Towards Sustainability in the Chinese Construction Industry: A Transition Approach

Ruidong Chang

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

School of Architecture & Built Environment
Faculty of the Professions
The University of Adelaide
December 2016
Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>iii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>ix</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xi</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>xiii</td>
</tr>
<tr>
<td>Abstract</td>
<td>xvii</td>
</tr>
<tr>
<td>Declaration</td>
<td>xix</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>xxi</td>
</tr>
<tr>
<td>Publications that Emanated from This Research</td>
<td>xxiii</td>
</tr>
<tr>
<td>Chapter 1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Introductory background</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Statement of the problem</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Gaps of knowledge</td>
<td>4</td>
</tr>
<tr>
<td>1.4 Research objectives</td>
<td>6</td>
</tr>
<tr>
<td>1.5 Research focus</td>
<td>6</td>
</tr>
<tr>
<td>1.6 Significance of research</td>
<td>7</td>
</tr>
<tr>
<td>1.7 Thesis structure</td>
<td>8</td>
</tr>
<tr>
<td>Chapter 2 Sustainability and construction enterprises</td>
<td>11</td>
</tr>
<tr>
<td>2.1 Introduction</td>
<td>11</td>
</tr>
<tr>
<td>2.2 Concept of sustainability</td>
<td>12</td>
</tr>
<tr>
<td>2.2.1 Emergence of the concept</td>
<td>12</td>
</tr>
<tr>
<td>2.2.2 Concepts and components of sustainability</td>
<td>15</td>
</tr>
<tr>
<td>2.3 Sustainability and enterprises: evolving theory</td>
<td>18</td>
</tr>
<tr>
<td>2.3.1 Corporate social responsibility</td>
<td>19</td>
</tr>
<tr>
<td>2.3.2 Stakeholder theory</td>
<td>21</td>
</tr>
<tr>
<td>2.3.3 Corporate sustainability</td>
<td>23</td>
</tr>
<tr>
<td>2.3.4 Green economics</td>
<td>25</td>
</tr>
<tr>
<td>2.3.5 Synthesis of the theories</td>
<td>26</td>
</tr>
<tr>
<td>2.4 Sustainability and construction enterprises</td>
<td>28</td>
</tr>
<tr>
<td>2.4.1 Construction industry and its impacts</td>
<td>28</td>
</tr>
<tr>
<td>2.4.2 Sustainability research on construction enterprises</td>
<td>29</td>
</tr>
<tr>
<td>2.4.2.1 Principles and practices of sustainable construction</td>
<td>29</td>
</tr>
</tbody>
</table>
Chapter 3 Approaches to sustainability transition

3.1 Introduction

3.2 Sustainability transition perspective: strengths and concepts

3.2.1 Comparison of sustainability transition perspective with other sustainability approaches

3.2.2 Definitions of socio-technical transitions towards sustainability

3.3 Approaches to sustainability transition

3.3.1 Multi-phase concept (MPC) of transition

3.3.2 Multi-level perspective (MLP) on transitions

3.3.3 Strategic niche management (SNM)

3.3.4 Transition management (TM)

3.3.5 Triple embeddedness framework (TEF)

3.3.6 Comparison of the five approaches to transition

3.3.7 Summary of the key mechanisms behind transitions implied by the MPC, the MLP and TEF

3.4 Development of a research plan for this study

3.4.1 Rationale for examining sustainability of construction firms from the transition perspective

3.4.2 Development of the research plan
Chapter 4 Methodology

4.1 Introduction .................................................................................................................. 85
4.2 Research paradigm and design of this study ............................................................... 86
  4.2.1 Overview of research paradigms ............................................................................ 86
  4.2.2 Sequential mixed methods research ..................................................................... 87
4.3 Research methods ......................................................................................................... 89
  4.3.1 Phase 1: Qualitative data collection and analysis .................................................. 91
    4.3.1.1 Qualitative content analysis ........................................................................ 91
    4.3.1.2 Holistic multiple-case study approach ......................................................... 92
  4.3.2 Phase 2: Connection ............................................................................................ 94
  4.3.3 Phase 3: Quantitative data collection and analysis .............................................. 95
    4.3.3.1 Data collection ............................................................................................ 95
    4.3.3.2 Statistical analysis ...................................................................................... 96
    4.3.3.3 Importance–performance analysis ............................................................... 97
  4.3.4 Phase 4: Synthesis and interpretation .................................................................... 99
4.4 Summary ..................................................................................................................... 99

