Technology*, 10(3), pp. 186-201.
- Chen, A. J., Boudreau, M.-C., Watson, R. T., & Karahanna, E. (2009). *Organizational Adoption of Green IS and Green IT: An Institutional Perspective*. Paper presented at the

International Conference on Information Systems (ICIS), 15 - 18 December, Phoenix, AZ.

- Chen, A. J., Watson, R. T., Boudreau, M.-C., & Karahanna, E. (2011). An Institutional Perspective on the Adoption of Green IS & IT. *Australasian Journal of Information Systems*, 17(1), pp. 23-45.
- Chen, Y. S. (2007). The driver of green innovation and green image -- green core competence. *Journal of Business Ethics*, 81(3), pp. 531-543.
- Cooper, V., & Molla, A. (2012). *A Contextualist Analysis of Green IT Learning*. Paper presented at the Proceedings of the International Conference on Information Resource Management (Conf-IRM 2012), 21 - 23 May, Vienna, Austria.
- Cooper, V., & Molla, A. (2014). Absorptive Capacity and Contextual Factors that Influence Green IT Assimilation. *Australasian Journal of Information Systems*, 18(3), pp. 271-288.
- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (3rd Edition)*. Thousand Oaks, CA: Sage Publications.
- Crossan, M., & Apaydin, M. (2010). A multi-dimensional framework of organisational innovation: A systematic review of the literature. *Journal of Management Studies*, 47(6), pp. 1154-1191.
- Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process*. Sydney: Allen & Unwin.
- Daft, R. L. (1978). A dual-core model of organisational innovation. *Academy of Management Journal*, 21(2), pp. 193-210.
- Daly, J., Kellehear, A., & Gliksman, M. (1997). *The public health researcher: A methodological approach*. Melbourne, Australia: Oxford University Press.
- Daly, M., & Butler, T. (2009). *Environmental responsibility and Green IT: An institutional perspective*. Paper presented at the 17th European Conference on Information Systems.
- Damanpour, F. (1988). Innovation type, radicalness, and the adoption process. *Communication Research*, 15, pp. 545-567.
- Damanpour, F. (1991). Organisational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal*, 34(3), pp. 555-590.
- Damanpour, F., & Aravind, D. (2012). Managerial innovation: Conceptions, processes and antecedents. *Management and Organisation Review*, 8(2), pp. 423-454.
- Damanpour, F., & Evan, W. (1984). Organisational innovation and performance: The problem of "organisational lag". *Administrative Science Quarterly*, 29(3), pp. 392-409.

- Damanpour, F., & Schneider, M. (2006). Phases of the Adoption of Innovation in Organizations: Effects of Environment, Organization and Top Managers. *British Journal of Management*, 17(3), pp. 215-236.
- Damanpour, F., & Wischnevesky, J. D. (2006). Research on innovation in organisations: Distinguishing innovation-generating from innovation-adopting organisations. *Journal of Engineering and Technology Management*, 23(4), pp. 269-291.
- Dao, V., Langella, I., & Carbo, J. (2011). From green to sustainability: Information Technology and an integrated sustainability framework. *Journal of Strategic Information Systems*, 20(1), pp. 63-79.
- Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information Systems Journal*, 8(4), pp. 273-289.
- Datschefski, E. (2001). *The Total Beauty of Sustainable Products*. Crans-Pres-Celigny: Rotovision.
- Davis, A. W., & Weinstein, I. M. (2005). *The Business Case for Videoconferencing: Achieving a Competitive Edge*: Wainhouse Research and Polycom.
- de Medeiros, J. F., Riberio, J. L. D., & Cortimiglia, M. N. (2014). Success factors for environmentally sustainable product innovation: a systematic literature review. *Journal of Cleaner Production*, 65, pp. 76-86.
- Dedrick, J. (2010). Green IS: Concepts and Issues for Information Systems Research. [Tutorials]. *Communications of AIS*, 27(1), pp. 173-184.
- Denzin, N. K., & Lincoln, Y. S. (1998). *Collecting and interpreting qualitative materials*. Thousand Oaks, CA: Sage Publications.
- DeSanctis, G., & Monge, P. (1998). Communication Processes for Virtual Organisations. *Journal of Computer-Mediated Communication*, 3(4).
- DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science* 5(2), pp. 121-147.
- DeSimone, L. D., & Popoff, F. (1997). *Eco-Efficiency: The Business Link to Sustainable Development*. Cambridge, MA: MIT Press.
- Dey, A. K., Abowd, G. D., & Wood, A. (1998). CyberDesk: A Framework for Providing Self-Integrating Context-Aware Services. *Knowledge-Based Systems*, 11(1), pp. 3-13.
- DiMaggio, P. J., & Powell, W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organisational Fields. *American Sociological Review*, 48(2), pp. 147 - 160.
- Dobson, P. J. (2001). The Philosophy of Critical Realism-An Opportunity for Information Systems Research. *Information Systems Frontier*, 3(2), pp. 199.

- Downs, G. W. (1978). Complexity and innovation research. In M. Radnor, I. Feller & E. Rogers (Eds.), *The Diffusion of Innovations: An Assessment*. Evanston, Illinois: Center for the Interdisciplinary Study of Science and Technology, Northwestern University.
- Downs, G. W., & Mohr, L. B. (1979). Toward a theory of innovation *Administration & Society*, 10(4), pp. 379-408.
- Du Plooy, N. F. (1998). *An Analysis of the Human Environment for the Adoption and Use of Information Technology*. University of Pretoria, Pretoria.
- Du, W., Pan, S. L., & Liu, S. (2015). *A Process Model of Effective Improvisation: Lessons from Tencent's Product Development*. Paper presented at the Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2015), 5 - 9 July, Singapore.
- Dwyer, C., & Hasan, H. (2012). Emergent solutions for global climate change: Lessons from Green IS research. *International Journal of Social and Organizational Dynamics in IT*, 2(2), pp. 18-33.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), pp. 532-550.
- Elliot, S. (2011). Transdisciplinary perspectives on environmental sustainability: A resource base and framework for IT-enabled business transformation. *MIS Quarterly*, 35(1), pp. 197-236.
- Emirbayer, M., & Johnson, V. S. (2004). *Bourdieu and Organizational Analysis*. Paper presented at the Annual Meeting of the American Sociological Association, 14 August, San Francisco, CA.
- Enkvist, P., Naucler, T., & Rosander, J. (2007). A cost curve for greenhouse gas reduction. *McKinsey Quarterly*(1), pp. 34-45.
- Esfahani, M. D., Nilashi, M., Abdul Rahman, A., Ghapanchi, A. H., & Zakaria, N. H. (2015). Psychological Factors Influencing the Managers' Intention to Adopt Green IS: A Review-Based Comprehensive Framework and Ranking the Factors. *International Journal of Strategic Decision Sciences*, 6(2), pp. 28-56.
- Fagerberg, J., Mowery, D. C., & Nelson, R. R. (2005). *The Oxford Handbook of Innovation*. Oxford, UK: Oxford University Press.
- Fischer, C. S., & Carroll, G. R. (1986). *The diffusion of telephone and automobile in the United States, 1902 to 1937*: Graduate School of Business, University of California.
- Foster, C., & Heeks, R. (2013a). Conceptualising Inclusive Innovation: Modifying Systems of Innovation Frameworks to Understand Diffusion of New Technology to Low-Income Consumers. *European Journal of Development Research*, 25(3), pp. 333-335.
- Foster, C., & Heeks, R. (2013b). Innovation and scaling of ICT for the bottom-of-the-pyramid. *Journal of Information Technology*, 28(4), pp. 296-315.

- Fuchs, C. (2008). The implications of new information and communication technologies for sustainability. *Environment, Development and Sustainability*, 10(3), pp. 291-309.
- Galliers, R. (1992). Choosing Information Systems Research Approaches. In R. Galliers (Ed.), *Information Systems Research - Issues, Methods and Practical Guidelines* (pp. pp. 144-162): Alfred Waller Ltd.
- Galliers, R. (2011). *Further developments in information systems strategizing: Unpacking the concept*. Oxford: Oxford University Press.
- Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness: a literature review. *The Journal of Product Innovation Management*, 19(2), pp. 110-132.
- Ghobakhloo, M., Arias-Aranda, D., & Benitez-Alamo, J. (2010). Adoption of e-Commerce Applications in SMEs. *Industrial Management & Data Systems*, 111(8), pp. 1238-1269.
- Gholami, R., Sulaiman, A., Ramayah, T. B., & Molla, A. (2013). Senior Management Perception on Green Information Systems Adoption and Environmental Performance: Results from a Field Survey. *Information & Management*, 50(7), pp. 431-438.
- Ghose, A., Hasan, H., & Spedding, T. (2008). *Carbon-centric Computing: IT Solutions for Climate Change*. Wollongong: The University of Wollongong.
- Ghose, A., Hoesch-Klohe, K., Hinsche, L., & Le, L.-S. (2009). Green Business Process Management: A Research Agenda. *Australasian Journal of Information Systems*, 16(2), pp. 103-117.
- Gossart, C. (2014). Rebound effects and ICT: A review of the literature. In L. Hilty & B. Aebischer (Eds.), *ICT Innovations for Sustainability* (pp. pp. 435-448): Springer International Publishing.
- Goswami, S., & Mathew, M. (2005). Definition of innovation revisited: An empirical study of Indian IT industry. *International Journal of Innovation Management*, 9(3), pp. 371-383.
- Grant, N. C., & Marshburn, D. G. (2014). *Understanding the Enablers and Inhibitors of Decision to Implement Green Information Systems: A Theoretical Triangulation Approach*. Paper presented at the Twentieth Americas Conference on Information Systems, 7 - 9 August, Savannah, GA.
- Gray, R. H., & Bebbington, K. J. (2000). Environmental Accounting, Managerialism and Sustainability: Is the Planet Safe in the Hands of Business and Accounting? *Advances in Environmental Accounting and Management*, 1, pp. 1-44.
- Green, C. W. (2003). *Adoption Rationale and Post-Adoption Activity: Institutional and Strategic Influences on EDI Adoption and Implementation*. Paper presented at the International Conference on Information Systems, 15 - 17 December, Seattle, WA.

- Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly*, 30(3), pp. 611-642.
- Grover, V., Purvis, R., & Coffey, J. (2005). Information Systems Effectiveness Retrieved 10 March 2010, from <http://business.clemson.edu/ISE/index.html>
- Hagedoorn, J. (1996). Innovation and entrepreneurship: Schumpeter revisited. *Industrial & Corporate Change*, 5(3), pp. 883-896.
- Hallstedt, S., Ny, H., Robert, K. H., & Broman, G. (2011). An approach to assessing sustainability integration in strategic decision systems for product development. *Journal of Cleaner Production*, 18(8), pp. 703-712.
- Hameed, M. A., Counsell, S., & Swift, S. (2012). A conceptual model for the process of IT innovation adoption in organisations. *Journal of Engineering and Technology Management*, 29(3), pp. 358-390.
- Hart, S. L. (1995). A natural-resource based view of the firm. *The Academy of Management Review*, 20(4), pp. 986-1014.
- Hart, S. L. (1997). Beyond greening: Strategies for a sustainable world. *Harvard Business Review*, 75(1), pp. 66-76.
- Hart, S. L., & Milstein, M. B. (1999). Global sustainability and the creative destruction of industries. *Sloan Management Review*, 41(1), pp. 23-33.
- Hart, S. L., & Milstein, M. B. (2003). Creating sustainable value. *Academy of Management Executive*, 17(2), pp. 56-67.
- Harvey, L., & Myers, M. D. (1995). Scholarship and Practice: The Contribution of Ethnographic Research Methods to Bridging Gap. *Information Technology & People*, 8(3), pp. 13-27.
- Hasan, H., Molla, A., & Cooper, V. (2014). A Green IS Taxonomy. In H. Hasan (Ed.), *Being Practical With Theory: A Window into Business Research* (pp. pp. 98-107). Wollongong, Australia.
- Hilpert, H., Kranz, J., & Schumann, M. (2014). *An Information System System Design Theory for Green Information Systems for Sustainability Reporting -- Integrating Theory With Evidence From Multiple Case Studies*. Paper presented at the 22nd European Conference on Information Systems, 9 - 11 June, Tel Aviv, Israel.
- Hilty, L., & Ruddy, T. F. (2000). Towards a Sustainable Information Society. *Informatik/Informatique*, 4, pp. 2-7.
- Hinings, C. R., Greenwood, R., Reay, T., & Suddaby, R. (2004). Dynamics of change in organisational fields. In M. S. Poole & A. H. van de Ven (Eds.), *Handbook of Organisational Change and Innovation* (pp. pp. 304-323). New York, NY: Oxford University Press.

- Hirt, S. G., & Swanson, E. B. (2001). Emergent Maintenance of ERP: New Roles and Relationships. *Journal of Software Maintenance: Research and Practice*, 13(6), pp. 373-397.
- Horbach, J. (2008). Determinants of environmental innovation — New evidence from German panel data sources. *Research Policy*, 37(1), pp. 163-173.
- Hovorka, S., & Corbett, J. (2012). *IS Sustainability Research: A Trans-disciplinary Framework for a 'Grand Challenge'*. Paper presented at the Proceedings of the Thirty Third International Conference on Information Systems (ICIS 2012), 16 - 19 December, Orlando, FL.
- Huang, A. H. (2009). A Model for Environmentally Sustainable Information Systems Development. *Journal of Computer Information Systems*, 49(4), pp. 114-121.
- Hult, G. T., Hurley, R. F., & Knight, G. A. (2004). Innovativeness: Its Antecedents and Impact on Business Performance. *Industrial Marketing Management*, 33(5), pp. 429-438.
- Hurley, R. F., & Hult, G. T. (1998). Innovation, market orientation, and organisational learning: An integration and empirical examination. *Journal of Marketing Research*, 62(3), pp. 42-54.
- Iacono, C., Brown, A., & Holtham, C. (2011). The use of the Case Study Method in Theory Testing: The Example of Steel eMarketplaces. *The Electronic Journal on Business Research Methods*, 9(1), pp. 57-65.
- Ihlsoon, C. H. O., & Young-Gul, K. I. M. (2001). Critical Factors for Assimilation of Object-Oriented Programming Languages. *Journal of Management Information Systems*, 18(3), pp. 125-156.
- Ijab, M. T. (2011). *Studying Green Information Systems as Practice: Proceedings of SIGGreen Workshop, Sprouts: Working Papers on Information Systems*, 11(16).
- Ijab, M. T., & Molla, A. (2011). *The Study of Green Information Systems Use from the Theory of Practice Perspective*. Paper presented at the 6th Mediterranean Conference on Information Systems (MCIS), 3 - 5 September, Limassol, Cyprus.
- Ijab, M. T., Molla, A., & Cooper, V. (2011). *A Theory of Practice-Based Analysis of Green Information Systems (Green IS) Use*. Paper presented at the Australasian Conference on Information Systems (ACIS 2011), 30 Nov - 2 December, Sydney, Australia.
- Ijab, M. T., Molla, A., & Cooper, V. (2012). *Green Information Systems (Green IS) Practice in Organisation: Tracing its Emergence and Recurrent Use*. Paper presented at the Proceedings of the 18th Americas Conference on Information Systems (AMCIS 2012), 9 - 11 August, Seattle, WA.
- Ijab, M. T., Molla, A., Kassahun, A. E., & Teoh, S. Y. (2010). *Seeking the "Green" in "Green IS": A Spirit, Practice and Impact Perspective*. Paper presented at the Pacific Asia Conference on Information Systems (PACIS) 2010, 9-12 July, Taipei, Taiwan.

- IPCC (2012). *The Fifth Assessment Report*. Available from: <https://www.ipcc.ch/report/ar5/>
- Isabella, L. A. (1990). Evolving interpretations as a change unfolds: How managers construe key organisational events. *Journal of Academy of Management Science*, 33(1), pp. 7-41.
- Issa, T., Chang, V., & Issa, T. (2010). Sustainable Business Strategies and PESTEL Framework *GSTF International Journal on Computing*, 1(1), pp. 73-80.
- Jackson, W., & Verberg, N. (2006). *Methods: Doing Social Research* (4th Edition ed.): Pearson Education Canada.
- James, P., & Pamlin, D. (2009). *Virtual Meetings and Climate Innovation in the 21st Century*.
- Jarvenpaa, S. L. (1991). *Panning for Gold in IS Research: "Second-Hand Data"*. Paper presented at the IFIP TC/WG 8.2 Working Conference, 14 - 16 December, Copenhagen, Denmark.
- Jena, R. K. (2013). Green Computing to Green Business. In P. O. de Pablos (Ed.), *Green Technologies and Business Practices: An IT Approach* (pp. pp. 138-150). Hershey, PA: IGI Global.
- Jenkin, T., Webster, J., & McShane, L. (2011). An Agenda for "Green" Information Technology and Systems Research. *Information and Organization*, 21, pp. 17-40.
- Jokonya, O., Kroeze, J. H., & van de Poll, J. A. (2012). *Towards a framework for decision making regarding IT adoption*. Paper presented at the Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference (SAICSIT '12), 1 - 3 October, Pretoria, South Africa.
- Kaewkitipong, L., & Brown, D. (2008). *Adoption and evaluation of E-Business in Thai SMEs: A Process Perspective*. Paper presented at the Proceedings of the Fourteenth Americas Conference on Information Systems, 14 - 17 August, Toronto, Canada.
- Karl, T., Milello, J., & Peterson, T. (2009). *Global Climate Change in the United States*. New York: Cambridge University Press.
- Kazlauskas, A., & Hasan, H. (2009). Web 2.0 Solutions to Wicked Climate Change Problems. *Australasian Journal of Information Systems*, 16(2), pp. 23-36.
- Kim, H. W., & Pan, S. L. (2006). Towards a process model of Information Systems implementation: The case of Customer Relationship Management (CRM). *The DATA BASE for Advances in Information Systems*, 37(1), pp. 59-76.
- Kim, L. K. (1980). Organisational innovation and structure. *Journal of Business Research*, 8, pp. 225-245.

- Kimberly, J. R., & Evanisko, M. J. (1981). Organisational innovation: the influence of individual, organisational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal*, 24, pp. 689-713.
- King, J. L., Gurbaxani, V., Kraemer, K. L., McFarlan, F. W., Raman, K. S., & Yap, C. S. (1994). Institutional Factors in Information Technology Innovation. *Information Systems Research*, 5(2), pp. 139-169.
- King, N. (1998). Template analysis. In G. Symon & C. Cassell (Eds.), *Qualitative methods and analysis in organisational research: A practical guide*. Thousands Oak, CA: Sage Publications.
- Kitou, E., & Horvath, A. (2006). Transportation Choices and Air Pollution Effects of Telework. *Journal of Infrastructure Systems*, 12(2), pp. 121-134.
- Klein, H. K., & Myers, M. D. (1999). A set of principles for evaluating and conducting interpretive field studies in information systems. *MIS Quarterly*, 23(1), pp. 67-94.
- Knight, K. E. (1967). A descriptive model of the intra-firm innovation process. *The Journal of Business*, 40(4), pp. 478-496.
- Kryvinska, N., Strausss, C., & Zinterhof, P. (2010). *Emerging Smart Service and Networking Technologies Facilitate Shared Intelligence via Unified Communication & Collaboration Platforms*. Paper presented at the P2P, Parallel, Grid, Cloud and Internet Computing (3PGCIC), 4 - 6 November, Fukuoka, Japan.
- Kundu, S. K., & Katz, J. A. (2003). Born International SMEs: BI-Level Impacts of Resources and Intentions. *Small Business Economics*, 20(1), pp. 25-47.
- Kuo, B. N., & Dick, G. N. (2010). *Organisational Green IT: It seems the bottom line rules*. Paper presented at the Proceedings of the 16th Americas Conference on Information Systems (AMCIS 2010), 12 - 15 August, Lima, Peru.
- Langley, A. (1999). Strategies for theorising from process data. *Academy of Management Review*, 24(4), pp. 691-710.
- Lassen, J. V., & Simonsen, J. (2014). *User-Driven Designs in Medical Informatics: Developing and Implementing Support for Inter-departmental Coordination of Hospital Work using Electronic Whiteboards*. Paper presented at the Information Systems Research Seminar in Scandinavia (IRIS), 10 - 13 August, Ringsted, Denmark.
- Lee, A. S. (1989). A Scientific Methodology for MIS Case Studies. *MIS Quarterly*, 13(1), pp. 33-50.
- Lee, A. S. (1991). Integrating Positivist and Interpretive Approaches to Organizational Research. *Organization Science*, 2(4), pp. 342-365.
- Lee, A. S., & Baskerville, R. L. (2003). Generalizing generalizability in information systems research. *Information Systems Research*, 14(3), pp. 221-243.

