# TABLE OF CONTENTS

*Originality Declaration Form* ............................................................................. i

**ACKNOWLEDGEMENTS** .................................................................................. ii

**TABLE OF CONTENTS** .................................................................................. iv

**LIST OF FIGURES** .......................................................................................... x

**LIST OF TABLES** ............................................................................................ xii

**GLOSSARY** ...................................................................................................... xv

**CHAPTER 1 INTRODUCTION** .......................................................................... 1

1.1. Outline of the Thesis .................................................................................... 2

1.2. The State of the ICT Industry ...................................................................... 5

1.2.1. The Trends in the ICT Industry ............................................................... 5

1.2.2. The Challenges in the ICT Industry ....................................................... 7

1.2.3. Data Services Innovation: The Key to Sustenance and Growth ............ 9

1.3. Open Innovation and Open Business Models ............................................. 10

1.3.1. Definitions ............................................................................................... 10

1.3.2. Open Innovation Elaborated .................................................................. 11

1.3.3. Open Innovation and Telecom Services ................................................. 12

1.3.4. Open Innovation and Open Business Models – The Nambisan Approach – Network Centric Innovation .................................................. 12

1.4. The Telco Industry Model ............................................................................ 15

1.5. Open Innovation in Services ....................................................................... 17

1.6. Three Major Innovation Phases .................................................................. 22

1.7. Efficiency in the Open Business Model .................................................... 22

1.8. Summary ...................................................................................................... 26

**CHAPTER 2 TRANSFORMING THE ICT ECOSYSTEM FOR THE SERVICES PARADIGM AND INNOVATION** ................................................. 27

2.1. Shifts in the ICT Industry ............................................................................ 28

2.2. The Position of Services Innovation ............................................................ 32

2.3. Enablers, Catalysts and Differentiators of Telecom Services .................... 34

2.4. Telecom Forums and Standards .................................................................. 38
4.7. Validating the Data ........................................................................................................ 78
4.8. Establishing Relationships .......................................................................................... 78

CHAPTER 5 OPEN INNOVATION IN ICT SERVICES: AN EMPIRICAL
ANALYSIS .......................................................................................................................... 80
5.1. Overview ....................................................................................................................... 81
5.2. A Review of Concepts ................................................................................................. 82
5.3. The Elements of Analysis ............................................................................................ 85
5.4. Measuring the Intensity of Open Innovation ............................................................... 87
5.5. Measuring the Performance of Open Innovation ......................................................... 88
5.6. Country Effects ............................................................................................................ 89
5.7. The Construct Parameters, Relationships and Postulates ......................................... 90
5.8. Social Capital of Innovation ....................................................................................... 92
5.9. The Focus of this Study ............................................................................................... 93
  5.9.1. The Research Problem Explained ........................................................................ 93
  5.9.2. The Research Question Expressed Simply .......................................................... 93
5.10. The Approach ........................................................................................................... 94
5.11. The Model .................................................................................................................. 96
5.12. Assumptions and Approximations ........................................................................... 97
5.13. Analyzing the Data with Clusters ............................................................................ 98
  5.13.1. Purpose of Cluster Analysis .............................................................................. 98
  5.13.2. Clustering of Data ............................................................................................. 98
  5.13.3. Clusters for the Set of Dependent Variables (Firm Performance) ................. 99
  5.13.4. Clusters for the Set of Independent Variables (Open Innovation Practice) 100
  5.13.5. Finding Relationship across Firms’ Performance and Open Innovation
Clusters ................................................................................................................................. 100
5.14. Interpretation of the Results of Cluster Analysis (Relationship among the
Clusters) ............................................................................................................................... 102
5.15. More Cluster Relationships – Along the same lines ............................................... 104
5.16. Establishing the Relationship .................................................................................. 105
  5.16.1. Creating a Performance Score for the Firm ...................................................... 105
  5.16.2. Principal Components Analysis of the Independent Variables ...................... 106
  5.16.3. Preparation and Validation of Data Prior to the Analysis ................................ 107
5.16.4. Results of the Quantitative Analysis .......................................................... 109
5.16.5. Including Profitability per Employee in the Firm’s Performance Score .... 110
5.16.6. Ruling out Distortions Due to Effect of Size ............................................. 111
5.17. Findings from the Analysis ............................................................................... 112
  5.17.1. Interpreting the Results .................................................................................. 112
  5.17.2. Practical Implications ..................................................................................... 114
  5.17.3. Summary and Linkage to the Next Chapter ..................................................... 115