Chapter 5 Facilitating the transition to sustainable construction: China’s policies

5.1 Introduction .................................................................................................................. 101
5.2 Method ....................................................................................................................... 102
5.3 China’s policy system for sustainability in construction enterprises ...................... 103
  5.3.1 Regulation and control ....................................................................................... 106
  5.3.2 Economic incentives ......................................................................................... 109
    5.3.2.1 Subsidies .................................................................................................. 110
    5.3.2.2 Awards .................................................................................................... 110
    5.3.2.3 Financial innovations ............................................................................. 111
  5.3.3 Supporting activities ............................................................................................. 111
    5.3.3.1 Technological innovation ......................................................................... 112
    5.3.3.2 Standards and evaluation ......................................................................... 113
    5.3.3.3 Demonstration projects ........................................................................... 117
    5.3.3.4 Publicity ................................................................................................... 117
5.4 Emerging challenges ................................................................................................. 118
  5.4.1 Economic and social dimensions of sustainable construction ......................... 118
Chapter 6 Sustainability transitions of leading Chinese construction enterprises: A multiple-case analysis

6.1 Introduction.................................................................................................................. 123
6.2 Method ...................................................................................................................... 124
   6.2.1 Intensity sampling and data source ................................................................. 125
   6.2.2 Inductive category development .................................................................... 129
   6.2.3 Pattern-matching analysis .............................................................................. 131
   6.2.4 Deductive category development .................................................................... 134
6.3 Analysis of individual cases ..................................................................................... 134
   6.3.1 Firm A: China State Construction Engineering Corp. Ltd ......................... 134
      6.3.1.1 Phase 1: Anticipatory ........................................................................... 136
      6.3.1.2 Phase 2: Innovation-based .................................................................. 137
      6.3.1.3 Phase 3: Sustainability-rooted .............................................................. 140
   6.3.2 Firm B: China Communications Construction Company Ltd .................... 142
      6.3.2.1 Phase 1: Reactive .............................................................................. 143
      6.3.2.2 Phase 2: Anticipatory ........................................................................... 144
   6.3.3 Firm C: China Gezhouba Group Co. Ltd ....................................................... 146
      6.3.3.1 Phase 1: Reactive .............................................................................. 147
      6.3.3.2 Phase 2: Anticipatory ........................................................................... 148
6.4 Cross-case analysis ................................................................................................... 150
   6.4.1 Sustainability practices implemented by the case firms ................................. 150
   6.4.2 Different performance of the three case firms ............................................... 152
   6.4.3 Comparison of the three case firms with sustainability guidelines ............... 153
      6.4.3.1 Strong aspects of the case firms ........................................................... 155
      6.4.3.2 Weak aspects of the case firms ............................................................. 156
6.5 Summary .................................................................................................................. 159

Chapter 7 Discovering transition pathways towards sustainability (TPS) for construction enterprises in China: An importance–performance analysis

7.1 Introduction .............................................................................................................. 165
7.2 Method .................................................................................................................... 167
   7.2.1 Identification of critical sustainability aspects (CSAs) and firm size ............. 167
   7.2.2 Data analysis ................................................................................................... 169
      7.2.2.1 Relative rankings of CSAs in the whole sample ................................. 169
      7.2.2.2 Associations between firm size, sustainability attitude and sustainability performance ................................................................. 170
Chapter 8 Drivers for and barriers to sustainability transition of Chinese construction enterprises