- Lei, C. F., & Ngai, E. W. T. (2014). *A Research Agenda on Managerial Intention to Green IT Adoption: From Norm Activation Perspective*. Paper presented at the Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2014), 24 - 28 June, Chengdu, China.
- Lin, Y.-L., Yang, Y. S. O., & Hsu, C. (2013). *Building legitimacy for Green IS innovations in Taiwan*. Paper presented at the Proceedings of the Pacific Asia Conference on Information Systems (PACIS 2013), 18 - 22 June, Jeju Island, Korea.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. San Francisco: Jossey-Bass Publishers Inc.
- Loeser, F. (2013). *Green IT and Green IS: Definition of Constructs and Overview of Current Practices*. Paper presented at the Proceedings of the Nineteenth Americas Conference on Information Systems, 15-17 August, Chicago, IL.
- Lubrano, A. (2013). *The Telegraph: How Technology Innovation Caused Social Change*, Routledge.
- Lynch, P., Walsh, M. M., & Harrington, D. (2010). *Defining and Dimensioning Organisational Innovativeness*. Paper presented at the International CHRIE Conference, 28 - 31 July, Amherst, Massachusetts.
- Lyytinen, K., & Damsgaard, J. (2001). *What's Wrong with the Diffusion of Innovation Theory*. Paper presented at the Proceedings of the IFIP TC8 WG8.1 Fourth Working Conference on Diffusing Software Products and Process Innovations, Banff, Canada.
- Mack, N., Woodsong, C., MacQueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative Research Methods: A Data Collector's Field Guide*. Research Triangle Park, North Carolina: Family Health International
- Madon, S. (1993). Introducing administrative reform through the application of computer-based information systems: a case study in India *Public Administration and Development*, 13, pp. 37-48.
- Mahmoud, S. S., & Ahmad, I. (2013). A green model for sustainable software engineering. *International Journal of Software Engineering and its Application*, 7(4), pp. 55-74.
- Malhotra, A., Melville, N. P., & Watson, R. T. (2010). Information Systems and Environmental Sustainability (Call for Papers - Special Issue). *MIS Quarterly*.
- Malhotra, A., Melville, N. P., & Watson, R. T. (2013). Spurring impactful research on information systems for environmental sustainability. *MIS Quarterly*, 37(4), pp. 1265-1273.
- Mallon, K., Johnston, G., Burton, D., & Cavanagh, J. (2007). *Towards a High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions* (No. 978-0-9804343-0-9).

- Mann, H., Grant, G., & Mann, I. G. (2009). *Green IT: An Implementation Framework*. Paper presented at the Proceedings of the Fifteenth Americas Conference on Information Systems, 6 - 9 August, San Francisco, CA.
- Mansoori, Y. (2011). *A Holistic Investigation of Energy Efficiency in Peer-to-Peer and Client-server Based Media Content Distribution*. Royal Institute of Technology, Stockholm.
- March, J. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2, pp. 71-86.
- Markus, M. L., & Silver, M. S. (2008). A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit. *Journal of the Association of Information Systems*, 9(10-11), pp. 609-632.
- Maughan, C. (2012). *Organisational Innovation: A Review of the Literature*. Alice Springs: Curtin University.
- McDonough, W., & Braungart, M. (1998). The NEXT Industrial Revolution. *The Atlantic Monthly*, pp. 82-92.
- Melville, N. P. (2010). Information Systems Innovation for Environmental Sustainability. *MIS Quarterly*, 34(1), pp. 1-21.
- Melville, N. P., & Whisnant, R. (2012). *Environmental sustainability 2.0: Empirical analysis of Environmental ERP Implementation*. Michigan, USA: Association for Information Systems.
- Menguc, B., & Auh, S. (2006). Creating a firm-level dynamic capability through capitalising on market orientation and innovativeness. *Journal of the Academy of Marketing Science*, 34(1), pp. 63-73.
- Meyer, M. (2000). Innovation roles: from souls of fire to devil's advocates. *The Journal of Business Communication*, 37(4), pp. 328-347.
- Miles, M. B., & Huberman, A. M. (1984). *Qualitative data analysis: A Sourcebook of New Methods*. New York: Sage Publications.
- Mines, C. (2011). Six Types of Sustainability Software that Meet Any Company's Needs Retrieved 15 July 2011, from <http://www.greenbiz.com/blog/2011/06/15/6-types-sustainability-software-meet-any-companys-needs>
- Mingay, S. (2007). *Green IT: Dealing with the shockwave*. Paper presented at the Gartner Symposium ITXPO, 20 - 23 November, Sydney, Australia.
- Mingers, J. (2003). The paucity of multimethod research: A review of the information systems literature. *Information Systems Journal*, 13(3), pp. 233-249.
- Mithas, S., Khuntia, J., & Roy, P. K. (2010). *Green Information Technology, Energy Efficiency, and Profits: Evidence from an Emerging Economy*. Paper presented at the

- International Conference on Information Systems (ICIS), 12 - 15 December, St. Louis, MI.
- Mohr, L. B. (1987). Innovation theory. In J. M. Pennings & A. Buitendam (Eds.), *New Technology As Organisational Innovation* (pp. pp. 13-31). Cambridge, MA, Ballinger.
- Molla, A. (2013). Identifying IT Sustainability Performance Drivers: Instrument Development and Validation. *Information Systems Frontier*, 15(5), pp. 705-723.
- Molla, A., & Abareshi, A. (2012). Organizational green motivations for information technology: Empirical study. *Journal of Computer Information Systems*, 52(3), pp. 92-102.
- Molla, A., Abareshi, A., & Cooper, V. (2014). Green IT beliefs and pro-environmental IT practices among IT professionals. *Information Technology & People*, 27(2), pp. 129-154.
- Molla, A., Cooper, V., Corbitt, B., Deng, H., Peszynski, K., & Teoh, S. Y. (2008). *E-readiness to G-readiness: Developing a green information technology readiness framework*. Paper presented at the 19th Australasian Conference on Information Systems, 3 - 5 December, Christchurch, New Zealand.
- Molla, A., Cooper, V., & Pittayachawan, S. (2011). The Green IT Readiness (G-Readiness) of Organisations: An Exploratory Analysis of a Construct and Instrument. *Communications of the Association for Information Systems*, 29, pp 67-96.
- Mumford, M. D., Scott, G. M., Gaddis, B., & Strange, J. M. (2002). Leading creative people: orchestrating expertise and relationship. *The Leadership Quarterly*, 13(6), pp. 705-750.
- Mustonen-Ollila, E., & Lyytinen, K. (2003). Why Organisations Adopt Information System Process Innovations: A Longitudinal Study Using Diffusion of Innovation Theory. *Information Systems Journal*, 13(3), pp. 275-297.
- Myers, M. D. (1997). Qualitative Research in Information Systems. *MIS Quarterly*, 21(2), pp. 241-242.
- Myers, M. D. (2009). *Qualitative Research in Business & Management*. London: Sage.
- Naumann, S., Dick, M., Kem, E., & Johann, T. (2011). The GREENSOFT Model: A reference model for green and sustainable software and its engineering. *Sustainable Computing: Informatics and Systems*, 1(4), pp. 294-304.
- Nedbal, D., Wetzlinger, W., Auinger, A., & Wagner, G. (2011). *Sustainable IS Initialisation Through Outsourcing: A Theory-Based Approach*. Paper presented at the Proceedings of the 17th Americas Conference on Information Systems (AMCIS 2011), 4 - 8 August, Detroit, MI.
- Newman, M., & Robey, D. (1992). A social process model of user-analyst relationship. *MIS Quarterly*, 16(2), pp. 249-266.

- Nohria, N., & Gulati, R. (1996). Is slack good or bad for innovation? *The Academy of Management Journal*, 39(5), pp. 1245-1264.
- Nolan, T., & Varey, R. J. (2014). Towards transition: resourcing socially learned decisions. *International Journal of Sustainable Development*, 17(2), pp. 208-226.
- Nooteboom, B. (2004). *Innovation, learning and cluster dynamics*. Rotterdam, The Netherlands: Erasmus Research Institute of Management.
- Olson, E. G. (2008). Creating an enterprise-level “green” strategy. *Journal Of Business Strategy* 29(2), pp. 22-30.
- Orlikowski, W. J. (1992). The Duality of Technology: Rethinking the Concept of Technology in Organisations. *Organization Science*, 3(3), pp. 398-427.
- Orlikowski, W. J. (1993). CASE Tools as organisational change: Investigating incremental and radical changes in systems development. *MIS Quarterly*, 17(3), pp. 309-340.
- Orlikowski, W. J. (1996). Improvising Organisational Transformation over Time: A Situated Change Perspective. *Information Systems Research*, 7(1), pp. 63-92.
- Orlikowski, W. J. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, 11(4), pp. 404-428.
- Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organisations: research approaches and assumptions. *Information Systems Research*, 2(1), pp. 1-28.
- Orlikowski, W. J., & Robey, D. (1991). Information technology and the structuring of organisations. *Information Systems Research*, 2(2), pp. 143-169.
- Orlikowski, W. J., Yates, J., Okamura, K., & Fujimoto, M. (1995). Shaping electronic communication: the metastructuring of technology in the context of use. *Organization Science*, 6(4), pp. 423-444.
- Orsato, R. J. (2006). Competitive environmental strategies: when does it pay to be green? *California Management Review*, 48(2), pp. 127-143.
- Otrell-Cass, K. (2015). Commentary: towards more responsibility in ICT. *Journal of Information, Communication and Ethics in Society*, 13(1), pp. 24-27.
- Pamlin, D. (2008). *Identifying and assessing the opportunities to reduce the first billion tonnes of CO2: The potential global CO2 reductions from ICT use*: WWF Sweden.
- Pather, S., & Remenyi, D. (2004). *Some of the philosophical issues underpinning research in information systems: from positivism to critical realism*. Paper presented at the Proceedings of the 2004 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT (SAICSIT), Stellenbosch, Western Cape, South Africa.

