# D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th>Workpackage</th>
<th>WP4 - SKILLS: Skills, Education, and Centres of Excellence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Editor(s):</td>
<td>Edo Osagie (INSIGHT)</td>
</tr>
<tr>
<td></td>
<td>Umair ul Hassan (INSIGHT)</td>
</tr>
<tr>
<td></td>
<td>Wassim Derguech (INSIGHT)</td>
</tr>
<tr>
<td></td>
<td>Edward Curry (INSIGHT)</td>
</tr>
<tr>
<td></td>
<td>Niki Pavlopoulou (INSIGHT)</td>
</tr>
<tr>
<td>Responsible Partner:</td>
<td>INSIGHT</td>
</tr>
<tr>
<td>Contributors</td>
<td>UPM, TILDE</td>
</tr>
<tr>
<td>Internal Reviewer</td>
<td>ATOS, EIT</td>
</tr>
<tr>
<td>Status-Version:</td>
<td>V1.0</td>
</tr>
<tr>
<td>Due to</td>
<td>M12</td>
</tr>
<tr>
<td>Submission Date:</td>
<td>22/12/2017</td>
</tr>
<tr>
<td>EC Distribution:</td>
<td>Public</td>
</tr>
<tr>
<td>Abstract:</td>
<td>Best practice guide for running Big Data Centres of Excellence based on a study of 4 leading European Big Data Centres.</td>
</tr>
</tbody>
</table>

This document is issued within the frame and for the purpose of the BDVE project. This project has received funding from the European Union’s Horizon 2020 Programme (H2020-ICT-2016-2017) under Grant Agreement No. 732630.
## History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Modifications Introduced</th>
<th>Modification Reason</th>
<th>Modified by</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>22/12/2017</td>
<td>Final for submission</td>
<td></td>
<td>Atos</td>
</tr>
</tbody>
</table>
Contents

1 INTRODUCTION 13
  1.1 THE TASK AND THE RESPONSIBILITY 13
  1.2 RELEVANCE AND AUDIENCE 13
  1.3 REPORT MAP 14

2 NATIONAL INNOVATION SYSTEMS 15

3 DATA ECOSYSTEM 15

4 CENTRES OF EXCELLENCE 17
  4.1 WHAT IS A CENTRE OF EXCELLENCE 17
  4.2 BIG DATA VALUE CENTRE OF EXCELLENCE 18
    4.2.1 European Environment Factors 19
  4.3 ORIENTATION OF BDVCOE 20
    4.3.1 Taxonomy of CoEs 21
    4.3.2 I-Space vs. BDVCoE 21
  4.4 EUROPEAN BIG DATA CENTRE OF EXCELLENCE 22

5 METHODOLOGY 25
  5.1 IDENTIFYING CHALLENGES AND CRITICAL SUCCESS FACTORS 28
  5.2 CASE STUDY CoEs & INTERVIEWEES 29
    5.2.1 Data Collection and Analysis 30

6 BDVCOE ORGANISATIONAL FRAMEWORK 31
  6.1 ENVIRONMENT 32
    6.1.1 Industry 32
    6.1.2 Policy 33
    6.1.3 Societal 33
  6.2 CORE ORGANIZATIONAL MODEL 35
    6.2.1 Strategy 35
    6.2.2 Governance & Structure 36
    6.2.3 Funding 38
    6.2.4 Culture 39
    6.2.5 Capabilities 39
      6.2.5.1 People 40
      6.2.5.2 Process 41
      6.2.5.3 Infrastructure 42
      6.2.5.4 Collaboration 43
6.2.6 Collaboration Framework
   6.2.6.1 Definitions of Collaboration: 44
   6.2.6.2 Factors supporting collaboration 46
   6.2.6.3 How academic research contributes to the economy 46
   6.2.6.4 Features of Academic-Industry Engagement 47

6.3 IMPACT
   6.3.1 Economic Impact 50
   6.3.2 Scientific Impact 51
   6.3.3 Societal Impact 51

6.4 HOW TO USE THE BDVCOE FRAMEWORK 52

7 SUMMARY AND CONCLUSION 54

8 APPENDIX A: INSIGHT CENTRE FOR DATA ANALYTICS: CASE STUDY 56
   8.1 ENVIRONMENT 56
      8.1.1 Industry 56
      8.1.2 Policy 56
      8.1.3 Societal 58
   8.2 BDVCOE CORE MODEL 59
      8.2.1 Strategy 59
      8.2.2 Governance & Structure 62
      8.2.3 Funding 67
      8.2.4 Culture 69
      8.2.5 Capabilities 70
         8.2.5.1 People 70
         8.2.5.2 Process 71
         8.2.5.3 Infrastructure 73
      8.2.6 Collaboration 75
   8.3 IMPACT ELEMENTS 77
      8.3.1 Economic Impact 77
      8.3.2 Scientific Impact 77
      8.3.3 Societal Impact 78
   8.4 CHALLENGES AND CRITICAL SUCCESS FACTORS 80
      8.4.1 Challenges 80
      8.4.2 Success Factors 81

9 APPENDIX B: CEADAR: CASE STUDY 81
   9.1 CeADAR RESEARCH FOCUS 83
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2</td>
<td>ENVIRONMENT</td>
<td>84</td>
</tr>
<tr>
<td>9.2.1</td>
<td>Industry</td>
<td>84</td>
</tr>
<tr>
<td>9.2.2</td>
<td>Policy</td>
<td>84</td>
</tr>
<tr>
<td>9.2.3</td>
<td>Societal</td>
<td>85</td>
</tr>
<tr>
<td>9.3</td>
<td>THE CORE MODEL OF BDVCoE</td>
<td>86</td>
</tr>
<tr>
<td>9.3.1</td>
<td>Strategy:</td>
<td>86</td>
</tr>
<tr>
<td>9.3.2</td>
<td>Governance and organisational structure:</td>
<td>86</td>
</tr>
<tr>
<td>9.3.3</td>
<td>Funding</td>
<td>89</td>
</tr>
<tr>
<td>9.3.4</td>
<td>Culture</td>
<td>90</td>
</tr>
<tr>
<td>9.3.5</td>
<td>Outreach</td>
<td>91</td>
</tr>
<tr>
<td>9.3.6</td>
<td>Capabilities</td>
<td>92</td>
</tr>
<tr>
<td>9.4</td>
<td>THE IMPACT</td>
<td>94</td>
</tr>
<tr>
<td>9.5</td>
<td>CHALLENGES AND CRITICAL SUCCESS FACTORS</td>
<td>95</td>
</tr>
<tr>
<td>9.5.1</td>
<td>Challenges</td>
<td>95</td>
</tr>
<tr>
<td>9.5.2</td>
<td>Success Factors</td>
<td>96</td>
</tr>
<tr>
<td>10</td>
<td>APPENDIX C: KNOW CENTRE: CASE STUDY</td>
<td>96</td>
</tr>
<tr>
<td>10.1</td>
<td>ENVIRONMENT</td>
<td>99</td>
</tr>
<tr>
<td>10.1.1</td>
<td>Industry</td>
<td>99</td>
</tr>
<tr>
<td>10.1.2</td>
<td>Policy</td>
<td>99</td>
</tr>
<tr>
<td>10.1.3</td>
<td>Societal</td>
<td>99</td>
</tr>
<tr>
<td>10.2</td>
<td>BDVCoE CORE MODEL</td>
<td>100</td>
</tr>
<tr>
<td>10.2.1</td>
<td>Strategy</td>
<td>100</td>
</tr>
<tr>
<td>10.2.2</td>
<td>Governance &amp; Structure</td>
<td>100</td>
</tr>
<tr>
<td>10.2.3</td>
<td>Funding</td>
<td>103</td>
</tr>
<tr>
<td>10.2.4</td>
<td>Culture</td>
<td>103</td>
</tr>
<tr>
<td>10.2.5</td>
<td>Capabilities</td>
<td>104</td>
</tr>
<tr>
<td>10.2.5.1</td>
<td>Process</td>
<td>104</td>
</tr>
<tr>
<td>10.2.5.2</td>
<td>Infrastructure</td>
<td>104</td>
</tr>
<tr>
<td>10.2.5.3</td>
<td>Collaboration</td>
<td>104</td>
</tr>
<tr>
<td>10.2.5.4</td>
<td>Outreach</td>
<td>105</td>
</tr>
<tr>
<td>10.3</td>
<td>IMPACT</td>
<td>106</td>
</tr>
<tr>
<td>10.4</td>
<td>CHALLENGES AND CRITICAL SUCCESS FACTORS</td>
<td>107</td>
</tr>
<tr>
<td>10.4.1</td>
<td>Challenges</td>
<td>107</td>
</tr>
<tr>
<td>10.4.2</td>
<td>Success Factors</td>
<td>108</td>
</tr>
<tr>
<td>11</td>
<td>APPENDIX D: SIRIUS: CASE STUDY</td>
<td>108</td>
</tr>
</tbody>
</table>
11.1 ENVIRONMENT
11.1.1 Industry
11.1.2 Policy
11.1.3 Societal

11.2 BDVCOE CORE MODEL
11.2.1 Strategy
11.2.2 Governance & Structure
11.2.3 Funding
11.2.4 Culture and Outreach
11.2.5 Capabilities
11.2.6 Collaboration

11.3 IMPACT

11.4 CHALLENGES AND CRITICAL SUCCESS FACTORS
11.4.1 Challenges
11.4.2 Success Factors

12 APPENDIX E: COE LITERATURE OVERVIEW
12.1.1 The SAGE Handbook of Research Management
12.2 SURVEY OF MATERIAL FOR RUNNING RESEARCH CENTRES
12.3 SURVEY OF MATERIAL FOR RUNNING NETWORKS OF RESEARCH CENTRES
12.4 ACADEMIC INDUSTRY COLLABORATION
12.5 INSTANCES OF BIG DATA CENTRES OF EXCELLENCE IN EUROPE

13 APPENDIX F: ORGANIZATIONAL DIAGNOSTIC MODELS
13.1.1 Force Field Analysis (1951)
13.1.2 Leavitt’s Model (1965)
13.1.3 Likert System Analysis (1967)
13.1.4 Open Systems Theory (1965)
13.1.5 Weisbord’s Six-Box Model (1976)
13.1.6 Congruence Model for Organization Analysis (1980)
13.1.8 Tichy’s Technical Political Cultural (TPC) Framework (1983)
13.1.9 High-Performance Programming (1984)
13.1.11 Burke-Litwin Model of Organizational Performance & Change (1992)
13.1.12 Falletta’s Organizational Intelligence Model (2008)
13.1.13 IT-Capability Maturity Framework (2007) 156
13.2 CROSS-MODEL CONCEPT ANALYSIS 157
14 REFERENCES 163
List of Figures

**FIGURE 1:** NATIONAL INNOVATION SYSTEMS MODEL. SOURCE: KUHLMANN & ARNOLD (2001). .... 15

**FIGURE 2:** THE MICRO, MESO, AND MACRO LEVELS OF A BIG DATA Ecosystem ([5]) ........ 16

**FIGURE 3:** GEOGRAPHIC HEAT MAP WITH ALL EUROPEAN BIG DATA CENTRES OF EXCELLENCE. 22

**FIGURE 4:** DESIGN SCIENCE APPROACH. ................................................................. 25

**FIGURE 5:** DELPHI PROCESS OF INTERVIEW IN CASE STUDY CENTRE ....................... 29

**FIGURE 6:** TRANFORMATION PROCESS ................................................................ 31

**FIGURE 7:** ANALYSIS FRAMEWORK FOR BIG DATA VALUE CENTRE OF EXCELLENCE .... 32

**FIGURE 8:** UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS ......................... 34

**FIGURE 9:** A FRAMEWORK OF EXTERNAL ENGAGEMENT BY ACADEMIC RESEARCHERS .... 47

**FIGURE 10:** CONCEPTUAL FRAMEWORK FOR ANALYSING THIRD-STREAM ACTIVITIES [71] ..... 52

**FIGURE 11:** THREE MAIN ORGANIZATIONS FUNDING RESEARCH & INNOVATION IN IRELAND .... 58

**FIGURE 12:** CORE RESEARCH AREAS FOR INSIGHT .................................................. 60

**FIGURE 13:** INSIGHT ORGANISATIONAL STRUCTURE (* DCU STRUCTURE SHOWN AS EXAMPLE; OTHER SITES FOLLOW SAME STRUCTURE) ................................................... 63