CHAPTER 6 OPEN INNOVATION AND CO-OPETITION IN ICT: THE
MODERATING EFFECT OF COMPETITIVE INTENSITY ........................................ 116
  6.1. Overview ............................................................................................................. 117
  6.2. Introduction ......................................................................................................... 117

  6.3. Dimensions of Competitive Priorities ................................................................. 120
    6.3.1. Cost .............................................................................................................. 120
    6.3.2. Quality ........................................................................................................ 121
    6.3.3. Delivery Performance ................................................................................... 121
    6.3.4. Flexibility ..................................................................................................... 122
    6.3.5. Innovativeness .............................................................................................. 123
  6.4. The Indicator of the Degree of Adoption of Open Innovation Strategy .......... 124
  6.5. The Indicator of the Performance of Open Innovation ........................................ 125
  6.6. The Indicator of Competition ............................................................................. 126
  6.7. The Indicator of Country Effects ........................................................................ 127

  6.8. The Construct and the Relationships .................................................................. 127
  6.9. Defining the Focus ............................................................................................. 128
    6.9.1. The Problem in Question ............................................................................ 128
    6.9.2. The Proposition pertaining to Competitive Intensity ..................................... 128
  6.10. The Methodology .............................................................................................. 129
    6.10.1. The Model ................................................................................................ 129
      6.10.1.1. The Basic Structure .......................................................................... 129
      6.10.1.2. Why Moderation .............................................................................. 130
  6.11. The Quantitative Analysis ............................................................................... 130
    6.11.1. Creating a Performance Score for the Firm ............................................. 130
    6.11.2. Establishing the Relationship .................................................................... 132
      6.11.2.1. Suitability of the Data ................................................................... 132
| 6.11.2.2. Principal Components Analysis for the Independent Variables | 132 |
| 6.11.2.3. The Basic Regression Model Adjusted for Use in Moderation Analysis | 133 |
| 6.11.3. Moderation Analysis | 134 |
| 6.11.4. The Results With and Without Moderation | 135 |
| 6.11.5. The Direction of the Moderation Effect of Competition | 136 |
| 6.12. Summary | 138 |
| 6.12.1. Interpreting the Results | 138 |
| 6.12.2. Practical Implications | 139 |

CHAPTER 7 IMPROVING THE DIGITAL SERVICES LANDSCAPE THROUGH OPEN INNOVATION 140 |
| 7.1. The Digital Services Landscape | 141 |
| 7.2. Open Innovation Forums for ICT | 142 |
| 7.3. Studying Characteristics of the ICT Forums | 145 |
| 7.4. More Insights from the Analysis | 151 |
| 7.5. The Quadruple Helix Model | 157 |
| 7.6. The Summary | 158 |

CHAPTER 8 CONCLUSIONS 160 |
| 8.1. Summary | 161 |
| 8.1.1. The Conclusions in brief | 161 |
| 8.1.2. Overview of the Research Done | 162 |
| 8.1.3. Chapter-wise Summary | 163 |
| 8.1.4. Technology Insights | 164 |
| 8.1.5. Towards Service Oriented Models and Alliances | 165 |
| 8.1.6. Linking Open Innovation to Telco’s Performance | 166 |
| 8.2. The Social Capital of Innovation | 168 |
| 8.2.1. Ambidextrous Thinking | 168 |
| 8.2.2. Intrapreneural Attitude | 169 |
| 8.2.3. Key Insights | 169 |
| 8.3. Telco’s Performance and its Relationship to Open Innovation | 170 |
| 8.4. The Effect of Competitive Intensity | 170 |
| 8.5. Regulation | 172 |
| 8.6. The Main Problem: Fragmentation | 174 |
8.7. The Second Significant Problem: Improper Remedies for Fragmentation........ 175