- Pattinson, C., & Gordon, N. A. (2011). *Green IS in teaching - specialist or generalist? :* Association for Information Systems.
- Pelz, D. C. (1983). Quantitative case histories of urban innovations: are there innovating stages? *IEEE Transactions on Engineering Management*, 30, pp. 60-67.
- Pelz, D. C. (1985). Innovation complexity and the sequence of innovating stages. *Science Communication*, 6(3), pp. 261-291.
- Perks, H., & Roberts, D. (2013). A Review of Longitudinal Research in the Product Innovation Field, with Discussion of Utility and Conduct of Sequence Analysis. *Journal of Product Innovation Management*, 30(6), pp. 1099-1111.
- Pernici, B., Aiello, M., vom Brocke, J., Donnellan, B., Gelenbe, E., & Kretsis, M. (2012). What IS Can Do for Environmental Sustainability: A Report from CAiSE'11 *Communications of the Association for Information Systems*, 30.
- Pernici, B., Ardagna, D., & Cappiello, C. (2008). Business Process Design: Towards Service-Based Green Information Systems. In R. B. Antonino Mazzeo, Gianmario Motta (Ed.), *IFIP International Federation for Information Processing: E-Government; ICT Professionalism and Competences; Service Science* (Vol. 280, pp. 195-203). Boston: Springer.
- Peterson, M. F. (1998). Embedded organisational events: the units of process in organisation science *Organization Science*, 9(1), pp. 16-33.
- Pettigrew, A. M. (1987). Context and action in the transformation of the firm. *Journal of Management Studies*, 24(6), pp. 649-670.
- Pettigrew, A. M. (1990). Longitudinal Field Research on Change: Theory and Practice. *Organization Science* 1(3), pp. 267 - 292.
- Pettigrew, A. M. (1997). What is a processual analysis? *Scandinavian Journal of Management*, 13(4), pp. 337-348.
- Pettigrew, A. M., Woodman, R. W., & Cameron, K. S. (2001). Studying Organizational Change and Development: Challenges for Future Research. *Academy of Management Journal*, 44(4), pp. 697-713.
- Pitt, L. F., Parent, M., Junglas, I., Chan, A., & Spyropoulou, S. (2011). Integrating the smartphone into a sound environmental information systems strategy: Principles, practices and a research agenda. *Journal of Strategic Information Systems*, 20(1), pp. 27-37.
- Plepys, A. (2002). The grey side of ICT. *Environmental Impact Assessment Review*, 22(5), pp. 509-523.
- Poole, M., van de Ven, A. H., Dooley, K. J., & Holmes, M. E. (2000). *Organisational Change and Innovation Processes. Theory and Methods for Research*. New York: Oxford University Press.

- Porter, M., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The Journal of Economic Perspectives*, 9(4), pp. 97-118.
- Pozzebon, M. (2000). *Combining a Structuration Approach with a Behavioral-Based Model to Investigate ERP Systems*. Paper presented at the Proceedings of the Americas Conference on Information Systems, 10 - 15 August, Long Beach, CA.
- Rivoli, P., & Waddock, S. (2011). "First They Ignore You ...": The Time-Context Dynamic and Corporate Responsibility. *California Management Review*, 53(2), pp. 87-104.
- Robey, D., & Newman, M. (1996). Sequential Patterns in Information Systems Development: An Application of a Social Process Model. *ACM Transactions on Information Systems*, 14(1), pp. 30-63.
- Roessler, R., Schlieter, H., & Esswein, W. (2014). *Extending Enterprise Management Systems - The Case of Energy Management*. Paper presented at the Proceedings of the Twentieth Americas Conference on Information Systems, 7 - 9 August, Savannah, GA.
- Rogers, E. (1983). *Diffusion of Innovations*. New York: Free Press.
- Rogers, E. (1995). *Diffusion of Innovations: 4th Edition*. New York: Free Press.
- Roode, D. (2003). Information Systems Research: A Matter of Choice? *South African Computing Journal*, 30, pp. 1-2.
- Rose, J., & Scheepers, R. (2001). *Structuration Theory and Information Systems Development - Frameworks for Practice*. Paper presented at the The 9th European Conference on Information Systems, 27 - 29 June, Bled, Slovenia.
- Russo, M. V., & Fouts, P. A. (1997). A Resource Perspective on Corporate Environmental Performance and Profitability. *Academy of Management Journal*, 40(3), pp. 534-559.
- Ryan, A., Mitchell, I. K., & Daskou, S. (2012). An Interaction and Networks Approach to Developing Sustainable Organisations. *Journal of Organizational Change Management*, 25(4), pp. 578-594.
- Saga, V. L., & Zmud, R. W. (1994). *The nature and determinants of IT acceptance, routinisation, and infusion*. Paper presented at the Proceedings of the IFIP TC8 Working Conference on Diffusion, Transfer and Implementation of Information Technology, New York, USA.
- Santos-Vijande, M. L., & Alvarez-Gonzales, L. I. (2007). Innovativeness and organisational innovation in Total Quality oriented firms: The moderating role of market turbulence. *Technovation*, 27(9), pp. 514-532.
- Sarkar, A. N. (2013). Promoting Eco-Innovations to Leverage Sustainable Development of Eco-Industry and Green Growth. *European Journal of Sustainable Development*, 2(1), pp. 171-224.

- Sarkar, P., & Young, L. (2011). *Sailing the Cloud: A Case Study of Perceptions and Changing Roles in An Australian University*. Paper presented at the 19th European Conference on Information Systems (ECIS 2011), 9 - 11 June, Helsinki, Finland.
- Schein, E. H. (1989). *The role of the CEO in the management of change: the case of IT management in the 1990s*. Working Paper Sloan School of Management, MIT.
- Schroeder, G., van de Ven, A. H., Scuder, G. D., & Polley, D. (1989). *The development of innovation ideas*. New York: Harper & Row.
- Schumpeter, J. A. (1934). *The Theory of Economic Development*. London: Oxford University Press.
- Scott, W. R. (1994). Institutions and Organisations. In W. R. Scott & J. W. Meyer (Eds.), *Institutional Environments and Organisations: Structural Complexity and Individualism*. Thousand Oaks, CA: Sage Publication.
- Scott, W. R. (2010). Reflections: The Past and Future of Research on Institutions and Institutional Change. *Journal of Change Management*, 10(1), pp. 5-21.
- Seidel, S., & Recker, J. (2012). *Implementing green business processes : the importance of functional affordances of information systems*. Paper presented at the Proceedings of the 23rd Australasian Conference on Information Systems, 3 - 5 December, Geelong, Victoria.
- Seidel, S., Recker, J., Pimmer, C., & vom Brocke, J. (2010). *Enablers and Barriers to the Organisational Adoption of Sustainable Business Practices*. Paper presented at the Proceedings of the 16th Americas Conference on Information Systems (AMCIS 2010), 12 - 15 August, Lima, Peru.
- Seidel, S., Recker, J., Pimmer, C., & vom Brocke, J. (2014). IT-enabled Sustainability Transformation--The Case of SAP. *Communications of the Association for Information Systems*, 35(1), pp. 1-17.
- Seidel, S., Recker, J., & vom Brocke, J. (2012). Green Business Process Management. In J. vom Brocke, S. Seidel & J. Recker (Eds.), *Green Business Process Management: Towards the Sustainable Enterprise* (pp. pp. 3-13): Springer Berlin Heidelberg.
- Seidel, S., Recker, J., & vom Brocke, J. (2013). Sensemaking and sustainable practicing: Functional affordance of information systems in green transformations. *MIS Quarterly*, 37(4), pp. 1275-1299.
- Seidel, S., Szekely, N., & vom Brocke, J. (2015). *Green IS: Are We Still Thinking in Mere Economic Imperatives or Are We Striving for Eco-Effectiveness*. Paper presented at the Proceedings of the 21st Americas Conference on Information Systems, 13 - 15 August, Puerto Rico, USA.
- Sharma, S., & Vredenburg, H. (1998). Proactive corporate environmental strategies and the development of competitively valuable organisational capabilities. *Strategic Management Journal*, 19, pp. 729-753.

- Sharman, Z. (2007). Remembering the basics: Administrative technology and nursing care in a hospital emergency department. *International Journal of Medical Informatics*, 76(1), pp. 222-228.
- Shaw, T., & Jarvenpaa, S. L. (1997). Process Models in Information Systems. In A. S. Lee, J. Liebenau & J. DeGross (Eds.), *Information Systems and Qualitative Research* (Vol. London, pp. pp. 70 - 100): Chapman & Hall.
- Shenoy, S. S., & Eeratta, R. (2011). *Green software development model: An approach towards sustainable software development*. Paper presented at the 2011 Annual IEEE India Conference (INDICON), 16-18 December, Hyderabad, India.
- Shrivastava, P. (1995a). Environmental Technologies and Competitive Advantage. *Strategic Management Journal*, 16, pp. 183-200.
- Shrivastava, P. (1995b). The Role of Corporations In Achieving Ecological Sustainability. *Academy of Management Review*, 20(4), pp. 936-960.
- Simula, H., Lehtimaki, T., & Salo, J. (2009). Managing greenness in technology marketing. *Journal of Systems and Information Technology*, 11(4), pp. 331-346.
- Sissa, G. (2013). Longer Use, Better Use: How to Avoid Software Induced Hardware Obsolescence. In P. O. de Pablos (Ed.), *Green Technologies and Business Practices: An IT Approach* (pp. pp. 163-174). Hershey, PA: IGI Global.
- Sobotta, A. T., Sobotta, I. N., & Gotze, J. (2010). *Greening IT: How Greener IT Can Form a Solid Base for a Low-Carbon Society*: Creative Commons.
- Somers, T. M., & Nelson, K. (2004). A Taxonomy of Players and Activities Across the ERP Project Life Cycle. *Information & Management*, 41(3), pp. 257-278.
- Sorgenfrei, C., Katharina, E., Stefan, S., & Murray, E. J. (2014). *From acceptance to outcome: Towards an integrative framework for information technology adoption*. Paper presented at the 22nd European Conference on Information Systems, 9 - 11 June, Tel Aviv, Israel.
- Souder, W. E., & Quaddus, A. (1982). A decision modeling approach to forecasting the diffusion of longwall mining technologies. *Technological Forecasting and Social Change*, 21, pp. 1-14.
- Sproedt, A., Plehn, J., Schonsleben, P., & Herrmann, C. (2015). A simulation-based decision support for eco-efficiency improvements in production systems. *Journal of Cleaner Production*, 105, pp. 389-405.
- Starik, M., & Rands, G. (1995). Weaving an integrated web: Multilevel and multisystem perspectives of ecologically sustainable organizations. *Academy of Management Review*, 20(4), pp. 908-935.

