Sociomateriality in the age of emerging information technologies: How big data analytics, blockchain and artificial intelligence affect organisations

By
Mark van Rijmenam

A thesis for the degree of
Doctor of Philosophy in Management
Course code: 21982

Submitted to the
University of Technology Sydney Business School
Management Discipline Group
5 February 2019

Supervisory Panel:
Associate Professor Jochen Schweitzer
Professor Mary-Anne Williams
Associate Professor Danielle Logue
Certificate of original authorship

I, Mark van Rijmenam, declare that this thesis, is submitted in fulfilment of the requirements for the award of the Degree of Doctor of Philosophy in the field of Management at the Faculty of Business at the University of Technology Sydney. This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

Signature: Production Note:
Signature removed prior to publication.

Date: February 5, 2019
Acknowledgments

Undertaking a PhD is a journey and for me it was journey in more ways than one. First of all, it was a physical journey as I moved to Sydney, Australia to do my PhD. Moving to Australia was a long-life dream for me and I wish to thank my parents, my sister and my friends for fully supporting me in this journey to the other side of the world, despite how difficult it might have been for them. Secondly, it is also an intellectual journey, where you are being challenged and stretched intellectually. I want to thank Jochen Schweitzer, my principal supervisor, for doing exactly that: challenging me, offering me direct and critical feedback on the work I created, but also supporting me in the intellectual journey that I gave myself. Thanks to your valuable and tireless input, I have been able to write this thesis in the way I did. Without your input, that would not have been possible. I would also like to thank my other supervisors, Mary-Anne Williams and Danielle Logue for your input and feedback on the work and papers I wrote. Your feedback helped me improve my work and see things differently when needed.

I would also like to thank my girlfriend, Louise. I am so glad that I met you during my journey as you added a great new chapter to it. Thank you for your support and listening to me when I was frustrated in my work and celebrating with me when things worked as planned. I love you and I am looking forward to continuing our journey together.

Thank you also to all other professors and staff at UTS and the Business School who have helped me in my journey by providing feedback for the work created, by offering great classes that helped me better understand the academic world and for having a nice chat once in a while. Thank you Stewart Clegg, Emmanuel Josserand,
Bron Harrison, Moira Scerri, Deborah Edwards, Natalia Nikolova, Christos Pitelis, Marco Berti, Hussain Rammal, Kirsty Kitto and Theresa Anderson. Thank you also to Cam Bellach, fellow PhD candidate, for inviting me to be part of your research into the experiences of international students. All the interviews that you conducted also helped me in gaining a better understanding in what I was trying to achieve, and they helped me a lot.

In addition, I would like to thank Stewart Clegg and Jochen Schweitzer for giving me the opportunity to co-author with them a chapter for the Cambridge Handbook of Open Strategy and I would like to thank Danielle Logue for co-authoring with me an essay on sociomateriality in times of artificial intelligence, which we will submit to the Journal of Management Inquiry.

Next, I would like to thank the Blockchain Research Institute in Toronto, for giving me the opportunity to write a white paper on the convergence of big data analytics and blockchain, which was published in 2017. Writing this paper gave me a better understanding of how blockchain changes organisations, which contributed positively to my second study.

Thank you also to the other fellow PhD Candidates at the Management Discipline Group, Patrick Shearman, Loïc Pedras, Veronica Lo Presti and Sumati Ahuja. I very much enjoyed our conversations and the beers we drank during the journey that we shared.

Thank you also for the editorial services of Capstone Editing, your edits have helped to improve my writing and make my work easier to read and understand.

Thank you Philippa Ryan for sharing another great journey with me during my PhD Candidature. Writing the book Blockchain: Transforming Your Business and Our World, together, which has been published in English with Routledge and in Chinese
with Cheers Publishing, was a fantastic experience and your input, thoughts and the many great coffees and lunches we shared are a great memory, which also helped me with my dissertation.

Finally, I wish to thank the University of Technology Sydney for offering me two scholarships: the UTS International Research Scholarship and the UTS President’s Scholarship. Without these scholarships, I would not have been able to pursue my PhD and finish this exciting journey.

Production Note:
Signature removed prior to publication.