8.8. The Key Recommendations................................................................. 177

8.8.1. Customer Centricity........................................................................... 177
8.8.2. Building Open Innovation Strategy ................................................. 177
8.8.3. Building Open Innovation Social Capital.......................................... 178
8.8.4. The Quadruple Helix Innovation Model............................................. 179
8.8.5. The Enterprise Architecture............................................................. 180
8.8.6. The Technology .............................................................................. 181
8.8.7. Governance ....................................................................................... 181
8.8.8. Superior Execution............................................................................ 182
8.8.9. The Industry Forums/Consortia/Alliances.......................................... 183
8.8.10. The End Users and Other Users...................................................... 184
8.8.11. Government and Regulations......................................................... 185
8.9. Limitations and Further Research Directions ........................................ 189

REFERENCES ............................................................................................. 191
APPENDICES .............................................................................................. 203
LIST OF FIGURES

Figure 1-1: Schematic Map of the Thesis ................................................................. 4
Figure 1-2: The Chesbrough Approach ................................................................. 11
Figure 1-3: The Landscape of Network-Centric Innovation .................................. 14
Figure 1-4: The Four Models of Network Centric Innovation .................................. 14
Figure 1-5: The Traditional Infocomm Industry – A Layer Model ......................... 15
Figure 1-6: The Infocomm Industry – A Layer Model ............................................. 16
Figure 1-7: Unlocking the Long Tail of Services ...................................................... 17
Figure 1-8: The Hybrid Model of Open & Closed Innovation Telco Model ............... 20
Figure 1-9: The Efficiency Model in Open Innovation .............................................. 23
Figure 2-1: Open Innovation, SDN and NFV ............................................................ 30
Figure 2-2: The Theoretical Framework for Telco Transformation towards its Next Generation Network .......................................................... 32
Figure 2-3: The 21st Century InfoComm ecosystem ................................................. 33
Figure 2-4: Moving From a Vertically Integrated Architecture to a Horizontal Architecture .................................................................................. 35
Figure 2-5: A Proposed Technology Innovation Model ............................................ 37
Figure 2-6: TM Forum's Frameworx Integrated Business Architecture .................... 39
Figure 3-1: Incumbent Player - British Telecom ....................................................... 47
Figure 3-2: Organizing Innovation at British Telecom .............................................. 47
Figure 3-3: Telco 2.0 Model ..................................................................................... 50
Figure 3-4: CD logic of service contrasted with service management and SD logic ...... 53
Figure 3-5: Towards the Theoretical Framework for Data Collection & Analysis Including Integrated Solutions ................................................................. 56
Figure 3-6: Elaboration of the Framework ............................................................... 57
Figure 3-7: Mobile Traffic Data Forecast 2013-2018 ................................................. 58
Figure 3-8: Global Total Data Traffic in Mobile Networks 2007-2014 ....................... 58
Figure 3-9: Shifts in the Mobile Telecom Industry .................................................. 59
Figure 4-1: The Open Innovation Construct ............................................................ 71
Figure 4-2: Delphi Procedure - Rating “Ambidextrous Thinking” for a Telco ............ 76
Figure 4-3: The Moderating Effect of Competitive Intensity .................................... 78
Figure 5-1: K-Means Cluster Analysis: Relationship between the two sets of Clusters 103
Figure 5-2: Histogram of Firm's Performance Score (2011+2012) ............................ 109
Figure 7-1: Pattern of Open Innovation Intensity: Alliance Forums vs. Participating Telcos ......................................................................................... 151
Figure 7-2: Parameter vs. Age of Alliance Forum .................................................. 154
Figure 7-3: Trends for No. of Orgs and No. of Countries in the Alliance Forum .... 154
Figure 7-4: The Locus of the Innovation Process of an Organization .................. 158
Figure 8-1: Summary of the Open Innovation Model ............................................. 171
Figure 8-2: Depiction of the Extended Model ....................................................... 173
LIST OF TABLES