**FIGURE 14:** OPERATIONS STRUCTURE ................................................................. 64

**FIGURE 15:** SFI RESEARCH CENTRE HUB AND SPOKE FUNDING MODEL .................. 68

**FIGURE 16:** RESEARCH PROJECT MANAGEMENT TOOLS AT INSIGHT ........................ 74

**FIGURE 17:** SFI IMPACT FRAMEWORK ..................................................................... 77

**FIGURE 18:** CeADAR ................................................................................................ 82

**FIGURE 19:** PRINCIPAL COLLABORATOR UNIVERSITIES ........................................... 82

**FIGURE 20:** CeADAR'S INDUSTRY MEMBERSHIP ..................................................... 84

**FIGURE 21:** GOVERNANCE ROLES CeADAR’S STEERING COMMITTEE ...................... 87

**FIGURE 22:** STRUCTURE AND COMPOSITION OF CeADAR ....................................... 87

**FIGURE 23:** STRUCTURE OF CeADAR’S STEERING COMMITTEE ............................. 88

**FIGURE 24:** A VISUAL REPRESENTATION OF KC TEAMS (CREATED BY AUTHOR) .......... 102

**FIGURE 25:** GROUPS OF COLLABORATORS .......................................................... 104

**FIGURE 26:** SIRIUS GENERAL GOVERNANCE STRUCTURE ..................................... 112

**FIGURE 27:** SIRIUS INNOVATION CYCLE ............................................................... 117

**FIGURE 28:** SIRIUS’S ENVISIONED GAPS: BETWEEN ACADEMIC COMMERCIAL IT AND INDUSTRY ................................................................. 122

**FIGURE 29:** FORCE FIELD ANALYSIS ...................................................................... 147
List of Tables

Table 1: Definitions of centre of excellence in existing literature .............. 17
Table 2: The distribution of BDVCoE in Europe ...................................... 23
Table 3: The four phases of our research methodology .............................. 26
Table 5: Definitions of Strategy .............................................................. 35
Table 6: Summary table of case study findings (sample) ............................. 36
Table 7: Common definitions of the terms 'Governance' & 'Structure' .......... 36
Table 8: Common definitions of the term 'Funding' ................................ 38
Table 9: Definitions of 'Culture' from the literature .................................. 39
Table 10: Definitions of 'People' from the literature ................................. 40
Table 11: Definitions of 'Process' ............................................................ 41
Table 12: Definitions of 'Infrastructure' .................................................. 43
Table 13: Summary of Strategy of Insight Centre ..................................... 61
Table 14: Summary of Governance of Insight Centre ............................... 65
Table 15: Summary of Structure of Insight Centre .................................... 66
Table 16: Summary of Funding of Insight Centre ...................................... 69
Table 17: Summary of People of Insight Centre ........................................ 70
Table 18: Summary of Process of Insight Centre ...................................... 72
Table 19: Summary of Infrastructure of Insight Centre .............................. 74
Table 20: Summary of Collaboration of Insight Centre .............................. 76
Table 21: Summary of Impacts of Insight Centre ...................................... 79
Table 22: Summary of Challenges of Insight Centre ................................. 80
Table 23: Summary of success factors of Insight Centre ........................... 81
Table 24: Summary of Environmental factors of CeADAR ....................... 85
Table 25: Summary of Strategy of CeADAR ........................................... 86
Table 26: Summary of Governance of CeADAR ...................................... 87
Table 27: Summary of Structure of CeADAR .......................................... 89
Table 28: Summary of Funding of CeADAR .......................................... 90
Table 29: Summary of Culture of CeADAR ............................................ 90
Table 30: Summary of Outreach of CeADAR ......................................... 91
Table 31: Summary of Capabilities of CeADAR ...................................... 92
Table 32: Summary of CeADAR impacts ............................................... 94
Table 33: Summary of Challenges of CeADAR ....................................... 95
Table 34: Summary of Success Factors of CeADAR ................................. 96
Table 35: Summary of Environmental influences on KC .......................... 99
Table 36: Summary of Strategy of KC .................................................... 100
Table 37: Summary of Governance of KC ............................................. 101
TABLE 38: SUMMARY OF STRUCTURE OF KC ........................................................ 102
TABLE 39: SUMMARY OF FUNDING OF KC .......................................................... 103
TABLE 40: SUMMARY OF CULTURE OF KC ....................................................... 104
TABLE 41: SUMMARY OF CAPABILITIES OF KC ............................................. 105
TABLE 42: SUMMARY OF IMPACTS OF KC ..................................................... 106
TABLE 43: SUMMARY OF CHALLENGES OF KC ............................................ 107
TABLE 44: SUMMARY OF SUCCESS FACTORS OF KC ...................................... 108
TABLE 45: SUMMARY OF ENVIRONMENTAL INFLUENCES ON SIRIUS ............. 110
TABLE 46: SUMMARY OF STRATEGY OF SIRIUS ............................................ 110
TABLE 47: SUMMARY OF GOVERNANCE OF SIRIUS ....................................... 112
TABLE 48: SUMMARY OF STRUCTURE OF SIRIUS .......................................... 113
TABLE 49: SUMMARY OF FUNDING OF SIRIUS .............................................. 113
TABLE 50: SUMMARY OF CULTURE OF SIRIUS ............................................. 114
TABLE 51: SUMMARY OF OUTREACH OF SIRIUS .......................................... 115
TABLE 52: SUMMARY OF PEOPLE OF SIRIUS .............................................. 116
TABLE 53: SUMMARY OF PROCESS OF SIRIUS ............................................. 118
TABLE 54: SUMMARY OF INFRASTRUCTURE OF SIRIUS ............................... 119
TABLE 55: SUMMARY OF COLLABORATION OF SIRIUS ................................ 120
TABLE 56: SUMMARY OF IMPACTS OF SIRIUS ............................................. 121
TABLE 57: SUMMARY OF CHALLENGES OF SIRIUS ..................................... 123
TABLE 58: SUMMARY OF SUCCESS FACTORS OF SIRIUS ............................... 124
TABLE 58: EXAMPLES OF BDVCoE IN EUROPE ........................................... 136
# Definitions, Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoE</td>
<td>Centre of Excellence</td>
</tr>
<tr>
<td>NCoE</td>
<td>Network for Centres of Excellence</td>
</tr>
<tr>
<td>BDV</td>
<td>Big Data Value</td>
</tr>
<tr>
<td>BDVA</td>
<td>Big Data Value Association</td>
</tr>
<tr>
<td>BDVe</td>
<td>Big Data Value Ecosystem Project</td>
</tr>
<tr>
<td>BDVCoE</td>
<td>Big Data Value Centre of Excellence</td>
</tr>
<tr>
<td>WG</td>
<td>Working Group</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Experts</td>
</tr>
<tr>
<td>KOL</td>
<td>Key Opinion Leader</td>
</tr>
<tr>
<td>TC</td>
<td>Technical Committee</td>
</tr>
<tr>
<td>TTOs</td>
<td>Technology Transfer Offices</td>
</tr>
</tbody>
</table>

*Table 1: Definitions, Acronyms and Abbreviations*
Executive Summary

This report is a deliverable D4.1 on Task 4.1 of the Big Data Value Centres of Excellence (BDVCoE) in Europe. The Insight Centre for Data Analytics (Insight) is the consortium member of the Big Data Value eCosystem (BDVe) H2020 project responsible for the execution of the research leading to the production of the report. The document assembles the information gathered from literature review of the Big Data Analytics services sectors and reports that the core practices in the sector essentially follow known managerial practices including strategy, governance, structure, Funding, and cultural practices. Whereas slight differences in the focus and implementation of these practices may exist in the data science and data analytics research and innovation environment, the basic theoretical concepts behind the practices are arguably same. Beside the above, other common practices in the Data Science industry include ‘Academic/Research-Industry Collaboration’ and Outreach. In particular, collaboration is found to be an important relationship between the research institute and the industry players. And also collaboration does exist between two or more research entities working on projects. While the latter focuses mainly on science and innovation development, the former is most concerned with the transfer of technology to the industry. Collaboration is a part of the Capabilities a CoE may possess among other capabilities such as People, Process and Infrastructure – elements by which the CoE converts its resource inputs into finished innovation for use by those in need of them.

The notion of the CoE’s output usability (as needed resources) by other entities and individuals exposes the fact that CoE’s activities do create positive IMPACT on the Economy, Scientific community and the Society in general. However, a CoE does not exist in space which means it is subject to the influence of the ENVIRONMENT factors in which it exists. Factors influencing BDVCoE activities are categorised, in this context, into Industry forces, Policy and Societal forces.

Based on the information from research on academic papers, a framework of the practices of BDVCoE is created. To improve the quality of completeness and rich in practical terms, this document also reports the interviews of top leaders of selected existing BDCoEs and uses the responses obtained to validate and upgrade the framework earlier developed from theories. The selected four case study Big Data centres include: Insight, CeADAR, KNOWN Centre and SIRIUS. In carrying out interview process, we applied the Delphi Methodology, which involves multi-level interview of top CoEs leaders – Top Manager, Subject Matter Expert (SME) and Top Leadership in that order. Appropriate question formats were applied to gain ideas from respondents at each level of interview.

Evidence of case study documentation and reports thereon as well as other documents prepared and used pursuant of this report are annexes to this document. Also featuring as appendices are the links to further readings for users.
1 Introduction

The Big Data Value eCosystem (BDVe) project is being sponsored by the European Union under the European Commission programme of Horizon 2020 (precisely H2020-ICT-2016-1). The objectives of work package 4 (WP4) they must deliver are: (1) to establish a **Network of National BDV Centres of Excellence** to foster collaboration and share best practices between existing centres and support the establishment of new centres; (2) to exchange knowledge on data scientist educational programmes across all Member States by delivering a **Big Data Value Education Hub** as a platform and repository for knowledge; (3) to establish a **Certification of Curricula and Training Programmes for BDV professionals** to ensure their alignment with industry needs and (4) to **stimulate and promote mobility of students, confirmed data professionals and domain experts** and mobility opportunities beyond the BDV PPP such as Industrial Internships.

1.1 The Task and the Responsibility

As part of the Tasks (T4.1) to achieve objective number 1 above, the Insight Centre for Data Analytics (**Insight**) is the consortium member charged with the responsibility to produce the **Deliverable (D4.1)** which aims at expounding information on the **Network of National Big Data Value Centres of Excellence (BDVCoE)** and to use the information gathered not only to develop a conceptual framework of the practices obtainable in the Big Data domain but additionally, to develop a **Best Practice Guide** for use in promoting value generation and sharing of ideas within the Big Data ecosystem. In other words, the output of this deliverable should: foster collaboration and promote sharing of best practices and know-how between Centres of Excellence and national initiatives; provide expert guidance and (non-financial) support to member states looking to establish new National BDV Centres of Excellence and finally, facilitate meetings of the network participants.

1.2 Relevance and Audience

This document is therefore the report of an extensive literature review of existing BDVCoEs, the case studies of selected centres and the reports of the interviews conducted with the top level representatives of the centres. The aforementioned case studies of BDVCoEs (four in number) were selected based on given criteria such as location, size, etc. (subsection 5.2) and the interviews of the elected officials of the centres followed a Delphi methodology (Figure 5). The findings from the interviews were used to augment the centre practices obtained from the literature for each of the case studies and further used to strengthen the authenticity of the BDVCoE framework developed from initial literature review of the domain practices.

This report is rich in information about the current practices of and management of Big Data Centres; the way things are done in order to produce desired results as well
as what some of the key players in the industry hope would shape the future of the industry. The information contained in this report should be of significant importance to current management teams of Big Data Centres of Excellence as well as potential and future stakeholders (i.e. Universities or regional government) whose ambitions are to set up Big Data Centres of Excellence in Europe or anywhere in the world.