Mark van Rijmenam, Sydney, February 2019
Thesis format

This thesis is a thesis by publication. That means that this thesis consists of three papers that are published/publishable, which are linked together using the introduction, literature review and discussion. It is structured as a single manuscript and the introduction, literature, the three papers, the discussion and the conclusion are separate chapters. The literature review as well as the three papers are distinct, but they are linked in a logical and coherent way.
# Papers included & statement of contribution

The following papers are included in this thesis:

<table>
<thead>
<tr>
<th>Paper 1</th>
<th>Paper 2</th>
<th>Paper 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Avoid being the turkey: How Big Data analytics changes the game of strategy in times of ambiguity and uncertainty – published in Long Range Planning</td>
<td>A Distributed Future: How Blockchain Changes Organisation Design – under review with Group &amp; Organization Management</td>
</tr>
<tr>
<td><strong>Lead author</strong></td>
<td>Mark van Rijmenam</td>
<td>Mark van Rijmenam</td>
</tr>
<tr>
<td><strong>Co-author 1</strong></td>
<td>Tatiana Erekhinskaya, Lymba Corporation, United States – assisting with the data analysis using machine learning and NLP. Contribution approximately 20%</td>
<td>Assoc. Prof. Jochen Schweitzer, University of Technology Sydney, Australia – Primary PhD supervisor providing feedback</td>
</tr>
<tr>
<td><strong>Co-author 2</strong></td>
<td>Assoc. Prof. Jochen Schweitzer, University of Technology Sydney, Australia – Primary PhD supervisor providing feedback</td>
<td>Prof. Mary-Anne Williams, University of Technology Sydney, Australia – PhD Co-supervisor providing feedback</td>
</tr>
<tr>
<td><strong>Co-author 3</strong></td>
<td>Prof. Mary-Anne Williams, University of Technology Sydney, Australia – PhD Co-supervisor providing feedback</td>
<td>Prof. Mary-Anne Williams, University of Technology Sydney, Australia – PhD Co-supervisor providing feedback</td>
</tr>
</tbody>
</table>

The above-stated information is correct:

| Mark van Rijmenam | Tatiana Erekhinskaya | Associate Prof. Jochen Schweitzer | Prof. Mary-Anne Williams |

**Table 1: Papers and contribution of co-authors**

Production Note: Signature removed prior to publication.
Contents

Certificate of original authorship ............................................................ iv
Acknowledgments ...................................................................................... v
Thesis format .............................................................................................. viii
Papers included & statement of contribution .............................................. ix
Contents ...................................................................................................... x
List of Tables ........................................................................................... xii
List of Figures .......................................................................................... xiii
Abstract ................................................................................................... xiv
Acronyms ................................................................................................. xvi
Chapter 1: Emerging information technologies ....................................... 18
  1.1 Aim and contributions of this research ............................................ 24
  1.2 Thesis structure .............................................................................. 25
Chapter 2: How technology changes organisations .................................. 27
  2.1 A sociomateriality view of new technologies ................................. 30
  2.2 Sociomateriality as a lens to understand EIT ................................. 36
  2.3 The concept of technology in organisation and management studies .. 40
  2.4 Understanding EIT and the introduction of the artificial ................. 44
  2.5 Towards a tripartite analysis of sociomateriality ............................ 49
  2.6 Theoretical framework .................................................................. 53
Chapter 3: Methodology ......................................................................... 55
  3.1 Study 1: Meta-synthesis ................................................................. 56
  3.2 Study 2: Qualitative research .......................................................... 57
Chapter 4: Three studies: big data analytics, blockchain and AI ............. 59
  4.1 Paper 1: Avoid being the turkey: How big data analytics changes the game of strategy in times of ambiguity and uncertainty ............... 60
  4.2 Paper 2: A distributed future: Where blockchain technology meets organisational design and decision-making .......................... 108
4.3 Paper 3: How to build Responsible AI: A conversation with Tay and
lessons for governance practices ............................................................... 140

Chapter 5: Discussion ....................................................................................... 177
  5.1 Big data analytics and strategic management ........................................ 179
    5.1.1 Big data analytics and open strategy ........................................ 181
  5.2 Blockchain and organisation design .................................................... 184
  5.3 Artificial intelligence and governance .................................................. 186
  5.4 Data-driven organisations ..................................................................... 189
    5.4.1 A critical note on data-driven organisations ............................... 190
  5.5 Research implications and contributions ........................................... 191
    5.5.1 Theoretical contribution ............................................................... 192
    5.5.2 Practical contribution ................................................................. 195
  5.6 Limitations and future agenda .............................................................. 196