- Staw, B. M., & Epstein, L. D. (2000). What bandwagons bring: Effects of popular management techniques on corporate performance, reputation, and CEO pay. *Administrative Science Quarterly*, 45(3), pp. 523-556.
- Steenwijk, M. (2011). *A Reference Architecture for Fuel-based Carbon Management Information Systems in the Logistics Industry*. University of Twente, Enschede.
- Stockdale, R., & Standing, C. (2006). An interpretive approach to evaluating information systems: A content, context, process framework. *European Journal of Operational Research*, 173(3), pp. 1090-1102.
- Swanson, E. B. (1994). Information Systems Innovation among Organizations. *Management Science*, 40(9), pp. 1069-1092.
- Swanson, E. B., & Ramiller, N. C. (2004). Innovating mindfully with information technology. *MIS Quarterly*, 28(4), pp. 553-583.
- Swartz, D. L. (1997). *Culture and Power: The Sociology of Pierre Bourdieu*. Chicago, IL: University of Chicago Press.
- Tan, B., Pan, S. L., & Zuo, M. (2011). *Attaining and enacting Green Leadership: Insights from the Green IT initiatives of China Mobile*. Paper presented at the 32nd International Conference on Information Systems (ICIS 2011), 4 - 7 December, Shanghai, China.
- Taylor, A., Cocklin, C., & Brown, R. (2012). Fostering environmental champions: A process to build their capacity to drive change. *Journal of Environmental Management*, 98, pp. 84-97.
- Teece, D. J. (1980). The diffusion of an administrative innovation. *Management Science*, 26, pp. 464-470.
- The Climate Group (2008). *SMART 2020: Enabling the low carbon economy in the information age*
- Thirtle, C. G., & Ruttan, V. W. (1986). *The Role of Demand and Supply in the Generation and Diffusion of Technical Change*, University of Minnesota.
- Thompson, V. A. (1965). Bureaucracy and innovation. , 10, pp. 1-20. *Administrative Science Quarterly*, 10, pp. 1-20.
- Toffel, M. W., & Horvath, A. (2004). Environmental implications of wireless technologies: News delivery and business meetings. *Environmental Science & Technology*, 38(11), pp. 2961-2970.
- Tolbert, P. S., & Zucker, L. G. (1983). Institutional sources of change in the formal structure of organisations: the diffusion of civic service reform, 1880-19935. *Administrative Science Quarterly*, 28, pp. 22-39.
- Tornatzky, L. G., Eveland, J. D., Boyland, M. G., Hetzner, W. A., Johnson, E. C., Roitman, D., et al. (1983). *The process of technological innovation: Reviewing the literature:*

Division of Industrial Science and Technological Innovation, National Science Foundation.

- Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington, Massachusetts: Lexington Books.
- Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management*, 29(1), pp. 28-43.
- Vaia, G., Carmel, E., DeLone, W., Trautsch, H., & Menichetti, F. (2012). Vehicle telematics at an Italian insurer: New auto insurance products and a new industry eco-system. *MIS Quarterly Executive*, 11(3), pp. 113-125.
- van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science*, 32(5), pp. 590-607.
- van de Ven, A. H., & Angle, H. L. (1989). An Introduction to the Minnesota Innovation Research Program. In A. H. van de Ven, H. L. Angle & M. S. Poole (Eds.), *Research on the Management of Innovation: The Minnesota Studies* (pp. pp. 3-30). New York: Harper & Row.
- van de Ven, A. H., Polley, D., Garud, R., & Venkatraman, S. (1999). *The Innovation Journey*. New York, NY: Oxford University Press.
- van de Ven, A. H., & Poole, M. (1989). Methods for studying innovation processes. In A. van de Ven, H. L. Angle & M. Poole (Eds.), *Research on the Management of Innovation* (pp. pp. 31-54). New York: Harper & Row.
- van de Ven, A. H., & Poole, M. (1990). Methods for studying innovation development in the Minnesota Innovation Research Program. *Organization Science*, 1(3), pp. 313-335.
- van de Ven, A. H., & Rogers, E. (1988). Innovations and organisations: Critical perspectives. *Communication Research*, 15(5), pp. 632-651.
- van Osch, W., & Avital, M. (2010). *From Green IT to Sustainable Innovation*. Paper presented at the Proceedings of the Americas Conference on Information Systems, 12 - 15 August, Lima, Peru.
- Vanier, D. J. (2004). *Geographic information systems (GIS) as an integrated decision support tool for municipal infrastructure asset management*. Paper presented at the CIB 2004 Triennial Congress, 2 - 9 May, Toronto, Canada.
- Vermaas, K., & Bongers, F. (2008). Broadband in Telework, Health and Safety: The User Perspective. *Journal of Internet Commerce*, 6(2), pp. 73-96.
- Visser, W., & Crane, A. (2010). Corporate sustainability and the individual: Understanding what drives sustainability professionals as change agents. *Social Science Research Network (SSRN)*.

- vom Brocke, J., Seidel, S., & Recker, J. (2012). *Green Business Process Management: Towards the Sustainable Enterprise*: Springer-Verlag.
- vom Brocke, J., Watson, R. T., Dwyer, C., Elliot, S., & Melville, N. P. (2013). Green Information Systems: Directives for the IS Discipline. *Communications of AIS*, 33(Article 30), pp. 509-520.
- Walsham, G. (1993). *Interpreting information systems in organisations*. London: John Wiley & Sons.
- Walsham, G. (2002). Cross-cultural software production and use: A structural analysis. *MIS Quarterly*, 26(4), pp. 359-380.
- Walsham, G., & Waema, T. (1994). Information Systems Strategy and Implementation: A Case Study of a Building Society. *ACM Transactions on Information Systems*, 12(2), pp. 150-173.
- Watson, R. T., Boudreau, M.-C., & Chen, A. J. (2010). Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community. *MIS Quarterly*, 34(1), pp. 23-38.
- Watson, R. T., Boudreau, M.-C., Li, S., & Levis, J. (2010). Telematics at UPS: En route to Energy Informatics. *MIS Quarterly Executive*, 9(1), pp. 1-11.
- Watson, R. T., Boudreau, M.-C., York, P. T., Greiner, M. E., & Wynn, D. (2008). The business of open source. *Communication of ACM*, 51, pp. 41-46.
- Watson, R. T., Howells, J., & Boudreau, M.-C. (2012). Energy Informatics: Initial Thoughts on Data and Process Management. In J. vom Brocke, S. Seidel & J. Recker (Eds.), *Green Business Process Management* (pp. 147-159). Berlin: Springer-Verlag Berlin Heidelberg.
- Watson, R. T., Lind, M., & Haraldson, S. (2012). *The Emergence of Sustainability as the New Dominant Logic: Implications for Information Systems*. Paper presented at the Proceedings of the Thirty Third International Conference on Information Systems (ICIS 2012), 16 - 19 December, Orlando, FL.
- Watson, R. T., Williamson, T., Boudreau, M.-C., Li, S., & Zeng, Z. (2011). *Energy Informatics and Business Model Generation*, Sprouts: Working Paper on Information Systems, 11(16).
- Weilbach, L., & Byrne, E. (2010). A human environmentalist approach to diffusion in ICT policies: A case study of the FOSS policy of the South African Government. *Journal of Information, Communication and Ethics in Society*, 8(1), pp. 108-123.
- Wellstead, P. E. (2003). Control and systems concepts in the innovation process. *IEEE Control Systems*, 23(6), pp. 21-29.
- Wernick, I. K. (2002). Environmental knowledge management. *Journal of Industrial Ecology*, 6(2), pp. 7-9.

- West, M. A., & Anderson, N. R. (1996). Innovation in top management teams. *Journal of Applied Psychology, 81*(6), pp. 680-693.
- Winnard, J., Adcroft, A., Lee, J., & Skipp, D. (2014). Surviving or flourishing? Integrating business resilience and sustainability. *Journal of Strategy and Management, 7*(3), pp. 303-315.
- Wolfe, R. (1994). Organisational innovation: Review, critique and suggested research directions. *Journal of Management Studies, 31*(3), pp. 405-431.
- Yang, X., Moore, P. R., Wong, C. B., Pu, J. S., & Chong, S. K. (2007). Product lifecycle information acquisition and management for consumer products. *Industrial Management & Data Systems, 107*(7), pp. 936-953.
- Yin, R. K. (1994). *Case Study Research, Design and Methods (2nd Edition)*. Newbury Park: Sage Publications.
- Yin, R. K. (2003). *Case Study Research (3rd Edition)*. London: Sage Publications.
- York, P. T., Watson, R. T., Boudreau, M.-C., & Chen, A. J. (2009). *Green IS: Using information systems to encourage green behaviour*. Paper presented at the 2009 Academy of Management Annual Meeting, 7 - 11 August, Chicago, IL.
- Zaltman, G., Duncan, R., & Holbeck, J. (1973). *Innovations and organisations*. New York: Wiley.
- Zhang, H., Liu, L., & Li, T. (2011). Designing IT systems according to environmental settings: A strategic analysis framework. *Journal of Strategic Information Systems, 20*(1), pp. 80-95.
- Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: A technology diffusion perspective on e-business. *Management Science, 52*(10), pp. 1557-1576.