8.1 Introduction ............................................................................................................. 199
8.2 Conceptual framework .......................................................................................... 200
8.3 Method .................................................................................................................... 203
  8.3.1 Identification and classification of factors influencing sustainability transitions 203
8.3.2 Data analysis ....................................................................................................... 206
8.4 Results .................................................................................................................... 207
  8.4.1 General features of ranking exercise by the three firm groups ....................... 207
  8.4.2 Comparison of factor categories generated by the three attributes ............... 209
    8.4.2.1 Comparison of drivers and barriers ......................................................... 209
    8.4.2.2 Comparison of niche, regime and landscape levels .............................. 211
    8.4.2.3 Comparison of industry, economic environment and socio-political environment ......................................................... 212
  8.4.3 Comparison of each factor across the three firm groups.............................. 213
    8.4.3.1 Comparison of drivers ........................................................................... 215
    8.4.3.2 Comparison of barriers not significantly different across the groups ....... 217
    8.4.3.3 Comparison of barriers significantly different across the groups .......... 219
8.5 Facilitating the transition towards sustainable construction .............................. 222
  8.5.1 Changes of perceived critical factors in the transition process ..................... 224
  8.5.2 Potential measures facilitating the transition process ...................................... 226
  8.5.3 Next step: towards a systematic model for facilitating transitions? .............. 229
8.6 Summary .............................................................................................................. 233

Chapter 9 Conclusions

9.1 Summary of the research work ............................................................................ 235
9.2 Key findings .................................................................................................................. 239
9.2.1 Policy system for sustainable construction .......................................................... 239
9.2.2 Sustainability perceptions and performance of construction enterprises in general ................................................................. 240
9.2.3 Sustainability perceptions and performance of construction enterprises of different sizes........................................................................................................ 241
9.2.4 Transitions from low-performing to high-performing firms ................................ 242
9.2.5 Drivers for and barriers to sustainability transition of construction enterprises 243
9.2.6 Potential measures to facilitate sustainability transitions ................................. 244
9.3 Contributions of this research ................................................................................... 245
9.3.1 Theoretical contributions ....................................................................................... 247
9.3.2 Empirical contributions ......................................................................................... 249
9.3.3 Practical contributions ......................................................................................... 250
9.3.4 Global implications .............................................................................................. 252
9.4 Suggestions for future research ................................................................................. 253
References ....................................................................................................................... 257
Appendix A: Online questionnaire (in Chinese) .............................................................. 287
Appendix B: English version of the online questionnaire ................................................. 295
Appendix C: Ethics approval.............................................................................................. 303
Appendix D: Published article in Journal of Cleaner Production .................................... 305
Appendix E: Published article in Journal of Management in Engineering ...................... 315
Appendix F: Acceptance letters for journal articles in press ......................................... 329
List of Figures