1.3 Report Map

Each section of this document reports on an aspect of the tasks involved in producing deliverable D4.1 (Network of National BDV Centres of Excellence and Best Practice Guide). Specifically, sections 2 (National Innovation Systems) assembles information on the existing ecosystem of the networks of public and private sector institutions that generate values for technological development and applications. Section 3 (Data Ecosystem) deals with the Big Data ecosystem with emphasis on European region and specific value creation levels within the ecosystem of Big Data domain. This leads to the question of what exactly are centres of excellence. Thus section 4 (Centres of Excellence) examines the depth and breadth of CoEs in general and introduces the concept of BDVCoE. It provides several definitions of and instances of these entities spread out in European region. In section 5 (Methodology), the report provides the approaches or processes which were followed to gather the current best practices obtainable in existing BDCoE. It describes the Delphi method of data gathering used in the interviews of case study centre representatives. Section 5.2 (BDVCoE Organisational Framework) attempts to develop a tri-aspect framework – comprising of environment, BDVCoE core model and impact aspects – for the BDVCoE. This is based on the theoretical concepts and other information gathered from literature review. The selected case studies in this deliverable are dealt with from section 7 to 11 of the Appendices with each section devoted to a case study. These include the theoretical findings from document review, the desktop case studies and the responses from interviews analysed to provide reasons to buttress recommendations as well as summary and conclusions of the report.
2 National Innovation Systems

National Innovation Systems constitute networks of public and private sector institutions that generate value from development and applications of new technologies. They play a crucial role in the socio-economic development of countries [1], [2].

![National Innovation Systems Model](image)

**Figure 1:** National Innovation Systems Model  Source: Kuhlmann & Arnold (2001).

Within this document, we focus on the networks around Big Data technologies and their roles in the creation and sustainability of centres of excellence. Particularly our interest lies in the national or pan-European innovation systems that have significant investment in terms of funding and work force directed towards addressing the challenges of Big Data. In this regard, we rely on the concept of “centre of excellence” to identify the characteristics of successful, mainly public sector and university, organizations that are leading the technological developments around Big Data in Europe. This requires us to also consider the data ecosystem that exist and the role that Centres of Excellence play within them.

3 Data Ecosystem

In natural ecosystems, smart organisms control their energy. In business ecosystems, a smart company manages information and its flows [3]. In terms of data, the ecosystem metaphor is useful to describe the data environment supported by a community of interacting organisations and individuals. Big Data Ecosystems can form in different ways around an organisation, community technology platforms, or within or across sectors. Data Ecosystems exist within many industrial sectors where
A well-functioning working data ecosystem must bring together the key stakeholders with a clear benefit for all. The key actors in a big data ecosystem, as illustrated in Figure 2 are:

- **Data Suppliers**: Person or organisation (Large and SME) that create, collect, aggregate, transform and provide data from both public and private sources.
- **Technology Providers**: Typically organisations (Large and SME) as providers of tools, platforms, services, and know-how for data management.
- **Data End Users**: Person or organisation from different industrial sectors (private and public) that leverage big data technology and services to their advantage.
- **Data Marketplace**: Person or organisation that host data from publishers and offer it to consumers/end users. This could be for free or for a charge that should be a reasonable minimum to cover cost or at freemium charge – a model that requires payment to access advanced services beyond ordinary ones.
- **Start-ups and Entrepreneurs**: Develop innovative data-driven technology, products, and services.
- **Researchers and Academics**: Investigate new algorithms, technologies, methodologies, business models, and societal aspects needed to advance big data.
- **Regulators** for data privacy and legal issues.
- **Standardisation Bodies**: Define technology standards (both official and de-facto) to promote the global adoption of big data technology.
- **Investors, Venture Capitalists and Incubators**: Person or organisation that...
provide resources and services to develop the commercial potential of the ecosystem.

Within this data ecosystem model researchers and academics play the research and innovation role. Traditionally academic departments and school, however there is a clear trend within the university sector for the establishment of special purpose Centre of Excellences to drive a research and innovation mission for Big Data, would host these academic researchers.

4 Centres of Excellence

4.1 What is a Centre of Excellence

Excellence as a concept has many varying definitions depending on the focus area, whether its research, development, education, or management. It is characterized as a complex concept that is difficult to define and operationalize due to its dynamic and multidimensional nature [6]. Hellström states “excellence is a term for the political and the scientific community: this because its evaluative dimensions clearly vary within a common theme which most researchers can relate to, and it is often tangible enough for external interests to partake and discuss its implications” [7]. Given that “excellence is a quintessential polymorphic term” [8], it is fundamental to define what is a “centre of excellence” within the scope of BDVe project. Following table provides a collection of definitions for the concept of the “centre of excellence”, as found in the literature.

Table 1: Definitions of centre of excellence in existing literature

<table>
<thead>
<tr>
<th>Definition and Source</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>A centre of excellence (CoE) is a team, a shared facility or an entity that provides leadership, best practices, research, support and/or training for a focus area. The focus area might be a technology (e.g. Java), a business concept (e.g. BPM), a skill (e.g. negotiation) or a broad area of study (e.g. women’s health). Within an organization, a centre of excellence may refer to a group of people, a department or a shared facility. It may also be known as a competency centre or a capability centre. The term may also refer to a network of institutions collaborating with each other to pursue excellence in a particular area [9].</td>
<td>Organizational structure</td>
</tr>
<tr>
<td>A centre of excellence is an organizational unit that embodies a set of capabilities that has been</td>
<td>Strategic management</td>
</tr>
</tbody>
</table>
explicitly recognized by the firm as an important source of value creation, with the intention that these capabilities be leveraged by and/or disseminated to other parts of the firm [10].

Centres of excellence are institutions (within the hierarchy of a firm or the national system of research and education) that concentrate expertise and/or train top experts [11].

CoEs may be described as organisational environments that strive for and succeed in developing high standards of conduct in a field of research, innovation or learning [12].

Create user-driven Centres of Excellence in the application of HPC for addressing scientific, industrial or societal challenges [13].

The overall objective of the centres of excellence initiatives, carried out in many European countries, has been to promote high-quality research through the concentration of resources and longer term funding for the best research environment [6]s.

...the concept of a centre of excellence in project management ... creates an environment to deliver a continuous stream of successfully managed projects – success is measured by having achieved performance that is in the best interest of the whole company as well as the specific project [14].

<table>
<thead>
<tr>
<th>4.2 Big Data Value Centre of Excellence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on the above definitions and within the context of the BDVe project, we define a centre of excellence as follows:</td>
</tr>
<tr>
<td>&quot;A centre of excellence is an organization or organizational unit within a national system of research and education that provides leadership in research, innovation and training for Big Data technologies.&quot;</td>
</tr>
</tbody>
</table>

The defining characteristic of the Big Data Value Centre of Excellence (BDVCoE) is its focus on enabling technologies and societal impacts of Big Data. Particularly they serve as a common place for accumulation and creation of knowledge that addresses challenges of Big Data, open new avenues of knowledge-based economies, guides policy instruments in era of digital life, and informs public about externalities of technological advances based on information processing. At a more general level a
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

centre of excellence can serve as a policy instrument for more than one of the following characteristics [15]

- Promotion of high quality scientific research
- Facilitating basic research through funding
- Promoting internationalization of national research
- Raising profiles of host institution through establishment of CoE
- Formulating strong research groups and collaborations
- Attracting experts and highly skilled researchers

Another view of the unique characteristics of Big Data centres of excellence is as follows [16]

- Data science skills
- Technical and policy infrastructure for data acquisition, efficient storage, and management.
- Knowledge generation
- Data security and privacy protection
- Sector-wide collaboration

4.2.1 European Environment Factors

The Big Data ecosystem that constitutes the regional environment for all of the centres of excellence is grounded in initiatives by European Union. These include:

- Digital Single Market:
- Digitising European Industry
- Building a European Data Economy
- Free flow of Data
- Big Data PPP

In the 2015 the European Union adopted the Digital Single Market (DSM\(^1\)) strategy that aims to facilitate free movement of people, services and capital; to have seamless access and use of online activities under fair conditions; and to increase the level of data protection for individuals and consumers. The DSM strategy is built on three pillars:

- Access: better access for consumers and businesses to digital goods and services across Europe;
- Environment: creating the right conditions and a level playing field for digital networks and innovative services to flourish;
- Economy & Society: maximising the growth potential of the digital economy.

The European Commission published a communication\(^2,3\) on digitising European industry that provides a set a policy measures for maximising the growth potential of

---


\(^2\) http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0180

\(^3\) http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0180
the digital economy in Europe. The communication was aimed at supporting the
digitization of industry by providing a framework for coordination between national
and regional initiatives; furthermore, it laid out policy actions such as boosting
Europe’s digital innovation capacities, providing the appropriate regulatory
framework conditions, and developing a human capital ready for the digital
transformation.

Within the Big Data space a key initiative is the development of a European Data
Economy [72]. A successful data ecosystem would “bring together data owners, data
analytics companies, skilled data professionals, cloud service providers, companies
from the user industries, venture capitalists, entrepreneurs, research institutes and
universities” (DG Connect 2013). A successful data ecosystem, which is a prominent
feature of the data-driven economy, would see these stakeholders interact
seamlessly within a Digital Single Market, leading to business opportunities, easier
access to knowledge, and capital (European Commission 2014). “The Commission
can contribute to this by bringing the relevant players together and by steering the
available financial resources that facilitate collaboration among the various
stakeholders in the European data economy” (DG Connect 2013).

Within the contract for DSM, the European Commission has supported the free flow
of data (FFoD4) initiative. This initiative has four primary actions: tackling data
location restrictions, launching a European Cloud initiative, clarifying emerging issues
of data ownership, access and liability, and encouraging access to public data.

Taking a more concrete step towards engaging with the right stakeholders, the
European Commission has signed public-private partnership with industry (through
the Big Data Value Association) to cooperate in data-related research and
innovation, enhance community building around data and to set the grounds for a
thriving data-driven economy. Specifically, this initiative has resulted in several
innovation projects5 aimed at specific sectors of industry and a strategic agenda for
research and innovation in Europe that is developed in consultation with industry
and academia.

4.3 Orientation of BDVCoE

Authors of a relevant paper have identified three basic schemes for centres of
excellence in Nordic countries [17] and these include:

● CoE schemes that focus on scientific excellence
● CoE schemes that aim for innovation excellence
● CoE schemes that address societal challenges

Similarly, researchers have developed an analytical framework for analysing CoE
schemes according to their strategic orientation, institutional and operational

5 http://big-data-value.eu/
conditions as well as impact and capacity building attributes [12]. In this regard, they classify CoE schemes according to following strategic orientations: Basic and strategic research, Innovation and advanced technological development and Social and economic development. Based on context consideration, we use the above listed classification to classify BDVCoEs according to their primary strategic orientations. It is to be noted, that a BDVCoE might also have a secondary strategic orientation.

4.3.1 Taxonomy of CoEs

We try to classify BDVCoE under two groups using the core attributes and using optional taxonomic attributes. Whereas the core attributes identify the basic or primary internal features and characteristics of the centre, the optional features trace the secondary features and linkages with the outside world. However, this taxonomy also includes the size of the centre regarding employee and student number.

**Core Taxonomy Attributes**

Based on the definition above we select the following primary features to classify BDVe and which can be used to track the existence of BDVCoE within Europe.

**Name, URL, Logo, Address of main site, Country, GPS Coordinates of main site, Senior Management, Centre Focus (As per model), Description of centre (from its website) and BDVA Membership Status (Associate | Full | None)**

**Optional Taxonomy Attributes**

- **No. of Partners (as of 2016):** Academic, Industry and Government
- **No. of Personnel (as of 2016):** Employees (Total Employees, Research Employees, Women Employees); Students (Masters Students, PhD Students)
- **Total Funding (for year 2016):** <1m, 1m-10m, 10m-25m, 25m-50m and >50m,
- **Research Areas:** Data Analytics, Data Applications, Data Management, Data Privacy, Data Processing Systems, Data Security, Data Storage, Data Visualization, Data-driven Business, Human-Computer Interaction, Interactive Data Interfaces, Internet of Things, Recommender Systems, High Performance Computing and Smart Environments,
- **Application Domains:** Energy, Finance/Insurance, Health, Industrial Internet, Mobility, Retail, Smart City, Social Networks, Transport and Shipping, Telecommunications and Culture
- **Output (in year 2016):** Research (Peer-reviewed Journal Articles, Peer-reviewed Conference Articles, Research Reports, Books and Thesis) and Application (Start-ups, Patents and Industry projects)

4.3.2 I-Space vs. BDVCoE

The BDVA has introduced the concept of Innovation Space (I-Space) to label and to define incubators that aim to accelerate data-driven innovation for commercial and societal value. The labelling is designed to recognize entities that provide necessary infrastructure and access mechanism for hosting of...
public and private data along with relevant software solutions. I-Spaces provide cross-organisational and cross-sectorial environments that support challenges to be addressed in an interdisciplinary way and will serve as a hub for other research and innovation activities. Therefore, I-Spaces may be closely related to a BDVCoEs that have primarily strategic orientation towards innovation and advanced technology development and secondary strategic orientation towards societal developments.