APPENDICES

Appendix 4.1: Ethics Approval



RMIT University

GPO Box 2476V
Melbourne VIC 3001
Australia

Tel. +61 3 9925 1408
Fax +61 3 9925 5595
www.rmit.edu.au

Ref: Ethics Appl. 1000234

Tuesday, 23 November 2010

Dear Mohamad

I am pleased to advise that your application for ethics approval for a Research Project has been approved by the Chair of the Business College Human Ethics Advisory Network. Approval has been granted for the period from 17 November 2010 to 20 July 2013.

The RMIT Human Research Ethics Committee (HREC) requires the submission of Annual and Final reports. These reports should be forwarded to the Business College Human Ethics Advisory Network Secretary. Annual Reports are due in December for applications submitted prior to September the year concerned. I have enclosed a copy of the Annual/ Final report form for your convenience. Please note that this form also incorporates a request for extension of approval, if required.

Best wishes for your research.

Yours sincerely

Kristina Tsoulis-Reay
Secretary
Business College Human Ethics Advisory Network

Encl.

Appendix 4.2: Plain Language Statement for Data Collection



College of Business
School of Business Information Technology & Logistics

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT PROJECT INFORMATION STATEMENT

Project Title:

The Use of Green Information Systems and its Benefits for Eco-sustainability

Investigators:

- Mohamad Taha Ijab (PhD Candidate, School of Business Information Technology & Logistics, RMIT University)
- Assoc. Prof. Alemayehu Molla (Senior Supervisor, School of Business Information Technology & Logistics, RMIT University, alemayehu.molla@rmit.edu.au, +(613) 9925 5803)
- Dr. Say Yen Teoh (Second Supervisor, School of Business Information Technology & Logistics, RMIT University, sayyen.teoh@rmit.edu.au, +(613) 9925 5788)

Dear Participant,

You are invited to participate in a research project being conducted by RMIT University. This information sheet describes the project in a straightforward language, or 'plain English'. Please read this sheet carefully and be confident that you understand its contents before deciding to participate. If you have any questions about the project, please contact one of the investigators.

This research is being conducted by Mohamad Taha Ijab, a PhD scholar enrolled in the School of Business Information Technology & Logistics. The research is supervised by Assoc Prof. Alemayehu Molla and Dr. Say Yen Teoh of the School of Business Information Technology & Logistics, RMIT University. The aim of the project is to understand how Information Systems can be developed, deployed and used in enabling organisational eco-sustainability practices. The examples of eco-sustainable practices include the use of environmental management systems, conduct of remote meeting via videoconferencing, use of intelligent building management systems, use of green procurement and use of reporting/auditing mechanisms or tools for power usage. This research project has been approved by the RMIT Human Research Ethics Sub-Committee (Ref. No: 1000234).

You have been approached to participate in this research project because Telecom Acadia is chosen as a case study, and Telecom Acadia has consented for this research to be conducted in consultation with Telecom Acadia's Information Technology Department. You have been identified as a person involved in Telecom Acadia's Green IT and MyEarth initiatives or as a person responsible for Telecom Acadia's environmental stewardship or Information Systems management or operation management activities. Being the employee of Telecom Acadia, you are invited to participate in this research. For this phase of the study, twelve (12) employees of Telecom Acadia will be invited to participate in this research. A further sixty (60) staff members is expected be invited to participate in the next phase of the study at the later stage of this research.

As a participant in this research, I would like to interview you and ask a series of questions relating to your involvement and use of Information Systems for eco-sustainability in your organisation. For example, I will be asking about your perception towards eco-sustainability, the role that you played in the use of Information Systems for eco-sustainability, the frequency of you using the systems and the factors influencing your use of the systems. The interview should take between 30 minutes to 1 hour. The interview will take place at a location convenient to you and your permission will be sought to audio-tape the interview.

All information gathered during the course of this research, including your responses, will be securely stored for a period of five years in the School of Business IT & Logistics, RMIT University and can only be accessed by the researchers. After five years, the data will be destroyed. Results published in academic journals and conferences will not include information that can potentially identify either you or your organisation. Pseudonyms will be provided in order to maintain anonymity.

There are no foreseeable risks associated with your participation in this research. Your participation will assist the researcher and the wider information systems community in understanding the roles played by Information Systems in enabling organisational eco-sustainability practices. Please read the consent form carefully and be confident that you understand its contents before signing the consent form. A copy of signed consent form will be given to you for your records.

Your participation in this research is voluntary. As a participant, you have the right to withdraw your participation at any time, have any unprocessed data withdrawn and destroyed, provided that it can be reliably identified and provided that so doing does not increase your risk; and have any questions answered at any time. Any information that you provide can be disclosed only if (1) it is to protect you or others from harm, (2) a court order is produced, or (3) you provide researchers with written consent.

You are encouraged to ask for clarification at any time of any aspect that concerns you. If you have any questions about the project, please telephone or e-mail me: Mohamad Taha Ijab, telephone +(613) 9925 5662, e-mail: mohamadtaha.ijab@rmit.edu.au or my Senior Supervisor, Associate Professor Alemayehu Molla, telephone +(613) 9925 5803, email: alemayehu.molla@rmit.edu.au.

Thank you for your participation and co-operation,

Yours sincerely,

Mohamad Taha Ijab
BIT, MSc

<p>Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745. Details of the complaints procedure are available from: www.rmit.edu.au/council/hrec</p>

Appendix 4.3: Consent Form

RMIT Human Research Ethics Committee

HREC Form 2b

Prescribed Consent Form For Persons Participating In Research Projects Involving Interviews, Questionnaires or Disclosure of Personal Information

Portfolio	College of Business		
School of	Business IT & Logistics		
Name of participant:			
Project Title:	THE USE OF GREEN INFORMATION SYSTEMS AND ITS BENEFITS FOR ECO-SUSTAINABILITY		
Name(s) of investigators:	(1)	MOHAMAD TAHA IJAB	Phone: +(613) 9925 5672
	(2)	ASSOC. PROF. ALEMAYEHU MOLLA	Phone: +(613) 9925 5803
	(3)	DR. SAY YEN TEOH	Phone: +(613) 9925 5788

- I have received a statement explaining the interview/questionnaire involved in this project.
- I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.
- I authorise the investigator or his or her assistant to interview me or administer a questionnaire.
- I acknowledge that:
 - Having read Plain Language Statement, I agree to the general purpose, methods and demands of the study.
 - I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
 - The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.
 - The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.
 - The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to RMIT University. Any information which will identify me will not be used.

Participant's Consent

Participant: _____ **Date:** _____
(Signature)

Witness: _____ **Date:** _____
(Signature)

Where participant is under 18 years of age:

I consent to the participation of _____ in the above project.

Signature: (1) _____ (2) _____ **Date:** _____
(Signatures of parents or guardians)

Witness: _____ **Date:** _____
(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

ANY COMPLAINTS ABOUT YOUR PARTICIPATION IN THIS PROJECT MAY BE DIRECTED TO THE EXECUTIVE OFFICER, RMIT HUMAN RESEARCH ETHICS COMMITTEE, RESEARCH & INNOVATION, RMIT, GPO BOX 2476V, MELBOURNE, 3001. THE TELEPHONE NUMBER IS (03) 9925 2251. DETAILS OF THE COMPLAINTS PROCEDURE ARE AVAILABLE FROM THE ABOVE ADDRESS.

Appendix 4.4: Interview Questions for Phase 1

Phase 1 Study Guide for Green IS Users



School of Business IT & Logistics
College of Business

INTERVIEW PROTOCOL

Name: Email:.....
Date: Time start: Time finish:
Company's name: Respondent:
Position: Department:
Year(s) of service: Broad Job Spec:
.....

Setting common understanding:

Eco-sustainability practice is generally framed around eco-sustainability strategies and goals. For example, organisations follow several strategies in pursuing eco-sustainability goals. Hart (1995, 1997) propose three stages of eco-sustainability strategies: *pollution prevention, product stewardship and clean technology*. Others such as Olander and Thøgersen (1995) and Vleg and Steg (2007) use *sustainability behaviour* as part of eco-sustainability strategies. Eco-sustainability goals refer to the outcomes organisations intend to achieve by formulating strategy and practices. These are commonly classified into three categories of *eco-efficiency* (DeSimone & Popoff, 1997), *eco-effectiveness* (McDonough & Braungart, 1998) and *eco-equity* (Gray & Bebbington, 2000).

In simple term, eco-sustainability practices can be understood as any practices that are good or friendly to the environment, sustainable in nature and not harmful to human and environment while practiced or used. For this research, the focus of study is the use of technology particularly information systems for eco-sustainability practices.

In this phase of the study, for open unstructured interviews, questions will be asked around, but not restricted to the followings:

General questions covering attitudes, beliefs and concerns

1. What is eco-sustainability and climate change mean to you?
2. How do you learn about climate change and eco-sustainability? *(i.e from reading newspapers, TV, Internet, workplace communications)*
3. Do you believe the impact of climate change and eco-sustainability (being good to the environment)? How does climate change and eco-sustainability impact you as a person and as a member of this organisation and also as a member of the society?
4. Thinking about your background, past experience, socialisation, education, ect, what are your expectations for eco-sustainability?
5. How do the practices of your immediate family members, friends, and colleagues shape your view and practices on eco-sustainability? *(i.e follow their examples of recycling, printer optimisation, teleworking, online collaboration, power management - switching off pc/standby appliances, car pooling, etc)*
6. Do you think we should actually take notice and take action?
7. What do you think can be done to reduce the impact of climate change from individual, group, organisation and societal level?
8. Are you concerned with what Acadia is doing (reflected through its actions and initiatives) on eco-sustainability?
9. If you are in the decision-making position, why do you think Acadia should invest, use, evaluate, communicate and influence others (i.e staff, customers, business partners/vendors) in using technology for eco-sustainability?