Figure 1.1 Structure of this thesis ................................................................. 10
Figure 2.1 Key events contributing to the emergence of sustainability ............. 14
Figure 2.2 Word cloud of sustainability ........................................................... 17
Figure 2.3 Milestone documents and evolving theories explaining sustainability issues in corporations .................................................................................. 18
Figure 2.4 Theory landscape of sustainability and business .............................. 27
Figure 2.5 Development of the Chinese construction industry: the GOV, GVA and GVAI .................................................................................................................. 36
Figure 2.6 Development of Chinese construction industry: number of enterprises and employment .................................................................................................................. 36
Figure 2.7 Evolution of construction industry composition ................................ 39
Figure 3.1 Mapping of different approaches to sustainability ............................... 54
Figure 3.2 Alternatives to S-shaped curve of transition ....................................... 62
Figure 3.3 Multi-level perspective on transitions ................................................. 64
Figure 3.4 Cyclical process model of transition management .............................. 68
Figure 3.5 Triple embeddedness framework of industries ................................... 69
Figure 3.6 Comparison of the different approaches ............................................ 71
Figure 3.7 Analysed actors involved in sustainability transition of the construction enterprise .............................................................................................................. 80
Figure 4.1 Visual model of exploratory sequential mixed methods design adopted in this study .................................................................................................................. 90
Figure 4.2 Importance–performance analysis (IPA) grid ..................................... 98
Figure 5.1 Policy gear model of sustainable construction in China ..................... 106
Figure 5.2 China’s technology development plan for green buildings ................ 113
Figure 5.3 Major governmental documents for green building evaluation .......... 116
Figure 6.1 Research procedure and methods in this chapter .............................. 125
Figure 6.2 Critical sustainability aspects (CSAs) identified (N=24) ................... 131
Figure 6.3 China State Construction Engineering Corp. Ltd (CSCEC)’s sustainability transition ...................................................................................................................... 135
Figure 6.4 Innovation throughout the industrial chain ........................................ 137
Figure 6.5 Institution building for environmental management .......................... 139
Figure 6.6 Practices used to manage impacts on biodiversity ............................. 139
Figure 6.7 CSCEC’s culture-led social responsibility progression model ............ 141
Figure 6.8 CSCEC’s approaches to address supply chain management ............... 142
Figure 6.9 China Communications Construction Company Ltd (CCCC)’s sustainability transition .................................................................................................................................................................................. 143
Figure 6.10 China Gezhouba Group Co. Ltd (CGGC)’s sustainability transition .......... 146
Figure 6.11 Main sections of CGGC’s 2012 and 2013 sustainability reports .......... 149
Figure 6.12 Sustainability practices of the case firms .................................................. 151
Figure 6.13 Sustainability transitions of the case firms ................................................ 153
Figure 7.1 Relative importance values (RIVs) of CSAs among construction enterprises of different firm sizes .................................................................................................................................................................................. 178
Figure 7.2 Relative performance values (RPVs) of CSAs among construction enterprises of different firm sizes .................................................................................................................................................................................. 180
Figure 7.3 Sustainability performance of construction enterprises of different firm sizes .................................................................................................................................................................................. 182
Figure 7.4 Three firm clusters on IPA grid .................................................................... 185
Figure 7.5 Performance gaps for three firm clusters ...................................................... 186
Figure 7.6 Transition pathways towards sustainability (TPS) for construction enterprises .................................................................................................................................................................................. 191
Figure 8.1 Key mechanisms of sustainability transitions for construction industry .... 202
Figure 8.2 Averaged means of factors driving and prohibiting sustainability transitions .................................................................................................................................................................................. 210
Figure 8.3 Changes in scores for factors assessed by the three groups ....................... 214
Figure 8.4 Roadmap of sustainability transition for the Chinese construction industry: the top five strongest drivers and barriers perceived by each firm group .................. 223
Figure 8.5 Conceptual model for development of a systematic approach to facilitate sustainability transitions ................................................................. 231
List of Tables