4.4 European Big Data Centre of Excellence

The European Big Data Centres of Excellence that were identified are illustrated in the following geographic heat map. Among them, 21 belong to Western Europe, 1 to Eastern Europe, 5 to Southern Europe and 5 to Northern Europe.

Figure 3: Geographic heat map with all European Big Data Centres of Excellence

The regions of the European Union in which some of the Big Data Centres are located are shown below and Table 2 shows the distribution of the data centres

1. Western Europe Region (WE): Austria, Belgium, France, Germany, Ireland, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland, and United Kingdom.
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

2. **Southern Europe Region (SE):** Andorra, Cyprus, Greece, Italy, Malta, Portugal, San Marino, Spain, Turkey, and Vatican City.

3. **Northern Europe Region:** Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway, and Sweden.

4. **Eastern Europe Region:** Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Kazakhstan, Kosovo, FYROM, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine.

Table 2: The distribution of BDVCoE in Europe

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>CENTRE</th>
<th>Url</th>
</tr>
</thead>
</table>
| WE | Ireland | 1. Insight Centre for Data Analytics  
| WE | UK | 1. Digital Catapult’s Data Catalyster  
2. Datalab  
3. Big Data Institute  
4. The Alan Turing Institute  
5. Business and Local Government Data Research Centre  
6. The Data Science Institute at the Imperial College London  
3. https://www.bdi.ox.ac.uk/  
4. https://www.turing.ac.uk/  
6. https://www.imperial.ac.uk/data-science/  
7. http://www.agrimetrics.co.uk/ |
| WE | Germany | 1. Deutsches Forschungszentrum für Künstliche Intelligenz  
2. Smart Data Innovation Lab  
3. Berlin Big Data Centre  
4. Data and Web Science Group, University of Mannheim  
5. Frankfurt Big Data Lab  
6. Competence Centre for Scalable Data Services and Solutions  
5. http://www.bigdata.uni-frankfurt.de/  
| WE | France | 1. Teralab  
2. INRIA | 1. https://www.teralab-datascience.fr/fr/  
2. https://www.inria.fr/en |
<p>| WE | Luxembourg | 1. IT for Innovative Services | <a href="https://www.list.lu/en/itis/">https://www.list.lu/en/itis/</a> |</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Centres of Excellence</th>
</tr>
</thead>
</table>
| **Netherlands** | 1. Big Data Value Center  
2. Data Science Center Eindhoven (DSC/e)  
3. Delft Data Science  
4. Amsterdam Data Science  
5. Leiden Data Science |
| **Austria** | 1. Know-Center GmbH  
2. Complexity Science Hub Vienna |
| **Spain** | 1. Big Data Center of Excellence  
2. Centre of Excellence and Technological Innovation in Bioimaging  
3. Cartif Technology Centre |
| **Greece** | Information Technologies Institute - Centre for Research and Technology Hellas |
| **Italy** | 1. Consorzio Interuniversitario del Nord est Italiano Per il Calcolo Automatico (Interuniversity Consortium High Performance Systems)  
2. CINI "Big Data" Laboratory |
| **Denmark** | 1. DAnish Center for Big Data Analytics driven Innovation  
2. Big Data DTU |
| **Finland** | 1. Finnish Centre of Excellence in Computational Inference Research |
| **Norway** | 1. SIRIUS Centre for Scalable Data Access in the Oil & Gas Domain  
2. SINTEF Digital |
| **Sweden** | 1. SICS |
| **Estonia** | 1. EXCITE |
| **Hungary** | 1. Institute for Computer Science and Control, Hungarian Academy of Sciences |

For more details please read the Appendix A, section 12.5 (Instances of Big Data Centres of Excellence in Europe)
5 Methodology

In this section, we describe the methodology followed for collection of best practices and guidelines for Centres of Excellence and Networks of Centres of Excellence. The methodology follows Design Science principles within a rigorous design process that facilitates the engagement of scholars as well as ensures consistency by providing a meta-model for structuring the methodology. The design science approach Figure 4 used here is closely aligned with the three design science research cycles (Relevance Cycle, Rigor Cycle and Design Cycle) proposed by Hevner [22].

![Design Science Approach](image)

Figure 4: Design Science Approach\(^6\).

In this approach we have step-by-step activities that begin with recognising the problem at hand, followed by a statements of objectives to be actualised in the task. The latter is met with the design of the activities to be engaged in for the development of the end result (the framework). Next, is the evaluation of the validity of the framework that should precede the demonstration of how it could be used. Finally, the validated framework is ready for communication to users. The steps are:

1. Identification and motivation of problem
2. Definition of objectives for the framework
3. Design and development of the BDVCoE Framework
4. Evaluation of framework
5. Demonstration of use of the Framework
6. Communication of the framework
7. 

In general, our methodology follows two parallel work plans for centre-centric and network-centric activities in Task 4.1. The activities under each work plan, as shown in following Figure 5, will support the activities of other work plan.

---


---
A research methodology based on Delphi method is employed for capturing the best practices and guidelines for Centres of Excellence [21]. The Delphi method is primarily used for forecasting with the help of a panel of experts over multiple iterations. Our methodology uses a two rounds approach for capturing and refining best practices and guidelines with the help of a panel of CoE managers. This methodology consists of four phases as highlighted in Table 3. The first phase primarily consists of desktop research applying techniques such as literature review, industry analysis and subject matter expert interview. The second and third phases are implementation of the Delphi method with the help of a working group of senior managers of select CoEs.

Table 3: The four phases of our research methodology

<table>
<thead>
<tr>
<th>Participant</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher</td>
<td>Work Group</td>
<td>Work Group</td>
<td>Work Group</td>
<td>Work Group &amp; Selected CoEs</td>
</tr>
</tbody>
</table>
A working group (WG) was established for the development of the Model that includes a mix of Subject Matter Experts (SMEs) and Key Opinion Leaders (KOLs), including academic researchers, centre managers and administrators. The objective of the working group was to capture the collective learning’s and experience of the group within a framework for BDVCoE. The working group on BDVCoE was established in 2017 with participation from over 5 Centres of Excellence across Europe.

In the design process, working group development output evolves through a series of stages and is reviewed at the end of each stage by a committee. As development of the work progresses through the various stages, the material is subject to more rigorous review and validation. The final design process consists of four phases separated by stage reviews with key deliverables at each stage. The main steps and procedure model are summarized in Table B and described below.

- **Phase 1:** The objective of this phase is to motivate the need for the model and to define the scope of the model. Reviewing relevant industry and academic literature performed initial background research. These are expanded with input from key opinion leaders and subject matter experts.

- **Phase 2:** The objective of this phase is to develop definition of the model and the building blocks within it. A working group consisting of senior managers of CoEs is setup and comparisons are made with artefacts in industry frameworks and industry best practices. CoE managers are interviewed directly and the model is created using a Delphi Study. The working group
performs an internal peer-review of artefacts.

- **Phase 3:** The objective of this phase is to complete the definition of the model by identifying best practices for the model. The artefacts are reviewed with the working groups and 3-5 CoE managers for the full material.

- **Phase 4:** The full model artefacts are exercised through case studies in at least three Centres of Excellence. The model is adjusted based on experiences and submitted for final review and approval to the Consortium.

The initial version of the model is defined by using a mode of argument called *induction by simple enumeration* by that rationalizes that “if a generalization has been positively instantiated in a large number of cases, and negatively instantiated in none, this makes it more likely that the generalization has been positively instantiated in a wide variety of circumstances” [24], and hence validity of inferences is increased.

Within phases 2 and 3 due to the exploratory nature of the work personal interviews with CoE senior manager were considered as a technique well suited to data collection, because they allow expansive discussions which illuminate factors of importance [25], [26]. To improve the reliability and repeatability of the research, a traceable, an “audit trail” of the research process, from data collection through to the drawing of conclusions, was sought. Findings were continuously presented and discussed within the working group. Venting was used, whereby results and interpretations are discussed with the working group to avoid the problem of what is called multiple realities [27]. The working group did not *equate consensus with validity* and the interviewers were engaged in points of discussion, using follow up questions to get a deeper understanding of why such contrasting opinions were being given.

### 5.1 Identifying Challenges and Critical Success Factors

In the case studies, to elicit data on centre challenges and CSFs, we designed the third stage interview to focus on the big picture of the centre (Figure 5). Relevant open-ended questions were used to interrogate top-level leadership officials to provide required information and opinions directed at internal and external environments of the centres as well as the industry trends. In the context described above, the interviewer in the interview session use open-ended questions such as those below, to private responses from top leaders hoping to get answers that address the challenges, enablers and CSFs of a Big Data Centre of Excellence:

- What are the common difficulties faced by the centre in achieving its objectives?
- What factors contribute to/enable the success of the centre?
- What are the typical mechanisms deployed to address success factors and challenges in the centre?
- What would you need to do to be more successful?

Using the above interview methodology to elicit information about the chosen CoE as case studies, we hope to achieve the diagnosis of the issues with each of the chosen case studies. The aim is to include the elicited information in the Best
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

Practice Guide for future references by stakeholder of Big Data Centres of Excellence. Thus, from an organization development perspective, an effective diagnosis of the salient characteristics of an organization is a critical task for management of change [28], [29]. Appendix 13 provides the theoretical background for the organizational models used to support the proposal of BDVCoE model that is described next.

5.2 Case Study CoEs & Interviewees

After a careful consideration of some criteria including the reputation for excellence, coverage of possible postures (basic to applied research), size (small, medium and large) and geographical distribution within European region; the following 4 centres of excellence were selected to be considered for the proposed Delphi study. These include the:

1. Insight Centre for Data Analytics (Insight Centre) – Ireland
2. Centre for Applied Data Analytics (CeADAR) – Ireland
3. Know-Center GmbH (KC) – Germany
4. SIRIUS Centre (SIRIUS) for Scalable Data Access in the Oil & Gas Domain – Norway

The Delphi methodology applies a multi-level of interview processes to acquire information form respondents knowledgeable about the management and operations as well as the research activities of each of the centres in the case study list. The Delphi process followed is visualised below along with the typical question formats suitable for each level of respondents.

**BDV CoE Interview Process**

Figure 5: Delphi process of interview in case study centre

Figure 5 shows the protocol applied in executing the Delphi methodology in our interview process in the case studies of the selected BDVCoE interviews. Leadership levels of interest to this study include those that have a good knowledge of the daily operations, management decisions and strategic decision-making processes of the
centres. Where necessary, we started with the designated manager of the centre with a view to getting ideas about all aspects of the centre activities. We followed lines of inquiries to specific Subject Matter Experts (SMEs) mentioned in the first interview in order to drill down on specific practices that are handled by each SME. For example specific areas include – outreach practices, cultural practices, and commercialisation and patent agreements practices. The final person interviewed in each centre is the person in the overall leadership position whose responsibility is to examine the big picture of the centre.

5.2.1 Data Collection and Analysis

A detailed case study protocol was used to ensure consistency between case study questions and data gathering. The core data collection was conducted using the assessment processes. The average timeline for an assessment was 1 week. A centre’s assessment was conducted using a mixed-methods approach that included an online literature review through desktop research and a set of in-depth interviews based on the findings of the research and with the aim to validate it.