Eco-sustainability practices using technology (IF INTERVIEWING USER)

10. What does technology personally mean to you?
11. What technologies (software or hardware) that you use in this organisation that can be considered as supporting eco-sustainability practices?
12. How and why do you use this technology for eco-sustainability practices? *(i.e sanctioned by the company, cheapest solution available (i.e free or minimum cost), simply using it to communicate, I am developing it for my company's use, etc)*
13. What is your attitudes (positive, negative, like, dislike) towards the use of this technology for eco-sustainability practices and why?

Phase 1 Study Guide for Green IS Users

14. What is the main purpose or goal for using this technology? *(i.e to reduce operation cost, to save energy, to reduce waste, to reduce emission, just to comply with the instructions of the bosses, etc)*
15. What role does the technology play in the context of your eco-sustainability practices? *(i.e enabling, promoting, transforming)*
16. Who else uses this technology? Why do they use this technology? *(i.e staff in other division, branches, technicians in the field, or fleet managers and drivers, etc)*
17. Who influences you to use this technology? Why do they do that?
18. How frequent do you use this technology? Is the frequency of use can be considered as the major element to achieve the benefits of this technology?
19. Who control the use of this technology?
20. What are the things that you need in order to continuously or repetitively use this technology? *(i.e information, guidance, training, budget, motivation from superior, direction from the superiors or regulators or business partners)*
21. What are the benefits you and Acadia gain from using this technology? *(i.e reduction in cost of operation, being able to give back to the environment, brand image, market leadership, etc)*
22. In terms of the benefits from the use of this technology for eco-sustainability practice, how are the baseline, targets and achievements are set, tracked, measured and evaluated? Who set, track, measure and evaluate them?
23. Is it part of the individual, department, division, or organisation key performance indicators?
24. What is at stake if you are not using this technology?
25. What other challenges do you encounter in practicing sustainable practices using this technology?



School of Business IT & Logistics
College of Business

INTERVIEW PROTOCOL

Name: Email:.....
Date: Time start: Time finish:
Company's name: Respondent:
Position: Department:
Year(s) of service: Broad Job Spec:
.....

Setting common understanding:

Eco-sustainability practice is generally framed around eco-sustainability strategies and goals. For example, organisations follow several strategies in pursuing eco-sustainability goals. Hart (1995, 1997) propose three stages of eco-sustainability strategies: *pollution prevention, product stewardship and clean technology*. Others such as Olander and Thøgersen (1995) and Vleg and Steg (2007) use *sustainability behaviour* as part of eco-sustainability strategies. Eco-sustainability goals refer to the outcomes organisations intend to achieve by formulating strategy and practices. These are commonly classified into three categories of *eco-efficiency* (DeSimone & Popoff, 1997), *eco-effectiveness* (McDonough & Braungart, 1998) and *eco-equity* (Gray & Bebbington, 2000).

In simple term, eco-sustainability practices can be understood as any practices that are good or friendly to the environment, sustainable in nature and not harmful to human and environment while practiced or used. For this research, the focus of study is the use of technology particularly information systems for eco-sustainability practices.

In this phase of the study, for open unstructured interviews, questions will be asked around, but not restricted to the followings:

General questions covering attitudes, beliefs and concerns

1. What is eco-sustainability and climate change mean to you?
2. How do you learn about climate change and eco-sustainability? *(i.e from reading newspapers, TV, internet, workplace communications)*
3. Do you believe the impact of climate change and eco-sustainability (being good to the environment)? How does climate change and eco-sustainability impact you as a person and as a member of this organisation and also as a member of the society?
4. Thinking about your background, past experience, socialisation, education, ect, what are your expectations for eco-sustainability?
5. How do the practices of your immediate family members, friends, and colleagues shape your view and practices on eco-sustainability? *(i.e follow their examples of recycling, printer optimisation, teleworking, online collaboration, power management - switching off pc/standby appliances, car pooling, etc)*
6. Do you think we should actually take notice and take action?
7. What do you think can be done to reduce the impact of climate change from individual, group, organisation and societal level?
8. Are you concerned with what Acadia is doing (reflected through its actions and initiatives) on eco-sustainability?
9. If you are in the decision-making position, why do you think Acadia should invest, use, evaluate, communicate and influence others (i.e staff, customers, business partners/vendors) in using technology for eco-sustainability?

Eco-sustainability practices using technology (IF INTERVIEWING SYSTEM DEVELOPER)

10. What does technology personally mean to you? What does developing this technology personally mean to you? Why?
11. What technologies (software or hardware) that you develop for Acadia that can be considered as supporting eco-sustainability practices?
12. What is the main objective or function of the system that you are developing? *(i.e to track, monitor and report energy use; to reduce energy usage of the company; to enable conferencing to happen and to reduce travel, etc)*
13. What is your attitudes (positive, negative, like, dislike) towards the anticipated use of the technology you are developing for eco-sustainability practices and why?

Phase 1 Study Guide – Interview with Green IS Developers

14. What eco-sustainability practices that you as a system developer get to use in your development work? *(i.e reuse of codes, open source, agile software development, use of leaner software design and architecture, etc)*
15. What are the resources that you need in getting the system designed and developed?
16. Who are the target users of your system? Why would they use this technology?
17. Who influenced or mandated or fund you to develop this technology? Why do they do that?
18. Who would control the use of this technology when it is released to end users?
19. What are the things that the end users need in order to be able to use this technology on continuous or repetitive basis? *(i.e information, guidance, training, budget, motivation from superior, direction from the superiors or regulators or business partners)*
20. What are the benefits you as system developer, end users and Acadia would gain from using this technology? *(i.e reduction in cost of operation, being able to give back to the environment, brand image, market leadership, etc)*
21. What is at stake if the system is not used?
22. What other challenges do you encounter in practicing sustainable practices while developing this system/technology?

Appendix 4.5: Interview Questions for Phase 2

Interview Questions - Phase Two Guide



College of Business
School of Business IT & Logistics

INTERVIEW PROTOCOL

Date: Time start: Time finish:
Company's name: Respondent:
Position: Department:
Year(s) of service: Broad Job Spec:
.....

Grand tour question (to begin the discussion and frame the interview)

1. How important is eco-sustainability to your organisation?

Knowledge and attitude toward environmental issues

2. What is your personal perception towards climate change and eco-sustainability?
3. What is your personal perception towards the use of IS for enabling eco-sustainability?
4. What is your general opinion with regards to the attitude of the IT sector, telecommunication industry, and individual users toward eco-sustainability?
5. Would you view your company as a non-compliant, compliant or proactive player in the eco-sustainability practices? Why do you think so?
6. Did your company change its attitude toward environmental issues overtime? Can you explain?

Organisation's IS-enabled eco-sustainability practices

7. What are the IS-enabled eco-sustainability practices that you are involved in? When did you start this initiative? What triggered this practice?
8. Explain your role in the implementation of this IS-enabled eco-sustainability practice.
9. Who and/or what influences you/your department/division to implement this IS-enabled eco-sustainability practice? (*i.e top management, other divisions, company policy, etc*)
10. Who are also involved in this IS-enabled eco-sustainability practice? (*i.e colleagues,*

Interview Questions - Phase Two Guide

business partners, vendors, customers, other industry players, government agencies?)

11. How frequent are you using this IS-enabled eco-sustainability practice? *(Can I observe your involvement in this particular IS-enabled eco-sustainability practice?)*
12. What are the processes involved in the implementation of this IS-enabled eco-sustainability practice? *(i.e evaluating → procuring → using → post-use evaluation OR designing/developing → using → post-use evaluation)*
13. What do you wish to achieve as the outcome of this IS-enabled eco-sustainability practice you are implementing?

Resources needed in the use of IS-enabled eco-sustainability practices

14. What are the resources or training that you need in order to practice IS-enabled eco-sustainable practices?
15. Are you having issues/problems in getting the right resources or training to practice IS-enabled eco-sustainable practices? What are they?
16. How do you propose to overcome these issues/problems?

Strategies used in the implementation of IS-enabled eco-sustainability practices

17. What are the strategies that you use in the implementation of IS-enabled eco-sustainability practice?
18. Are you aware of the eco-sustainability strategies and its associated initiatives implemented by your company? What are they?
19. What strategies, policies, and procedures do you think the company could adopt to widely embrace IS-enabled eco-sustainable practices?

Factors affecting the use of IS-enabled eco-sustainability practices

20. What are the factors (i.e personal beliefs, values, culture or upbringing) do you think influence the way you perceive about eco-sustainability issues and change your behaviour towards a more sustainable ones?
21. What about other factors (internal and external to the company) that you believe significantly influence IS-enabled eco-sustainability practices?