Table 2.1 Representative definitions of sustainability.................................................. 16
Table 2.2 Representative definitions of corporate social responsibility (CSR) ............ 20
Table 2.3 Examples of a firm’s stakeholders................................................................ 22
Table 2.4 Representative definitions of corporate sustainability.................................. 23
Table 2.5 Representative definitions of sustainable construction............................... 30
Table 3.1 Key points of different approaches to sustainability...................................... 55
Table 3.2 Analysis strategies for the actors..................................................................... 80
Table 5.1 China’s policy system for sustainable construction........................................ 104
Table 5.2 Key policies of regulation and control............................................................ 107
Table 5.3 Main sustainable construction standards in China.......................................... 113
Table 6.1 Process used to select the case firms.............................................................. 127
Table 6.2 Details of the case firms.................................................................................. 128
Table 6.3 Sustainability reporting guidelines................................................................. 130
Table 6.4 Strategic sustainability behaviours of corporations....................................... 133
Table 6.5 Strong and weak aspects of sustainability dimensions in the three case firms ................................................................. 155
Table 6.6 Major requirements which the case firms failed to fulfil ................................ 157
Table 6.7 Sub-aspects (N=92) of sustainability practices implemented by the studied case firms................................................................................................................................. 161
Table 7.1 List of CSAs for construction enterprises....................................................... 167
Table 7.2 Attitude and performance evaluation of CSAs............................................... 175
Table 7.3 Results of Mann–Whitney U tests for sustainability attitude level (SAL).... 179
Table 7.4 Results of Mann–Whitney U tests for sustainability performance level (SPL) .......................................................................................................................... 181
Table 7.5 Mean value of importance and performance of CSAs .................................... 184
Table 7.6 Cross-table linking firm groups divided by size and firm groups divided by sustainability levels............................................................................................ 185
Table 7.7 Comparison of IPA grid positions for the three firm clusters....................... 188
Table 8.1 List of claims related to sustainability transitions of Chinese construction industry ........................................................... 204
Table 8.2 Ranking of claims............................................................................................ 207
Table 8.3 Spearman’s rank correlation test between groups of respondents............... 209
Table 8.4 Averaged scores of factors at the three levels................................................ 211
Table 8.5 Averaged scores of factors at the three dimensions ......................................... 212
Table 8.6 Results of the Mann–Whitney U test.............................................................. 214
Table 8.7 Mainly distributed levels and positions of top rated drivers and barriers... 225
Table 9.1 Contributions of this project to the body of knowledge........................................... 246
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANOVA</td>
<td>one-way analysis of variance</td>
</tr>
<tr>
<td>ANT</td>
<td>actor network theory</td>
</tr>
<tr>
<td>AoD</td>
<td>arena of development</td>
</tr>
<tr>
<td>AQSIQ</td>
<td>General Administration of Quality Supervision, Inspection and Quarantine (China)</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>BAT</td>
<td>best available techniques</td>
</tr>
<tr>
<td>BM</td>
<td>business model</td>
</tr>
<tr>
<td>BREEAM</td>
<td>Building Research Establishment Environmental Assessment Methodology</td>
</tr>
<tr>
<td>BREF</td>
<td>BAT (best available techniques) Reference Document</td>
</tr>
<tr>
<td>CASS-CSR</td>