Table 1-1: Non-Traditional Businesses of Telcos Worldwide.......................................................... 7
Table 1-2: Principles of Network-Centric Innovation (Nambisan).................................................... 13
Table 1-3: The Web 2.0 Array of Services ......................................................................................... 21
Table 2-1: SDN and NFV .................................................................................................................... 31
Table 3-1: Provider vs. Customer Dominant Logic of Service............................................................. 54
Table 3-2: Literature Gaps Summary .................................................................................................. 61
Table 5-1: Cluster Centres for Firm Performance (Dependent Variable).............................................. 99
Table 5-2: Number of Cases in Each Cluster...................................................................................... 99
Table 5-3: Cluster Centres for Firm Performance (IV's) ..................................................................... 100
Table 5-4: Number of Cases in Each Cluster...................................................................................... 100
Table 5-5: Cross Tabulation Results (Horizontal Stacking of Clusters)............................................. 101
Table 5-6: Chi-Square Test Results ................................................................................................... 102
Table 5-7: Checking Cluster Relationships across the Two Dimensions using
Different Cluster Combinations......................................................................................................... 105
Table 5-8: Principal Components Analysis: Component Matrix of Dependent
Variables – With Component Loadings............................................................................................... 106
Table 5-9: Rotated Component Matrix of the Independent Variables – With
Component Loadings........................................................................................................................... 107
Table 5-10: Normality Test Results.................................................................................................... 108
Table 5-11: Regression Results ........................................................................................................ 110
Table 5-12: Component Matrix for Dependent Variables .................................................................. 110
Table 5-13: Regression Results for 2011 & 2012 Combined Data (Dependent
Variables: Open Innovation Strategy and Open Innovation Social Capital) ............................. 111
Table 5-14: Levene’s Test Results ..................................................................................................... 112
Table 6-1: Competitive Priorities as Used in the Model................................................................. 124
Table 6-2: Principal Components Analysis to Create Performance Score (Dependent
Variable) ............................................................................................................................................. 131
Table 6-3: Principal Components Analysis: Component Matrix of Dependent
Variables – With Component Loadings............................................................................................. 131
Table 6-4: Principal Components Analysis of Open Innovation Variables – KMO &
Bartlett’s Tests................................................................................................................................. 133
Table 6-5: Principal Components Analysis of Open Innovation Variables -
Component Scores............................................................................................................................. 133
Table 6-6: Regression Results of the Basic Model (Firm’s Performance) ........................................ 134
Table 6-7: Regression Results With and Without Using Moderation for the Dependent Variable ................................................................. 136
Table 6-8: Standardized Beta Value of OI Strategy in Regression, Before and After Moderation ........................................................................... 137
Table 7-1: Open Innovation ICT Forums ......................................................... 143
Table 7-2: Characteristics of the ICT Forums ..................................................... 145
Table 7-3: Principal Components Analysis of Open Innovation Variables - KMO & Bartletts's Tests ........................................................................ 147
Table 7-4: Rotated Component Matrix ............................................................. 147
Table 7-5: The Open Innovation Clusters ......................................................... 148
Table 7-6: Participating Telcos in the Open Innovation Forums – Mapping to Earlier Chapters’ Analysis ................................................................... 150
Table 7-7: Open Innovation ICT Clusters Analyzed ....................................... 153
LIST OF EQUATIONS

Equation 5-1: The Regression Model ................................................................. 109
Equation 6-1: The Basic Model used for Moderation Analysis ...................... 133
Equation 6-2: The Moderation Model ................................................................. 134
Equation 6-3: Standardization of a Variable .................................................... 135
GLOSSARY

API: Application Programming Interface

Application: When used as a noun, it refers to Software Application

ARPU: Average Revenue per User, of a Telecom Operator

B2B: Business to Business

B/OSS: Combined name for BSS and OSS

BSS: Business Support Systems

CME: Communications, Media and Entertainment Industry; also known as ICT, IMT, TMT, and Telecom

CDMA: Code Division Multiple Access

Coopetition or Co-operation: Collaboration between business competitors, in the hope of mutually beneficial results.