The assessment begins with the establishment of contact with centre leadership to seek materials about the centres’ management, operational and other practices. These materials include annual reports, flyers, posters, magazines, and other materials not ordinarily posted online or are not available as part of the website pages of the centres. Once these were obtained, they were used in addition to the website documentation to develop the needed information packages as case study report of each of the centres in the case study list. Figure 5: Delphi process of interview in case study centre) shows a template of questionnaires of same style for each level of interview. The questions are more general at the first stage but more specific at the second stage with Subject Matter Experts. This process enables us to drill down to elicit detailed information from next respondent following the Delphi methodology. In this manner, we were able to trace certain themes or practices to the specific Subject Matter Expert (SME) responsible for those practices and who knows the most about such practices. Generally, question styles (open ended) applicable to all case studies at each stage of interview (Stage 1: General Manager; Stage 2: SME and Stage 3: Senior Leadership) were same across case studies. Each stage of interview had it objectives and question formats as seen on Figure 5. Further drilling questions were formulated according to responses received with the aims to elicit further and/or the true information right at the interview desk. This drilling process, in some cases, led to the introduction of, usually, additional SMEs to explain in details what the earlier interviewee had expressed briefly. Thus the drilling process enabled us to reach the depth and breath (scope) and to enhance the true information regarding the practices in the Big Data Centre of Excellence for the purpose of enriching the substance of this report.

A close look at the interview process (Figure 5) reveals that whereas stage 1 (Manager level) had an aim to elicit data which is general but more about the internal operations of the CoE, stage 2 interview (SME level) was designed to drill down on specific practices. Stage 2 interview aims to elicit data on focused areas that could be internal (mainly) but also external to the CoE depending on the theme.
being drilled. Based on the above drilling process, it is logical to say that the number of interviews conducted for each centre is dependent on the number of topics requiring further drilling among the SME group. The last stage (Leadership level) interview questions were designed to look at the big picture of the CoEs in operation. These are areas relating to individual centre’s vision, their challenges, enablers as well as the success factors.

6 BDVCoE Organisational Framework

In this study, we carried out two aspects of work to provide information:

- Literature review of CoEs and the network of related organisation (section 2 to 4 and 6.1 to 6.3)
- Literature reviews selected Centres of Excellence and their practices (section 8 to 11)

Based on the information obtained from these key areas of work, we have designed a model that summarizes the important concepts that describe a Centre of Excellence as an organisation. The model is depicted in Figure 7 and it features three main components: Environment, Centre of Excellence, and Impact. Each of these components covers one of the organisational elements defined in open systems theory Figure 6: Inputs (environment), Transformation (Centres of Excellence) and Outputs (Impact).

- **Environment**: highlights three main elements: Industry, Policy and Citizens.
- **Core BDVCoE Model**: includes Strategy, Governance, Structure and Funding, Cultures and Capabilities that are People, Process and Infrastructure.
- **Impact**: includes Economic, Scientific and Social impacts.

![Figure 6: Transformation process](image)

Each of these elements is described in details in the following sections.
6.1 Environment

As defined for the purpose of organizational diagnosis, the “environment means forces difficult to control from inside that demand a response” [37]. Another view of the external environment of an organization is that it comprises of forces that initiate organizational change [31]. Therefore, we define the environment of a BDVCoE in terms of three forces: industry, policy, and citizens. These forces influence the practices followed by a centre of excellence; therefore, we examine the environment of a BDVCoE in terms of these forces.

6.1.1 Industry

The term industry refers to the production of goods or related services within an economy. It also refers to companies and business operating in a particular sector. In the context of this report, we use Big Data industry to refer to companies, start-ups, businesses, etc. that are carrying out economic activities related to big data: collection, provision, analysis, etc. While Big Data industry would directly affect the strategy and performance of a BDVCoE, the relative strengths or weaknesses of other industrial sectors might also be reflected in the core elements of BDVCoE model. In fact, it is well understood that industry represents a significant influence on the research performance of academics [45]. Based on these observations we define the industry element of our BDVCoE framework as follows:

**Definition:** Our proposed definition:

*Industry is defined as the ecosystem of companies surrounding a Big Data Value Centre of Excellence that is associated with the creation of economic value, at both national and European levels.*

---

7 Industry as defined in dictionary.com http://www.dictionary.com/browse/industry
While examining a BDVCoE, we enumerate the set of prominent companies and significant industrial sectors that make-up majority of the national economic value. Furthermore, we aim to analyse the relationship of European industry with the Centre of Excellence. Industry being a strong influencing factor, it is critical to how a BDVCoE interfaces with the national, regional, and international industry. Establishing and maintaining strategic industry-research collaborations should be a priority for BDVCoEs. It has been understood that improved organizational arrangements are needed to promote university-industry collaborations within the context of national innovation systems [46].

6.1.2 Policy

Policies and regulation that affect a Big Data research centre can be divided into two broad categories: research & innovation policy and data protection policy. The national level research and innovation policy defines the goals of funding provided to research centres and influences the alignment of elements within the BDVCoE core model with those goals.

Data protection policies and regulations primarily focus on clarifying rules about data usage, data ownership, data localisation and data portability [47]. The use of personal data is necessary for carrying out reliable and high quality scientific research [48]. Regulations at the national or international levels aim to protect people with regard to the processing of their personal data: “[European Union (EU)] 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data [general data protection regulation (GDPR)], repealing Directive 95/46/EC, strengthens and harmonises the rules for protecting individuals’ privacy rights and freedoms within and, under certain conditions, outside the EU territory” [48].

**Definition:** Our proposed definition:

> Policy is defined as the set of public laws, regulations and policies that govern research and innovation activities at national and European level, as well as dictate the access, manipulation, and distribution of data.

6.1.3 Societal

**Context**

Citizens or civil society communities play an important role within the external environment of a BDVCoE. Social, political, and cultural values influence the progress of scientific research and technological innovation in a society [49]. The state of a societal environment around a BDVCoE can be assessed in terms of composite statistic produced by organizations such as the OECD or the UN. In this regard, we use following three indexes:
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

- Human Development Index\(^8\) ranks countries according to three tiers for human development: life expectancy, education, and standard of living.
- Global Competitiveness Index\(^9\) ranks countries according to the twelve dimensions of competitiveness including but not limited to the ability to harness the benefits of existing technologies and innovation.
- Global Innovation Index\(^10\) measures a country’s capacity for innovation and use of innovative output.

The United Nations has set 17 goals (Figure 8) for sustainable development through a resolution in 2015 [50]. As national and regional policies as being aligned to these goals, we assess the environment of a BDVCoE in terms of its priorities and their alignment with the UN SDGs. Similarly, there are seven societal challenges as one the main pillars of Horizon 2020\(^11\) programme. These challenges and development goals can help define national priorities in terms of research excellence; thus, affecting a BDVCoE’s strategy.

Figure 8: United Nations Sustainable Development Goals

In the context of Big Data, citizens or users are the main providers of data that is used to build models and test applications. Protection and legal use of such data becomes an important concern in Big Data intensive research that is of serious nature regarding individual’s privacy when dealing with healthcare and medical records [51].

**Definition:** Our proposed definition is

*The societal environment of a BDVCoE comprises of state of human development as measured by composite statistics and indexes, and the national priorities for human development in terms of the UN Sustainable Development Goals and H2020 Societal Challenges.*

---

\(^8\) https://en.wikipedia.org/wiki/Human_Development_Index  
\(^10\) https://en.wikipedia.org/wiki/Global_Innovation_Index  
6.2 Core Organizational Model

This subsection provides detailed information on the main element or concepts within the BDVCoE core model – other aspects of the model or framework being the ‘Environment’ and the ‘Impact’ aspects. As highlighted by Figure 7, the theoretical information on elements featuring the core model aspect will be expounded in this subsection. These elements include the **Strategy, Governance, Structure, Funding, Culture** and **Capabilities** that are further split into sub-elements such as **People**, **Process** and **Infrastructure**. Other sub-elements of ‘Capability’ include **Outreach** and **Collaboration**. Due to the importance of ‘Collaboration’ to the success of Big Data Value Centres’ operations, this report devotes a subsection to treat academic-industry **‘Collaboration framework’** in details. See subsection 6.2.6 (Collaboration Framework). A subsection (from 6.2.1 to 6.2.5.4) is devoted to the presentation of existing definitions (in tabular format) of concepts by various authors. We have, from contextual viewpoint; selected or created definitions based on the definitions examined which we believe are most applicable to BDCoEs.

### 6.2.1 Strategy

In the following Table 4, we provide definitions of strategy from the literature:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[52]</td>
<td>Strategy is “the direction and scope of an organisation over the long term, which achieves advantage in a changing environment through its configuration of resources and competences with the aim of fulfilling stakeholder expectations.”</td>
</tr>
<tr>
<td>[53]</td>
<td>McKinsey’s definition of strategy is “an integrated set of actions designed to create a sustainable advantage over competitors”</td>
</tr>
<tr>
<td>[31]</td>
<td>Mission and Strategy is “what the organisation’s: (a) top management believes is and has declared is the organisation’s mission and strategy and (b) employees believe is the central purpose of the organisation... Strategy is how the organisation intends to achieve that purpose over and extended time scale.”</td>
</tr>
</tbody>
</table>

**Definition:** Our proposed definition is

*Strategy represents the means by which a centre of excellence intends to achieve its overall mission and goals.*
Good Practices: Examples of good practice as a set of factors that constitute a dynamic and innovative research environment in terms of strategy, objectives and priorities include the following as identified by [6]

The research environment:

- has a clear and visible research strategy
- has clear and visible research objectives
- has a research strategy and objectives that are formulated by the senior research group
- has a research strategy and objectives that are formulated by the management group
- has well-defined, distinct, narrow-ranged, research areas
- has a focused and positivistic research profile
- performs research which is unique in its area (or country)
- has a continuous dialogue on research target areas, theories, and methods

Below Table 5: Summary table of case study findings (sample) – shows a template designed for recording the summaries of each of the elements (e.g. strategy, governance, funding, etc.) of the BDVCoE framework for the selected case studies of the BDVCoEs reported in this document. The populated summary tables feature under sections dealing with the case studies - sections 8 to 11.

Table 5: Summary table of case study findings (sample)

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keyword</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

6.2.2 Governance & Structure

Available definitions of Governance and Structure are presented in Table 6 below:

Table 6: Common definitions of the terms ‘Governance’ & ‘Structure’

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[31]</td>
<td>Structure is “the arrangement of functions and people into specific areas and levels of responsibility, decision-making authority, communication, and relationships to assure effective implementation of the organisation's mission and strategy”.</td>
</tr>
<tr>
<td>[52]</td>
<td>Corporate governance is concerned with “the structures and systems of control by which managers are held accountable to those who have a</td>
</tr>
</tbody>
</table>
**Definition:** Our proposed definition is:

- *Governance in Centres of Excellence* refers to the level of decision-making and operations.
- The *structure* is how a Centre of Excellence is designed (i.e., levels, roles, units, decisions rights, and accountability).

**Good Practices:** Examples of Good practice depend on the type of institutions and at the level of decision making, as defined by [56]

- Centre of Excellence as a “republic of scholars”: Leadership and decision-making is at the collegial level by independent scholars
- Centre of Excellence as a “stakeholder organisation”:
  - institutional autonomy is considered a basis for strategic decision making by leaders who are assumed to see it as their primary task to satisfy the interests of major stakeholders
  - academic freedom is therefore circumscribed by the interests of other stakeholders
- [57] propose a set of good research practice for high quality science regarding research governance and integrity as follows:
  - Training in good research practice
  - Openness about consequences of misconduct
  - Adoption of appropriate ethical review processes

Examples of Good practice as a set of factors that constitute a dynamic and innovative research environment, include the following as identified by [6]

- The research environment (structure):
  - has a flexible organisation structure
  - consists of a core researcher group and a number of attached members or affiliates
  - has an organisation structure with a high adaptability to external changes
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

- has an organisation structure with a high adaptability to structural changes

6.2.3 Funding

Various funding definitions in literatures are presented in Table 7 below:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[58]</td>
<td>“Research funding is a term generally covering any funding for scientific research, in the areas of both “hard” science and technology and social science. The term often connotes funding obtained through a competitive process, in which potential research projects are evaluated and only the most promising receive funding. Such processes, which are run by government, corporations or foundations, allocate scarce funds.”</td>
</tr>
<tr>
<td>[59]</td>
<td>“University income stems from four main sources: general government grants or general university funds, direct government funds, internal funds, and the sale of academic services. ... Government funds to universities are funneled through three different channels: incremental funding, formula funding, and contractual funding.”</td>
</tr>
</tbody>
</table>

**Definition:** Our proposed definition:

Funding refers to the availability, diversity, and sustainability of the monetary support for carrying out research and educational activities in a centre of excellence.