Chapter 6: Conclusion ...................................................................................... 201

References ....................................................................................................... 204
List of Tables

Table 1: Papers and contribution of co-authors ................................................... ix
Table 2: 101 use case articles analysed for meta-synthesis ................................. 86
Table 3: Traditional and New Decentralised Organisations ............................. 133
Table 4: Codes .................................................................................................. 162
Table 5: Agency theory and artificial agents...................................................... 174
List of Figures

Figure 1: Tripartite of sociomateriality...............................................................52
Figure 2: Relevant literature regarding data and data related technologies.......54
Figure 3: Conceptual framework ......................................................................75
Figure 4: Overview impact factor and publication date articles used ...............82
Figure 5: Origin of companies in case studies...................................................85
Figure 6: Industries vs use case .......................................................................85
Figure 7: Use case vs analytics type .................................................................88
Figure 8: Company type vs analytics type.........................................................97
Figure 9: Use case vs company type .................................................................98
Figure 10: Analytics vs use case vs organisation .............................................101
Figure 11: Conceptual Framework ..................................................................134
Figure 12: Theoretical framework to guide the qualitative research ...............160
Abstract

Emerging information technologies (EIT), such as big data analytics, blockchain and artificial intelligence (AI), challenge organisation design and strategic management, and bring the role of data in organising to the fore. Big data analytics empower consumers and employees, resulting in open strategy and a better understanding of the changing environment. Blockchain enables peer-to-peer collaboration and trustless interactions. And, AI facilitates new and different levels of involvement among human and artificial actors. From these interactions and responses, new modes of organising are emerging, where technology facilitates collaboration between stakeholders and where human-to-human interactions are increasingly replaced with human-to-machine and even machine-to-machine interactions. In this doctoral research, I use the theory of sociomateriality to untangle the social and material when dealing with EIT within organisations. I endeavour to explore these theoretical issues and present a new understanding of the relationships between the social, material and artificial.

Addressing this context, my research consists of three studies. Each study is arranged as a standalone paper. In the first study, I investigate how big data analytics can be used to better understand the changing organisational environment. The second study looks at how blockchain can result in new forms of organisational design and how it changes decision-making. In the third study, I seek to answer how organisations can ensure that artificial intelligence performs as planned. The results are discussed and made tangible by exploring how the social, material and artificial are changing collaboration among those actors involved in organisations.
I adopt three methodologies. The first study is a meta-synthesis of 101 peer-reviewed papers. The second study is conceptual and in the third study, I use qualitative research methodologies to interview managers of organisations who developed conversational AI.

The significance of this research is twofold. First, my academic contribution lies in understanding how big data analytics affect strategic management theory in general, and dynamic capabilities literature in particular; how blockchain requires us to rethink organisation design theory, and how agency theory can help when dealing with artificial actors. Also, I argue for the addition of the artificial as an independent actant in organisation design theories. Second, my findings inform organisational practice in terms of how to design organisations using EIT in an increasingly data-driven world. The key thesis underlying this research is that emerging information technologies change how we organise activities within organisations.
Acronyms

AGI: Artificial General Intelligence
AI: Artificial Intelligence
ANT: Actor-Network Theory
CEV: Coherent Extrapolated Volition
DAO: Decentralised Autonomous Organisation
DApp: Decentralised Application
DARPA: Defense Advanced Research Projects Agency
DNS: Domain Name Servers
DQM: Data Quality Management
EIT: emerging information technologies
ETH: Ethics
FAQ: Frequently asked questions
GE: General Electric
HMN: Human-Machine Network
ICB: Industry Classification Benchmark
IPFS: InterPlanetary File System
IoT: Internet of Things
IT: Information Technology
KPI: Key Performance Indicator
MDM: Master Data Management
MNE: Multinational Enterprise
NAI: Narrow Artificial Intelligence
NLP: Natural Language Processing
PBFT: Practical Byzantine Fault Tolerance
PKI: Public Key Infrastructure
PoS: Proof of Stake
PoW: Proof of Work
SAI: Super Artificial Intelligence
SHA: Secure Hash Algorithm
SME: Small and Medium Enterprise
SMS: Strategic Management Society
SSL: Secure Sockets Layer
USC: Utility Settlement Coin
UTS: University of Technology, Sydney
XAI: Explainable AI
Y2K: Year 2000