<td>Chinese Academy of Social Sciences-Corporate Social Responsibility Guidelines</td>
</tr>
<tr>
<td>CCCC</td>
<td>China Communications Construction Company Ltd</td>
</tr>
<tr>
<td>CCIA</td>
<td>China Construction Industry Association</td>
</tr>
<tr>
<td>CED</td>
<td>Committee for Economic Development</td>
</tr>
<tr>
<td>CHINCA</td>
<td>Chinese International Contractors Association</td>
</tr>
<tr>
<td>CIB</td>
<td>International Council for Research and Innovation in Building and Construction</td>
</tr>
<tr>
<td>CNY</td>
<td>Chinese yuan (currency)</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>CRM</td>
<td>customer relationship management</td>
</tr>
<tr>
<td>CS</td>
<td>corporate sustainability</td>
</tr>
<tr>
<td>CSA</td>
<td>critical sustainability aspect</td>
</tr>
<tr>
<td>CSCEC</td>
<td>China State Construction Engineering Corp. Ltd</td>
</tr>
<tr>
<td>CSP</td>
<td>corporate social performance</td>
</tr>
<tr>
<td>CSR</td>
<td>corporate social responsibility</td>
</tr>
<tr>
<td>DRIFT</td>
<td>Dutch Research Institute for Transitions</td>
</tr>
<tr>
<td>EID</td>
<td>Economic Information Daily</td>
</tr>
<tr>
<td>ESCAP</td>
<td>Economic and Social Commission for Asia and the Pacific</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FFF</td>
<td>foreign-funded firm</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>GCP</td>
<td>Global Construction Perspective</td>
</tr>
<tr>
<td>GDP</td>
<td>gross domestic product</td>
</tr>
<tr>
<td>GHG</td>
<td>greenhouse gases</td>
</tr>
<tr>
<td>GOV</td>
<td>gross output value</td>
</tr>
<tr>
<td>GRI</td>
<td>Global Reporting Initiative</td>
</tr>
<tr>
<td>GVA</td>
<td>gross value added</td>
</tr>
<tr>
<td>GVAl</td>
<td>Gross Value Added Index</td>
</tr>
<tr>
<td>HE</td>
<td>huge enterprise</td>
</tr>
<tr>
<td>High-tech</td>
<td>high-technology</td>
</tr>
<tr>
<td>HMTFF</td>
<td>Hong Kong, Macao and Taiwan-funded firms</td>
</tr>
<tr>
<td>ICCREM</td>
<td>International Conference on Construction and Real Estate Management</td>
</tr>
<tr>
<td>IISD</td>
<td>International Institution of Sustainable Development</td>
</tr>
<tr>
<td>IPA</td>
<td>importance–performance analysis</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IT</td>
<td>information technology</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for Conservation of Nature and Natural Resources</td>
</tr>
<tr>
<td>LE</td>
<td>large enterprise</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy &amp; Environmental Design</td>
</tr>
<tr>
<td>m²</td>
<td>square metre</td>
</tr>
<tr>
<td>ME</td>
<td>medium enterprise</td>
</tr>
<tr>
<td>MHUD</td>
<td>Ministry of Housing and Urban-Rural Development (China)</td>
</tr>
<tr>
<td>MIP-SR</td>
<td>major infrastructure projects' social responsibility</td>
</tr>
<tr>
<td>MLP</td>
<td>multi-level perspective (on transitions)</td>
</tr>
<tr>
<td>MOF</td>
<td>Ministry of Finance (China)</td>
</tr>
<tr>
<td>MOST</td>
<td>Ministry of Science and Technology (China)</td>
</tr>
<tr>
<td>MPC</td>
<td>multi-phase concept (of transition)</td>
</tr>
<tr>
<td>NBS</td>
<td>National Bureau of Statistics (China)</td>
</tr>
<tr>
<td>NDRC</td>
<td>National Development and Reform Commission (China)</td>
</tr>
<tr>
<td>NGO</td>
<td>non-governmental organization</td>
</tr>
<tr>
<td>NOx</td>
<td>nitrous oxide</td>
</tr>
<tr>
<td>NPC</td>
<td>National People’s Congress of China</td>
</tr>
<tr>
<td>OE</td>
<td>Oxford Economics</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
</tbody>
</table>
OHS occupational health and safety
OTDF other types of domestic firms
R&D research and development
RIV relative importance value
RPV relative performance value
SAL sustainability attitude level
SASAC State-owned Assets Supervision and Administration Commission
SBM sustainable business model
SCC State Council of China
SE small enterprise
SEM structural equation modelling
SNM strategic niche management
SOE state-owned enterprise
SOX sulphur oxide
SPL sustainability performance level
SWOT strengths, weaknesses, opportunities, threats
TBL triple bottom line
TEF triple embeddedness framework
TM transition management
TPS transition pathway/s towards sustainability
UK United Kingdom
UN United Nations
UNCTAD United Nations Conference on Trade and Development
UNEP United Nations Environment Programme
URC urban and rural collective
US/USA United States of America
WBCSD World Business Council for Sustainable Development
WCED World Conservation on Environment and Development
WTO World Trade Organization
Abstract