**Good Practices:** The research environment (funding):

- has sufficient funding
- is excellent so as to obtain external funding because securing further funding is a function of good results from previous financial input
- receives a substantial funding share as external funding
- external funding is diverse and comes from many sources
- is dependent on external funding
- external funding enables recruitment of new researchers
- external funding strengthens interdisciplinary/transdisciplinary initiatives

[57] proposes two good research practices for high quality science regarding funding as follows:

- Adoption of diverse funding approaches
- Clear communication of funding opportunities and assessment criteria
6.2.4 Culture

Table 8 below contains scholastic definitions of the term *culture*.

**Table 8: Definitions of 'Culture' from the literature**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[60]</td>
<td>Organisational culture is the “basic assumptions and beliefs that are shared by members of an organisation, that operate unconsciously and define in a basic taken for granted fashion an organisation’s view of itself and its environment”</td>
</tr>
<tr>
<td>[31]</td>
<td>Culture is “the collection of overt and covert rules, values, and principles that are enduring and guide organisational behaviour”.</td>
</tr>
<tr>
<td>[61]</td>
<td>An organization’s culture consists of “the set of shared norms, values, beliefs, and assumptions, along with the behaviour and other artefacts (e.g., symbols, rituals, stories, and language) that express these orientations.”</td>
</tr>
</tbody>
</table>

**Definition**: Our proposed definition is

Culture represents the underlying values, beliefs and norms that drive the teams and the centre of excellence as a whole.

**Good Practices**: Examples of good practice as a set of factors that constitute a dynamic and innovative research environment in terms of Working climate, Research traditions and Approaches, as identified by [6]

The research environment

- has a good working climate
- working environment is based on internalised norms
- working environment is based on research traditions
- working environment is open towards new ideas
- working environment is open towards new methods
- working environment is open towards new approaches
- staff policy is based on research autonomy during the research process
- working climate is based on teamwork
- is characterised by close cooperation among research staff
- encourages internal professional dialogue
- encourages internal social dialogue

6.2.5 Capabilities
The concept of capability has been defined by [62] and [63], from organizational and data perspectives, as the ability of organizations to efficiently use their resources (i.e., human capital, knowledge, available data, etc.) to generate value and achieve their objectives. Our BDVCoE model considers organizational capabilities in terms of people, processes, infrastructure, and collaboration.

6.2.5.1 People

Table 9 show definition of ‘People’ from the literatures reviewed in this research.

Table 9: Definitions of ‘People’ from the literature

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[31]</td>
<td>Task requirements and individual skills/abilities are “the required behaviour for task effectiveness, including specific skills and knowledge required of people to accomplish the work for which they have been assigned and for which they feel directly responsible”.</td>
</tr>
<tr>
<td>[39]</td>
<td>Staff refers to the “Organization's human resources, demographic, educational and attitudinal characteristics.”</td>
</tr>
<tr>
<td>[61]</td>
<td>“The human resources available to a research organization are also important to the analysis of integrity in research. The background characteristics of scientists coming into a research organization influence its structure and processes as well as its overall culture and climate, and these factors, in turn, influence the responsible conduct of research by individual scientists.”</td>
</tr>
</tbody>
</table>

Our proposed definition:

The human capital required to carry out specific tasks towards the goals of the organization.

Good Practice: Examples of Good practice as a set of factors that constitute a dynamic and innovative research environment in terms of Human Resources Management, Recruitment and Competences, as identified by [6]

The research environment:

- prioritises development of scientific elite
- supports young researchers’ career development
- prioritises competence development among researchers
- is attractive for early stage (international) researchers
- has a well-defined human resources management profile
- has a transparent human resources management profile
- manager’s right to manage is justified by strong research competences
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

- prioritises development of scientific elite
- creates excellence in research through recruitment of the best researchers
- has a clear recruitment policy
- recruitment policy builds on core senior competences
- has a diverse staff composition (young/old, women/men, nationals/internationals)
- supports young researchers’ career development
- prioritises competence development among researchers
- is attractive for early stage (international) researchers

6.2.5.2 Process

The following and definitions of ‘Process’ obtained from the review of literatures

Table 10: Definitions of 'Process'

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[31]</td>
<td>Management practices are “what managers do in the normal course of events to use the human and material resources at their disposal to carry out the organisation’s strategy”.</td>
</tr>
<tr>
<td>[39]</td>
<td>In the McKinsey 7S Frame, process is defined from two perspectives: structure and systems. Structure is defined as “Division of activities; integration and coordination mechanisms” and Systems as “Formal procedures for measurement, reward and resource allocation”</td>
</tr>
<tr>
<td>[61]</td>
<td>Organizational processes are “the patterned forms of interaction between and among groups or individuals within an organization. Processes represent the dynamic aspects of an organization. ... The processes of most interest consist of (1) leadership, (2) competition, (3) supervision, (4) communication, (5) socialization, and (6) organizational learning.”</td>
</tr>
</tbody>
</table>

Definition: Our proposed definition is:

Process is the knowledge of procedures and tasks for the achievement of the goals of the centre of excellence.

Good Practices: Examples of good practice are a set of factors that constitute a dynamic and innovative research environment and management of research activities, as identified by [6]. The research environment has a management that:

- plans and coordinates research activities
● defines research target areas
● prioritises among research areas
● prioritises among research projects
● prioritises research productivity
● leaders should support high ethical standards, pay attention to responsible conduct of research, and are openly and strongly committed to integrity in research.
● create a reward system and policies that promote being the “best” within the scientific enterprise, and within a context that encourages the responsible conduct of research
● Communication among members of a research organization or research group that is frequent and open
● being learner-centred, active rather than passive, relevant to the learner’s needs, engaging, and reinforcing

Examples of good practice, as identified by Davies (2016), include:
● Understanding the legal terminology from policy text
● Identify a clear definition of consent for data usage
● Designation of a data protection officer
● Data protection impact assessment
● Notification and communication of personal data breach

Good Practices (Move to process)
Examples of good practice for citizen information, as identified by [51], include:
● avoid the inclusion of non-professionals in the collection and volunteering of data
● avoid the participation of non-experts in scientific experimentations and the analysis of the data
● getting consent from citizen scientists is indispensable
● data should be anonymised and matching with third party dataset should not re-identify individuals

6.2.5.3 Infrastructure
Infrastructure is defined by many authors and some of the available definitions are reprinted in Table 11 below:
Table 11: Definitions of ‘Infrastructure’

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[31]</td>
<td>Systems are “standardized policies and mechanisms that facilitate work, primarily manifested in the organisation’s reward systems, management information systems (MIS), and in such control systems as performance appraisal, goal and budget development, and human resource allocation”.</td>
</tr>
<tr>
<td>[64]</td>
<td>Research infrastructures (RIs) are “facilities, resources and services used by the science community to conduct research and foster innovation.”</td>
</tr>
<tr>
<td>[61]</td>
<td>Organization’s infrastructure/technology “offers the methods for transforming system resources into system outputs. It consists of such aspects of an organization’s infrastructure as facilities, tools and equipment, and techniques. These aspects can be mental and social, mechanical, chemical, physical, or electronic.”</td>
</tr>
</tbody>
</table>

**Definition:** Our proposed definition is

Infrastructure is the systems, practices and tools that facilitate and reinforce the work within the organisation.

**Good Practices:** Examples of Good practice as proposed by the [61]
- Research environments need the necessary tools and equipment for their respective types of scientific research.
- Research centres must also establish technologies (e.g., accounting systems and library and information retrieval systems)
- Research infrastructures should support organisations for the effective and efficient operation of the research.
- Research centres should be ready to enter competitions to acquire the various forms of technology that are of sufficient quantity and quality to facilitate research production.
- The availability of this technology may, in turn, attract highly skilled scientists who hope to carry out research at the cutting edge of technology.
- Infrastructures should also be used for promoting the responsible conduct of research.

**6.2.5.4 Collaboration**

Collaboration is a capability that a research centre of excellence possesses and through which it attracts partners to co-create value for both parties. Due to the importance of this element in the BDVCoE model, we considered it necessary to treat collaboration under its own sub-section (sub-section 6.2.6) of the core
organisational model section of this report. This gives us the opportunity to evaluate the concept of Collaboration theoretically in details and to examine the typical stakeholders, the methodologies of attracting collaborators, the advantages and other implications is has on the success of BDVCoE.

6.2.6 Collaboration Framework

6.2.6.1 Definitions of Collaboration:

“Universities-industry collaboration (UIC) refers to the interaction between any parts of the higher educational system and industry aiming mainly to encourage knowledge and technology exchange”\(^{12}\). Another term for research-industry collaboration is academic engagement and is “defined as knowledge-related collaboration by academic researchers with non-academic organisations. These interactions include formal activities such as collaborative research, contract research, and consulting, as well as informal activities like knowledge exchange and providing ad hoc advice and networking with practitioners”\(^ {13}\).

Collaboration between academic institution (Universities, Research Centres and Colleges of Technology) and the industry has been recognised as a factor that enhances innovation through knowledge exchange\(^ {14}\). In agreement with this premise, a profound research work highlights the relevance of collaborative research, contract research, consulting and informal relationships for university–industry knowledge transfer\(^ {15}\). To buttress the relevance of academic-industry collaboration to the business world, \(^ {16}\) produce a preliminary business model for visualising collaboration between universities and industrial partners (through project works). This model proposes a general framework for the creation of successful collaboration between the academia and business entrepreneurs. In this regard, collaboration is a necessary initiative in that while a company may not have all the competencies to perform each operation in-house for the development of competitive products, collaboration with universities could help them in developing solutions to problems that cannot be solved internally\(^ {17}\). Furthermore, academic collaboration with firms, particularly working on common projects, may offer the academic partner an opportunity of insight into what ideas are commercially viable.

---


\(^{14}\) Perkmann and others.

\(^{15}\) (Perkmann et al. 2013)

\(^{16}\) Ivascu, Cirjaliu and Draghici.

\(^{17}\) Perkmann and others.
and hence the chance to develop or co-develop inventions that can be patented or incubated as a start-up. Universities no longer just develop new technologies and deliver them to the business sector as it used to be. Academic research is now central to the economic cycle of innovation and growth. Thus universities and firms must collaborate in teamwork to foster together knowledge or technology for full exploitation particularly for the fact that universities boast of the appropriate physical facilities and staff expertise to make scientific discoveries and technological breakthroughs for industry applications. It has been argued that world-class research universities are at the forefront of pioneering university-industry partnerships because these institutions have metamorphosed into centres of excellence designed to run longer, invest more, look farther ahead and drive corporate competitiveness, provide the competence to help tackle social challenges and drive economic growth.

Some theorists believe that a collaborative initiative between academia and industry may not necessarily result in commercialisation. Successful exploitation of new external knowledge requires effective knowledge transfer mechanisms between the sharing entity and the receiving entity and because knowledge is progressive and co-created, knowledge transfer entails active involvement of participants who must learn together. In the light of the argument above try to excavate how academic engagement differs from commercialisation and identifies the individual, organisational and institutional antecedents and consequences of academic engagement. It further compares these findings with the antecedents and consequences of commercialisation. First it defines commercialisation as intellectual property creation and academic entrepreneurship. To this end, many universities have developed an additional mission by fostering links with knowledge users and facilitating technology transfer through collaboration with industry. There are however, similarities between academic engagement and commercialisation because commercialisation is an outcome or follow-on activity, intended or unintended, arising out of academic engagement. In other words,

---


19 Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano.


21 Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano.

22 (Berbegal-Mirabent et al. 2015)

23 Perkmann and others.

24 Perkmann and others; Berbegal-Mirabent, Sánchez García and Ribeiro-Soriano.

25 Perkmann and others.

26 Ivascu, Cirjaliu and Draghici.
commercialisation helps to bring the result of engagement into commercial environment for profit making.