Appendix 4.6: Survey Questions for Phase 2

Survey Questions – Phase 2



**School of Business IT & Logistics
College of Business**

SURVEY QUESTIONS

1. Gender: Male/Female
2. Age range
 - a. < 20 years
 - b. 20 – 25 years old
 - c. 26 – 30 years old
 - d. 31 – 36 years old
 - e. 36 – 40 years old
 - f. 41 – 45 years old
 - g. 46 – 50 years old
 - h. > 50 years old
3. Position
4. Unit/Section/Department/Division
5. Years of service
 - a. < 2 years
 - b. 2 – 5 years
 - c. 6 – 10 years
 - d. 11 – 15 years
 - e. 16 – 20 years
 - f. 21 – 25 years
 - g. 26 – 30 years
 - h. > 30 years
6. Based on the following statements, choose the statements that best reflect your environmental orientation.
 - a. The environmental problems can only be controlled by enforcing radical changes in human behavior and in society as a whole
 - b. The environmental problems are not running out of control, but the government should dictate clear rules about what is and what is not allowed
 - c. We do not need to worry about environmental problems because in the end, these problems will always be resolved by technological solutions
 - d. We do not know whether environmental problems will aggravate or not, so we need not worry much about it

Survey Questions – Phase 2

7. Your practice of using UCC:

Practice Use of UCC	Using	Not Using
To chat with colleagues		
To SMS to colleagues		
To make VoIP calls		
To do video conferencing with colleagues		
To do file transfer with colleagues		
To fax documents to colleagues		
To create special interest group with colleagues		

8. Your practice of using SDAM:

Practice Use of SDAM	Using	Not Using
To download company's organisational documents		
To access the company's online services/applications relevant to your work		
To read the messages written by the GCEO on various topics including on environmental sustainability related entries		
To download shared documents by your colleagues in Acadia		
To share documents with your colleagues in Acadia		
To book/reserve a meeting room		
To create small applications on your division's Workgroup (such as creating e-forms)		
To create and maintain your personal MySite		

9. Your practice of using MyEarth portal:

Practice Use of MyEarth portal	Using	Not Using
To read environmental sustainability tips and opinions shared by your colleagues within Acadia		
To download MyEarth e-Calendar		
To register yourself to become a volunteer in MyEarth related activities		
To register yourself to become a Nature Loving Club member		
To share environmental sustainability tips and opinions with your colleagues within Acadia		

Appendix 5.1: Detailed Description of the Fleet Management System (FMS)

The **Auto Leasing and Servicing System (ALSS)** becomes the “feeder” of information pertaining to vehicles for SIMO, AVLS, CSM and e-Log Book. This is because all information pertaining to each individual vehicle is stored inside the ALSS database. Fleet Management Department staff members update the information for each vehicle when it is acquired from the vehicle supplier. This information includes the registration (plate) number, date of registration, road tax information, the vehicle model, type of vehicle, engine type, engine size, road tax number, the cost center, the description of cost center where the vehicle is assigned to, the fleet card number associated with the vehicle, the name of authorised driver(s) associated with the vehicle, fuel consumption information, service maintenance information, traffic violation information, disposal date, and various other information.

For fuel consumption information and payment to the fuel suppliers, Acadia uses a system called **SIMO(Supplier Invoice Management Online)**. SIMO is a system used by Finance Division to capture fuel spending and consumption from its fleets. Acadia started using SIMO in 2002 when the company signed a contract on fuel supply from three preferred fuel providers for its fleet, including Shell, Exxon Mobil and the state-owned fuel supplier.

Fuel purchases are made using a fleet card issued to each authorised drivers. Based on the fuel purchase record, Acadia receives the softcopy of fuel invoices(via email) from the fuel suppliers’ headquarters on monthly basis. Finance Clerks import the invoice data into SIMO. Once monthly invoices are entered into SIMO, the Finance Manager requests all the fleet supervisors to verify the data on SIMO via email. In response, the fleet supervisors view, verify and approve fuel purchase amounts on SIMO against the information recorded in the e-Log Book or manual Log Book. Upon approval, the finance manager releases the payment to the fuel suppliers.

The Finance Division also generates an Excel-based report from SIMO. The report is

shared via email with the Manager of the Fleet Management Department for their further analysis. Fleet Manager 01 explained that the SIMO-based report contains information including the cost center, fuel vendor name and service station, invoice number, fleet card number (associated with the authorised driver), vehicle number, supervisor name, transaction date, transaction amount, volume usage, and receipt number. Typically, Fleet Managers analyse the SIMO report for irregularities such as a sudden spikes in the overall fuel consumption. If there is such as situation, a “flag” would be raised (manually), and the cause of the fuel increase would be traced to specific cost centers contributing to the spike. Justifications would be asked from the cost center (via their fleet supervisors) on the increased fuel consumption, such as in additional workloads during the month, or other possible causes. If further action is needed, for example if a specific vehicle was using too much fuel, this could be pinpointed. This action is used to overcome behavioural misconduct (for example, the use of company vehicles for personal use during or beyond standard work hours excluding over time; or pilfering company fuel for personal use).

According to the Assistant General Manager of Support Business, the management team of Property Operations Department and Fleet Management Department would have a meeting with the Support Business’ top management chaired by the Vice President of Support Business on monthly basis. Both General Managers of Property Operations and Fleet Management would present and report strategic and operational issues internal to them to the top management of Support Business for information, decision and/or further action.

“Structure-wise, the top management of Support Business would report to Acadia’s Chief Financial Officer (CFO). Members of the SB top management include the VP, the GMs of Property Operations and Fleet Management, and some GMs from Finance Division. People like me and my staff, we form the working level”(Assistant General Manager of Support Business)

The AGM added:

“We go into detail during the meeting, until specific summonses level. Very

detail.” (Assistant General Manager of Support Business)

Another Fleet Management System called **Automatic Vehicle Location System (AVLS)** was also used in Acadia. It is a telematics system used to automatically track the location of mobile assets in near real time basis (i.e., 3-5 minutes interval) with the use of global positioning system (GPS) and Global System for Mobile communication (GSM) antenna technologies. AVLS uses the GPS network communications and geo-spatial system technology to monitor the location and status information of vehicles or any mobile assets from remote locations through the Internet, and relaying the location back to the monitoring centre using GSM network. The fleet data are integrated with Acadia’s informative GIS technology and it provides pinpoint accuracy up to 3meter – 5meter on the street level. For efficient planning and routing, the mapping software was purpose-built to include all Acadia’s commercial buildings, network exchanges buildings, transmission towers, and hill stations for switching and transmission operations as well as network maintenance as the AVLS’ “point of interests (POIs)”. Fleet managers at Fleet Management Department and fleet supervisors are able to track the vehicles using the AVLS secure website, protected by password and enable only authorised users to use the AVLS website (i.e., not open to all Acadia’s staff).

AVLS is partly software and partly hardware. The software part is the mapping system enabling the tracking of the fleets while the hardware part consist of the black box and RFID tag installed onboard of the selected vehicles, as well as the mapping software accessed through the AVLS website. The AVLS is only activated when the driver pushed on the button, and then turn on the vehicle’s engine. To ensure usage, no manual override is allowed. Hence, driver has no interaction with the AVLS.

The cost of AVLS installation with the RFID tag and subscription is AUD\$570 each. The subscription is for the cost of SMS, digital maps and fleet tracking solution. The total cost from installation in July 2007 was AUD\$186,700. Installation of AVLS RFID hardware started in stages beginning July 2007 involving 352 vehicles in 7 zones nationwide. Due to the small number of vehicles (as of 2007, the number of vehicles are 5,478, the percentage of installation of 6%), the AVLS project can be

considered as pilot. However, AVLS did not go past its pilot implementation because in the middle of 2010, the project was closed down due to unavoidable issue with the partner company.

The features of AVLS include near real time tracking via AVLS website, vehicle positions (locations), speed, direction, date and time of each location, distance traveled, estimation of fuel consumption, idling behavior, routing, usage after work hours, automatic alarm if over-speeding (beeping sound) detected through the RFID sensor, capturing record of number of times speeding. AVLS is also used to generate daily report based on the above data (shared with the top management or supervisors of the authorised drivers if requested). AVLS enables searching capability such as searching by vehicle registration number (supplied by ALSS). AVLS keeps up to 3 months of historical data memory for trend analysis.

The **Customer Service Module** and **e-Log Book** are two sub-systems of ALSS. It is developed as to provide the fleet supervisors and authorised drivers the ability to interact and feed information into the system. Customer Service Module and e-Log Book can be used by other staff in Acadia, log in using staff ID and password. While CSM and e-Log Book can be accessed by everyone, it is more useful for “authorised drivers” and staff who are managing fleet operations at the regional and state offices. CSM and e-Log Book are more operation-oriented, while ALSS is more “administrative” or “back-office” information for the vehicles. CSM tracks the history of the vehicle, vehicle movement, and the travels it made. CSM contains information such as the date when the road tax will expire, and the next maintenance date will expire. CSM also have clock-in for maintenance, and odometer readings. Most of these data come from the ALSS and also from the data keyed in the e-Log Book.

There are two practices in updating dynamic information of vehicles by the drivers. One is updating the dynamic information directly using e-Log Book every time after making the trip, and the second practice is by using manual Log Book, and updating the information to the e-Log Book system on weekly basis. Dynamic information includes refuelling record, and trips made using the vehicles such as the odometer readings, destination, and purpose of the task being attended to. For the first practice,

the authorised drivers would update the information themselves, while in the second practice, fleet supervisors may also assist in updating the information onto the system.

It is noted that while the use of e-Log Book is a new fleet management practice in Acadia, its use was not made mandatory as yet. According to the Fleet Manager, eventually, e-Log Book is meant to replace the manual log book previously used by authorised drivers every time they are using the company's vehicles. However, due to lack of policy, its use is still being "encouraged" by the Fleet Management Department instead of being made mandatory.

"At the moment, we just encourage them to use the system (CSM and e-Log Book). Not mandatory. So some people still use the manual system which is logging on a manual log book. We have not really enforce on that. We just look at our service centre only at the moment, not at the subsidiaries." (Fleet Manager 01)

For the manual practice, drivers would update the manual log book whenever they are using the vehicle, such as noting down the odometer reading when the trip is made, and the odometer reading when the trip is completed. Additional information such as refuelling (amount, volume, fuel service station, receipt number) would also be noted down in the manual log book. The authorised driver or the fleet supervisor would update the data into the e-Log Book on weekly basis.

For vehicle maintenance, repair, renewal of road tax, auto-reminder is sent by ALSS to authorised driver via email. In the future, SMS alert is being planned based on the drivers database. Using the ALSS data, fleet managers at Fleet Management Department can analyse the utilisation pattern of the vehicles for each cost center. Such utilisation include pattern such as "normal usage", "under-used", or "overused". For example, during the interview, the Fleet Manager opened a report on CSM and by looking at total distance made by two vehicles randomly picked by him. Using the data, and experience of 20 years working in the Fleet Management Department, the manager was able to say that the vehicle's use pattern as "normal" while the other vehicle was considered "underused".

When there is a need to analyse certain information such as utilisation of vehicles beyond work hours, **MS-Excel** is used to generate specific data in addition to the data provided by AVLS. Report generated based on the Excel file is used to communicate issues with fleet supervisors (i.e., usage of fleet beyond work hours, vehicles underutilised, fuel consumed beyond normal average consumption, summons unpaid, etc). When there is a valid issue to be raised such as misuse of vehicles, evidence provided by the combination of Fleet Management System are used to substantiate the arguments.