Despite the massive scale of the Chinese construction industry, there is a lack of adequate awareness of sustainable development within this industry. This study aims to analyse the current status of, and the motivations for and barriers to, the sustainability transitions of Chinese construction enterprises.

Firstly, as the policy environment could significantly influence sustainability transitions, this study holistically examined China’s policy landscape for facilitating the transition to sustainable construction. Regulation and control, economic incentives and supporting activities have been identified as the main policy instruments for facilitating sustainable construction in China. Two critical challenges of the policy system are revealed, namely, a lack of consideration of the economic and social dimensions of sustainable construction, and the ineffectiveness of some policies.

This study then examined the transition processes towards sustainability in three leading Chinese construction firms from 2009 to 2013. In total, 29 critical sustainability aspects and 92 sub-aspects of sustainability practices implemented by the case firms were identified. By comparing the implemented sustainability practices with the requirements of three sustainability guidelines, this study revealed that the three firms presented different strategic sustainability behaviours, and that practices towards environmental sustainability are weak compared with practices towards economic and social sustainability.

Subsequently, to investigate how various construction firms in China, other than only the leading firms, perceive and perform in relation to sustainability, a questionnaire was developed based on the 29 sustainability aspects identified from the case study. The questionnaire survey results revealed that quality management and customer service are perceived by the firms as not only the most important but are also the best-performed aspects while supporting community development is the least important and worst-performed aspect. Sustainability attitude is positively correlated with performance, and larger firms tend to have better sustainability performance than smaller firms. However,
larger firms do not necessarily believe sustainability is more important than is the case among smaller firms. Based on k-means cluster analysis and importance–performance analysis, this study then classified the investigated firms into three groups according to their sustainability performance, namely, low-performing, medium-performing and high-performing firms, and identified the transition pathways from low-performing to high-performing firms.

Last but not least, after discovering the transition pathways, this study investigated the various factors driving and prohibiting these transitions, based on an integrated conceptual framework built on the multi-level perspective and triple embeddedness framework of sustainability transitions. The results show that for low-performing firms, the key stimulus for sustainability comes from external socio-political pressures, while economic and industry issues, for example, inadequate incentives present the biggest hindrance. Even though medium-performing firms also regard external socio-political pressures as key drivers, they start to recognize the benefits brought by sustainability, for example, improved corporate image as key drivers. Although high-performing firms clearly acknowledge the economic benefits of sustainability, they still experience complex barriers to sustainability, for example, the inconsistency of policies and the culture of conservatism. Thus, this study shows that China has a long way to go to facilitate sustainable practices in the construction industry.
I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and, where applicable, any partner institution responsible for the joint award of this degree.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I acknowledge that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, Library Search and also through web search engines, unless permission has been granted by the university to restrict access for a period of time.

Signed:

Date: 9/12/2016
Acknowledgements

This research has involved much assistance and kind support from many people and organizations who contributed in plentiful ways to its completion. I would like to take this opportunity to express my gratitude to them.

My deepest gratitude goes to my supervisors, Professor George Zillante, Associate Professor Veronica Soebarto, Professor Zhen-Yu Zhao, and Associate Professor Jian Zuo. During my PhD study, they have provided unconditional support, encouragement and guidance to my research. This research could not reach its current standard without the excellent guidance and constructive criticism from my supervisors.

I also need to convey my gratitude to the University of Adelaide which has provided me with a comfortable office environment and other facilities, as well as enabling me to conduct high-quality research without worrying about monetary pressures by supporting me with the Beacon of Enlightenment Scholarship, the Research Abroad Scholarship and the annual postgraduate fund. Without this financial support, I could not have focused on my research.

I would like to convey my special thanks to the questionnaire respondents who made it possible for me to dig into their perceptions of the Chinese construction industry’s sustainability transitions and to apply the transition theory in reality. Their data significantly contribute to both the theoretical and empirical values of this research. I also need to extend my gratitude to the anonymous reviewers and editors of the published articles derived from this research which has been optimized by their input.

Furthermore, I would like to thank the academic and support staff from the School of Architecture & Built Environment for their kind support and encouragement. I would like to thank Dr Xiao-long Gan for his informal input and guidance in this research; Mr Ian Florance for his assistance in resolving IT issues during these past three years of research; and all my fellow PhD students for their company and encouragement. I am also grateful to all my friends in Australia and back in China for their support during my PhD research journey.

Last but not least, I express my heartfelt gratitude to my family members for giving me their utmost love, support and advice. Special thanks go to my mom Yanfang Li: without your encouragement and unreserved love, I could not have completed this PhD.
Publications that Emanated from This Research