6.2.6.2 Factors supporting collaboration

In line with the above findings – universities’ additional mission – several factors have been discovered to foster effective collaboration between university and industry in open innovation \(^{27}\). According to these authors, six key elements are common in academic-industry partnerships:

1. **Structure**: A well-defined structure that supports efficient research projects is installed in the university;
2. **Project Management/communication**: The presence of effective and efficient capabilities such as these coupled with good monitoring strategies in the university;
3. **Identification of Economic environment**: The identification of the characteristics of economic environment is particularly done using young researchers.
4. **Partnering**: Developing new partnerships and supporting existing projects to launch new opportunities.
5. **Culture**: Developing a strong organizational culture providing and supporting the openness that universities have towards collaboration with industry;
6. **Dissemination strategy**: Designed to attract new partners using elements of marketing and to strengthen shared research.

6.2.6.3 How academic research contributes to the economy

The value-creation opportunity arising from collaboration between research entities and the industry has been investigated and the resulting impact on the economy studied as well. Values from academic-industry relationship contribute to the economy and the society in multiple ways \(^{28}\) namely: **Commercialisation through Technology Transfer Offices (TTOs)** and **Academic engagement**. Whereas commercialisation – for example, generating academic impact from immediate, measurable, market-acceptable academic research outputs – through TTO, involves the commercialisation of academic knowledge through the patenting and licensing of inventions as well as academic entrepreneurship; academic engagement, on the other hand, refers to interactions including formal activities such as collaborative research, contract research, and consulting as well as informal activities such as knowledge exchange and providing ad hoc advice and networking events with industry practitioners \(^{29}\). Further in this argument, \(^{30}\) opine that in order to explore

\(^{27}\) Perkmann and others.

\(^{28}\) Perkmann and others.

\(^{29}\) (Perkmann et al. 2013)

\(^{30}\) Perkmann and others.
commercialisation opportunities, many universities have established specialised structures (such as TTOs), science parks and incubators. These are infrastructures that enable the output of academic engagement, typically knowledge, to be transferred into the industrial domain.

6.2.6.4 Features of Academic-Industry Engagement

Certain characteristics support successful collaboration between the academic entity and industry participant (Figure 9). These features have been examined by some researchers who discovered that the characteristics have two aspects – organisational and objective aspects:

- First, academic engagement is a form of collaboration between organisations, notably, the university and another organisation, usually a firm. The relationship involves interactions that link the university to other organisations or firms
  - Such relationship may be driven by financial needs where the academic earns a fee for participation, or
  - Non-financial relationship – involving benefits such as access to materials or data for academic research projects or ideational input

- Second, the collaborators may pursue goals that are beyond research initiatives for other benefits such as academic publishing, to generate some kinds of utility for the non-academic partners. For instance, the academic participant may offer expertise towards the creation of new ideas to solve problems and suggest solutions to collaborating organisations.

![Figure 9: A Framework of external engagement by academic researchers](image)

---

31 Edmondson and others.

In a report that aims to address the challenge of bridging the industry-university divide, authors highlight three important considerations:

1. what makes universities attractive to the industry partners
2. what structure constitutes successful partnerships
3. what approach produces seamless interactions

These authors further proposed that for the relationship between the academic and the industry to work together certain issues have to be addressed and these include:

1. **Policy environment** – policymakers need to ensure a stable funding environment with regulatory support for long-term strategic partnerships to thrive.
2. Universities need **autonomy** to operate effectively and to form productive partnerships.
3. Provide (funding) **incentive** or reward for institutions that are pro academic-industry collaboration to encourage practicing universities and more to join in the collaboration relationship.
4. Because companies want to work with the best institutions, **universities must strive for excellence** while **governments must promote** its best universities

Other antecedents to collaboration has been proposed but this time in more specific level of personnel characteristics:

- **Individual characteristics**: Gender, age, attitude of researchers towards industry and scientific quality and success of the institution have influence on collaboration.
- **Organisational context**: This is based on the academic quality of the department in the university involved in the collaboration or the university as a whole. However, the organisational factors will likely ameliorate the impact of individual characteristics on external engagement.
- **Institutional context**: Under this context, two factors have been seen to influence academic-industry engagement and they include **affiliation to a scientific discipline** and **the effect of specific national regulations and public policies**. These factors have influence on engagement because they shape the norms and rules relevant to researchers.

---

33 Edmondson and others.
34 Perkmann and others.
Conclusively, there is a positive correlation between engagement and government grant; and between engagement and academic success. Furthermore, assert that transfer of knowledge plays important roles in innovation and growth of both technology and commerce and that culture contributes to the innovation. However, to balance the way to create culture in order to lead to better transfer and exploitation of university knowledge for innovation five stages of actions need to be addressed:

1. Company Opportunity to be explored,
2. Co-recognition (identifying the business needs),
3. Co-formulation of strategy to the needs and opportunities of the business partner,
4. Co-creation (whereby partners create opportunity for innovation processes, products or markets), and
5. Commercialization (main purpose of industrial partners is the commercialization).

In the report, a set of key lessons and recommendations from industry-university partnerships analysis were the following:

- University leadership is vital for creating strategic collaborations and maintaining them
- Long-term strategic partnerships with built-in flexibility work best
- Start with a shared vision and develop a strategy
- Put the right people in charge – those who cross boundaries
- Kick-start the dialogue – encourage cross-fertilisation of ideas
- Do not get hung up on intellectual property (IP): develop a broad overarching framework agreement and work out details on a case-by-case basis
- Promote a multidisciplinary approach to research and learning
- Do not get hung up on measuring the results of a strategic alliance
- Redefine the role of the research as a source of competence and problem-solving for society

6.3 Impact

Impact defines the benefits or changes brought by an organization to society, the economy or the environment. Society benefits for successful Big Data research

---

36 (Craig et al. 2009)
when the outcomes are converted into consumable products or services [68]. The economic impact is the effect on commerce, employment, or incomes generated from Big Data research in general and by the centre of excellence in particular. In terms of environment, the impact for a BDV CoE can be its roles in supporting sustainable practices for industry, government, and citizens.

**Definition:** Within the context of this document, impact is defined as follows [67]:

The direct and indirect ‘influence’ of research or its ‘effect on’ an individual, a community, or society as a whole, including benefits to the economic, social, human and natural capital.

Definition of the impact metrics and their measurement methods are significant part of the impact assessment methodology. The following subsections provide guidelines from literature on how to measure economic, scientific, and societal impact. Basically, impact on the environment and society would be seen in reports of innovation activities derived from the field researches in relation to impact areas such as economic, scientific and societal impacts. The parameters to understand impacts could be measured through some kinds of KPIs being monitored by the BDVCoE, on the one hand, and those monitored by the country government agencies in which the BDVCoE is located on the other. For example, in a nation such Ireland, economic impact could be how centre-industry partnership or collaboration in research and technology is bringing about measurable increase in commercial activities, companies creation through commercialisation, spinouts and jobs creation, skills development, etc.

### 6.3.1 Economic Impact

**Definition**

The economic impact is the effect on commerce, employment, or incomes generated from big data research in general and by the centre of excellence in particular.

As described in [66], the examples of best practices for the assessment of economic impact are:

- Funders need to be sure that job creation is reported consistently across multiple organisations, so researchers need an agreed standard such as ‘full-time equivalent jobs created’ to avoid counting part-time roles.
- Claims of impact remain assertions, however, unless there is independent validation of impact evidence.
- Evaluators require an audit trail to use impact data for evaluation purposes.
- The impact evidence must be collected over time, attributing each impact to original research or expertise and tracing the developing sequences of activities.
- Evidence types can vary widely depending on the discipline, the stakeholders and the changes that have occurred.
• Impact evidence can include quantitative reports of increased sales for a commercial stakeholder or quality of life improvements.
• Qualitative testimonials can directly attribute changes to the research or the contributions made by researchers because of their expertise.
• Impact information needs a standard structure and categorisation.

A digital research report by Digital Science & Research Ltd that was released in March 2016 suggests the following best practices for a Research Excellence Framework to improve both the quality and value of future Centres of Excellence [66]:
• To ensure that the full range of meaningful impacts can be recognised, consider extending the eligible period both for impacts and for the research on which they were based
• Require listing of funders and grant references in the case study template
• To aid assessment and further use, consider developing guidance on certain types of evidence where appropriate e.g. sales, staff numbers, company investment
• Where possible, re-use information from other systems e.g. ORCID

6.3.2 Scientific Impact
The assessment of the scientific impact of a Centre of Excellence helps funding agencies to evaluate returns on research investment from a research impact perspective. Scientific impact can be assessed qualitatively or quantitatively. An analysis carried out by [68] identifies the following practices for the quantifying the impact and relevance of scientific research:
• Qualitative approaches: involve expert panels evaluating impact, for example as high, medium or low, based on written descriptions of impact.
• Quantitative approaches: involve numerical indicators derived from scoring systems or questionnaires focused on the various possible impacts of a research programme or project. Numerical indicators can include:
  ○ number of publications,
  ○ impact factors of venues,
  ○ number of download,
  ○ number of views,
  ○ citations, etc.

6.3.3 Societal Impact
Societal impact can be measured in terms of impact on human lives and health, organisational capacities, societal behaviours and the environment. There are a
variety of frameworks and models that are proposed to quantify and measure societal impact [68]–[70]. Such variety might also be reflected in the nature impact assessment methods adopted by national funding agencies across Europe. Regardless of the specifics of assessment tools or methods, the underlying objective of assessing societal impact is to understand the societal externalities of research and innovation activities undertaken in a BDVCoE.

Societal impact can be reached through various practices that centres of excellent can adopt to influence the relationship between research and the society (non-academic community). These activities, shown in Figure 10 and defined in [71], are part of a conceptual framework for analysing third-stream activities that are categorised as follows:

- Research centres have capabilities in two main areas: (a) knowledge capabilities and (b) physical facilities. These capabilities are developed as centres carry out their core functions of teaching and research.
- Using the means at their disposal, centres carry out three main sets of activities; they: (c) research, (d) teach, and (e) communicate the results of their work.

![Conceptual framework for analysing third-stream activities](image)

Figure 10: Conceptual framework for analysing third-stream activities [71]

### 6.4 How to use the BDVCoE Framework

To use the concepts and ideas of BDVCoE framework is not a call for re-invention of the wheel. This stems from the fact that the theories and concepts it contains are
those which have be theorised and applied extensively by known business authors, entrepreneurs and researchers. These concepts and the manner of implementing them can seamlessly be harnessed to support the development and growth of Data-oriented entities.

From the premise above, it is logical to believe that an attempt to use the BDVCoE model calls for overall overhaul of the manner of designing/drafting the strategic initiatives or direction of the Big Data entity. Considering the elements of the model which consists of Strategy, Governance and Structure, Funding, culture and Capabilities, it is clear that appropriate practices under each of these elements need to be designed into activities to be pursued in achieving the strategic goals of the centre. Thus at the highest level of decision-making, management team needs to evaluate various factors including environmental, industry and societal which have great influences on the ways or methodology a Big Data Centre can be run. It also needs to consider the users of its outputs – what is currently in great demand as well as what trends in industry are unfolding. Beside the aforesaid, the management team must make a decision on what specific value direction the organisation must explore hence guide the process of resources allocation.