CPA: Content Provider Access

CPE: Customer Premises Equipment; this includes servers, routers, session border controllers, etc.

CSP: Communication Service Provider; also known as Telco, Telecom Provider, Telecom Operator

GSM: Global Systems Mobile

EBITDA: Earnings before Interest, Taxes, Depreciation and Amortization

Firm: Telco firm

Forum: Unless otherwise understood in a different context, in this thesis it refers to Open Innovation based ICT Alliances Forum or Consortium

HHI: Herfindahl Hirschman Index, a standard measure of competitive intensity in a country. This is sector specific.

ICT: Information Communications Technology industry, which is Telecommunications’ extended eco-system and industry. Also known as CME, or IMT, TMT or Telecom

IMT: Information Media Technology; also known as ICT, TMT, CME, Telecom

Industry: Refers to the ICT industry, unless otherwise specified

Intrapreneur: A person within a large corporation who takes direct responsibility for turning an idea into a profitable finished product through
assertive risk-taking and innovation. This definition has been taken from The American Heritage Dictionary of the English Language, and the term is widely used in the industry today. The Intrapreneur has the enterprise and thinking of an entrepreneur, but is employed in an organization and applies his talents, skill and effort for the organization.

**Intrapreneurship or Intraprenural Attitude:** Embodying the spirit and thinking of an Intrapreneur. Actively playing the role of an Intrapreneur.

**IoT:** Internet of Things

**IP:** Internet Protocol

**KMO:** Kaiser-Meyer-Olkin statistical measure of Sampling Adequacy used in Principal Components Analysis

**M2M:** Machine-to-Machine

**MDS:** Mobile Data Services

**MPLS:** Multi-Protocol Label Switching

**MVAS:** Mobile Value Added Services

**MVNO:** Mobile Virtual Network Operator

**NGOSS:** Next Generation OSS, from TMF. This is been superseded by TMF’s Frameworx

**NFV:** Network Function Virtualization

**OI:** Open Innovation

**OSS:** Operations Support Systems

**PCA:** Principal Components Analysis in statistics

**PPP:** Purchasing Power Parity

**Regression:** Linear Regression in Statistics

**Revenue-Split:** Refers to the percentage of Revenue that the Telco shares (i.e. gives away) to the VAS/MDS Partner out of the total revenue yield from a service launched jointly with the VAS/MDS Partner

**SDN:** Software Defined Networks

**Telco:** Telecom Operator; otherwise known as Telecom Service Provider or CSP. Examples of Telcos are: Vodafone, AT&T, Bharti Airtel, Telefonica, Verizon, China Mobile, Softbank, KDDI, Deutsche Telekom, Sprint, SingTel etc.

**Telecom:** Telecommunications Industry; also known as ICT, TMT, CME, IMT
**TMF**: TeleManagement Forum

**TMT**: Telecommunications, Media, Technology industry; also known as ICT, IMT, CME, Telco and Telecommunications

**TOGAF**: The Open Group Architecture Framework, from the Open Group

**VAS**: Value Added Services, otherwise called MVAS in this thesis

**VIF**: Variance Inflation Factor; in the results of linear regression, VIF is inspected for the individual regressors to check the presence of multi-collinearity. A VIF of less than 2 indicates no multi-collinearity

**VoIP**: Voice over IP

**WEF**: World Economic Forum

**XaaS**: An acronym for “X as a Service”, where ‘X’ is a generic placeholder for Software, Process, Knowledge, Network, etc., and the acronym expands to “Software as a Service”, “Process as a Service”, etc. These are usually Cloud based service offerings.