From the foregoing argument, the management of a Big Data entity – whether of small, medium or large or of potential entity or whether it is already at the level of excellence, should apply existing theories in strategy designs and implementation. By implementing the new strategic initiative, organisations will inevitably encounter change of some magnitude hence the management team should plan how to tackle the common problems associated with organisational change through appropriate management. To design strategies and implement them, management team should use existing theories of strategic analysis and practices, as said earlier, and these include the following:

**Tools for Strategic Analysis:** Industry Analysis – Structure (5 forces) & Strategic Groups, PEST (or PESTEL), SWOT analysis, Key Success Factors, Value Chain Analysis, Benchmarking and Scenarios / forecasting / prediction. Other strategic choices include: Porter’s Generic Strategies, Ansoff Growth Matrix, Miles and Snow Strategic Types, Resource Based View and Value Innovation: Blue and Red Ocean Strategies

**Tools for Strategy Implementation:** McKinsey 7S, Structure & Strategy, Culture, Leadership, Balanced Scorecard and Mendelow’s Matrix

**Concepts for Change Management:** These include but not limited to change success drivers such as staff motivation and encouragement, overcoming resistance and rewarding performance.
7 Summary and Conclusion

This study is far-reaching in scope and data elicitation. Combining both literature review and interview approaches, we developed useful information put together in this compendium of knowledge to be shared as the BDVCoE Best Practice Guide. The key findings contained in this guide include the following:

- The management practices of existing Big Data Centres in Europe do not deviate in any significant manner from management practices of other types of organisations.
- The main themes of the managerial practices include Strategy, Governance and Structure, Funding, Culture and Capabilities. The latter is further broken down into People, Process, Infrastructure and Collaboration as well as Outreach and/or communication.
- The framework developed for the BDVCoE practices shows three segments Figure 7. With the BDVCoE model elements at its middle, the framework includes the Environment in which the centre operates and contains the influencing forces such as Industry, Policy and Societal factors on the one hand and the Environment in which the outputs of the BDVCoE create positively impactful benefits Economically, Scientifically and for the Society. These three blocks (Environment | BDVCoE Core Model | Impact) together demonstrate and validates the resource transformation process of: Input-Transformation-Output from status of low value to status of high value in that order.
- There is however, interdependence between the core BDVCoE model and the environments (Influencing and the Impact) in that there are backward flows:
  - First, of influencing forces (as in the case of CoEs contributing to or influencing national research policies and financial allocations) and
  - Second, resources and technologies needed to further develop CoEs could also be obtained from the environment as part of its initial output of the centre as in the case of skill development, financial rewards from collaboration with industry, etc.
- Collaboration, as a practice has become an integral part of thriving research institutions. This is because, it does not only yield income for the research institute, it also creates an opportunity for knowledge transfer and may in fact result in the creation of patentable licences or an outright start-up. All these are results of co-creation of values due to the synergy of skills and other resources between the research entity and the industry participant.
- Research-industry collaboration has great impact on industrial development and the economy in general in a place – city or country. Thus there is further attraction of entrepreneurs to locate new entities in places where research-
industry collaboration is at advanced stage, producing not just the innovative products for industrial uses but also skills and expertise to create values in these entities.

Other significant findings in this report include factors that have measurable contributions to the popularity of the centre. For example, cultural and Outreach practices coupled with powerful communication capability enable centres to disseminate information about the activities of the centre which help the centre attract skills and expertise from the international scene. Furthermore, a cultural practice as it is known in other types of entities, help organisations to bind its personnel together in shared focus thus enabling them achieve target goals. Outreach in the context of participation in conferences and submission of scientific papers have same advantages – creating local and international awareness on the operation, scientific and technological innovation of centre – and this is effective in attracting particularly industrial collaborators who are looking for technology for application in business domain.

Finally, utilising the output of this report as best practice guide may inevitably result in the change of approaches to operations of the organisation. Although there is no re-invention of the wheel in trying to utilise the result of this report in managing a centre, however, it make sense for the management to plan changes into their existing practices. Such changes may result in the need to implement change management strategies so as to gain the best results.
Appendix A: Insight Centre for Data Analytics: Case Study

The Insight Centre for Data Analytics is a joint initiative between researchers at University College Dublin, National University of Ireland Galway, University College Cork, Dublin City University, and other partner institutions. It brings together a critical mass of more than 401 researchers from Ireland’s leading ICT centres to develop a new generation of data analytics technologies in a number of key application areas. This section introduces the Insight Centre for Data Analytics as a case study for the application of BDVCoE model. The objective of this exercise is to provide a starting point of feedback cycles to be conducted as part of the Delphi study. The rest of this section describes INSIGHT NUIG according the BDVCoE model.

8.1 Environment

The environment for Insight is primarily defined according its geographic location in Ireland and its active involvement in European research and innovation programmes.

8.1.1 Industry

The industrial production in Ireland is dominated by four sectors: pharmaceutical, food, computers and chemical. According to the Central Statistics Office of Ireland, these four sectors combined accounted for 82.8% or €110.4 billion of total net selling value in Ireland in 2016. Enterprise spent in excess of €2.2bn on research and development (R&D) activities in 2015 out of which roughly two-thirds of expenditure was by foreign owned enterprises. These statistics highlight considerable focus on research and innovation in Irish economy.

Ireland has a well-established industrial ecosystem in software and data analytics with a significant industrial cluster of large multinational tech companies including Amazon, Accenture, Facebook, Google, and Teradata. There is a vibrant tech start-up scene with hubs developing in Dublin, Galway, and Cork. The Irish Government has made a commitment to funding world-class research in these areas with two major research centres the INSIGHT Centre for Data Analytics (www.insight-centre.org) and LERO: The Irish Software Research Centre (www.lero.ie).

8.1.2 Policy

The research and innovation policy in Ireland is primarily driven by the Department of Business, Enterprise and Innovation (DBEI). Through the report of the Research
Prioritisation Steering Group in 2012, Ireland has set out a specialisation strategy by recommending 14 areas of opportunity, as well as underpinning technologies and infrastructure, which should receive the majority of competitive public investment in Science, Technology and Innovation (STI) over the following until 2017. The 14 priority areas are:

1. Future Networks and Communications
2. Data Analytics Management, Security and Privacy
3. Digital Platforms, Content and Applications
4. Connected Health and Independent Living
5. Medical Devices
6. Diagnostics
7. Therapeutics – synthesis formulation, processing and drug delivery
8. Food for Health
9. Sustainable Food Production and Processing
10. Marine Renewable Energy
11. Smart Grids and Smart Cities
12. Manufacturing Competitiveness
13. Processing Technologies & Novel Materials

This was complemented by the launch of the Innovation 2020 programme that defines Ireland's vision of establishing itself as a global innovation leader by focusing on excellence, talent, and impact. The programme aims to achieve gross expenditure of 2.5% of GNP on R&D by 2020 through:

- Increased public investment in research base;
- Increased investment in programmes that support enterprise RDI and improve the leverage of private investment;
- Increase in the number of significant enterprise R&D performers by 15%
- Increased private funding of publicly performed R&D to €48m per annum

DBEI implements the Innovation 2020 programme through three organizations: Science Foundation Ireland (SFI), Enterprise Ireland (EI), and Industrial Development Authority (IDA). Each of these organizations provides support for research and innovation at different levels of maturity, as shown in the following figure.

---

Insight is primarily funded by Science Foundation Ireland through its Research Centres funding model. The goals of this programme are:

- Achieve, maintain and enhance research excellence and leadership
- Deliver significant economic and societal impact
- Increase the level of industrial and commercial investment in R&D activities with existing Ireland-based companies
- Attract large FDI investments in corporate R&D centres
- Spin-out new, high-tech start-ups
- Transfer technology & expertise to Irish-based MNCs & SMEs
- Undertake joint research projects with industry
- Educate next generation of engineers & scientists for Irish MNCs & SMEs
- Leveraging of non-Exchequer funding

### 8.1.3 Societal

The Irish society in general rankings very high in composite statistics:

- Ireland is ranked 8th on the human development index of United Nations.
- Ireland is ranked 23rd on the global competitiveness index of World Economic Forum and scores particularly high on technological readiness, business sophistication and innovation.
- Ireland is ranked 10th on the global innovation index. Specifically, Ireland holds leadership position in terms of two key outputs of innovation: knowledge impact (2nd) and knowledge fusion (1st).

In a recent report of Irish perspective on 9th EU Framework Programme, Ireland has supported the alignment of national strategies with UN SDGs.
8.2 BDVCoE Core Model

This section provides a detailed analysis of INSIGHT according the core elements of BDVCoE model.

8.2.1 Strategy

**Insight mission:** “At Insight we undertake high impact research in data analytics that has significant benefits for the individual, industry and society by enabling better decision making.”

**Insight Vision:** “Empowering Citizens. Smarter Societies.”

As an overview of the strategic direction, the Insight Centre focuses its research efforts mainly on two basic areas that are **Data Science** and **Data Analytics**. Whereas *Data Science* is a multi-disciplinary research domain which draws expertise from mathematics, statistics, machine learning, data mining, image analysis, multi-modal data analytics, semantic theories, data engineering and data management, pattern recognition, uncertainty modelling, artificial intelligence, optimisation solutions, high performance computing, and so on; **Data Analytics**, although requires same range of expertise, deals with decision support, knowledge discovery and the development of new technologies in a range of scientific and technological application domains such as Health and Human Performance, Smart Communities and Internet of Things, Enterprises and Services, and Sustainability and Operations.

Insight Centre assumes the responsibility to assemble researchers and other related talents in these two broad domain aspects from worldwide sources to develop technologies, data infrastructures and systems applicable in four major domain thematic areas namely (1) Health & Human Performance, incorporating connected health, sports science, pharmaceutical and healthcare systems; (2) Smart Communities and the Internet of Things, incorporating Smart Cities, Smart Networks, Connected mobility and public services; (3) Enterprises and Services incorporating smart enterprises, financial services, news and media, retail and customer engagement and (4) Sustainability and Operations, including smart manufacturing 4.0/logistics, agriculture/food analytics, marine analytics and the environment.

- **Research Strategy:** Insight’s long-term strategy combines scientific excellence to deliver social and economic impacts. To a large extent, this strategy that relies on the leadership, expertise and hard work of its leading researchers has been successful in plotting a course for achieving these ambitious targets. In addition to leading and partnering in multiple EU projects over the period 2013-2017, Insight researchers have taken up leadership roles in key national and European initiatives, developed a coherent and effective method of influencing EU research priorities, and helped to push for Ireland’s engagement in large research infrastructures.

- **Strategic Goals**
To pursue scientific excellence in data analytics and its applications
To pursue excellent research and innovation as a single integrated national Centre with critical mass and scale
To deliver beneficial impact to our industrial partners and to the Irish economy and society
To create and grow strategic partnerships with other research institutions, in Ireland and overseas.
To foster a new generation of data scientists in Ireland, equipped to pursue the opportunities of data analytics in science, industry and beyond
To attract and retain the best researchers, by providing a supportive, collegiate and stimulating environment that rewards excellence
To inform and enthuse the general public, and students in particular, about data science and its value to society
To facilitate discussion and understanding of data analytics, its applications and limitations, its ethical aspects and societal value, in the public arena.
To grow our profile as a world-renowned centre in data analytics and its applications
To grow and diversify funding to sustain the long-term development of the Centre.

- **Clear Objectives**: Insight has clearly stated objectives on research; ecosystem and collaboration; sustainability and growth; impact; host institutions; people; profile; operations; and governance.
- **Research Areas**: Insight has clearly identified and stated seven priority areas of research: Linked Data, Semantic Web, Machine Learning and Statistics, Media Analytics, Optimisation and Decision Analytics, Personal Sensing, and Recommender Systems.

The core research areas of include are detailed in Figure 12.

![Figure 12: Core research areas for Insight](image)

Insight conducts research projects whose outcomes are expected to benefit the following fields:

- Chronic Disease Management & Rehabilitation
- Novel Personal Sensing
- Connecting Health & Life Sciences
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

- Smart Enterprise
- The Future of News and Media
- The Analytical Society
- Discovery Analytics

Table 12: Summary of Strategy of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Clearly stated research strategy and objectives</td>
<td>Strategy &amp; objective</td>
<td></td>
</tr>
<tr>
<td>2. Senior management formulates strategy and objectives</td>
<td>Strategy / objectives formulation process</td>
<td></td>
</tr>
<tr>
<td>3. Has broad research areas across the data analytics spectrum</td>
<td>Research niche</td>
<td></td>
</tr>
<tr>
<td>4. Aligns with national research and innovation priorities</td>
<td>addresses national research focus</td>
<td></td>
</tr>
<tr>
<td>5. Has a dialogue with other partners in the research ecosystem</td>
<td>Partner’s input</td>
<td></td>
</tr>
<tr>
<td>6. Grow and develop a positive international profile</td>
<td>Profile development</td>
<td></td>
</tr>
</tbody>
</table>

- Widespread consultation for the formulate
- The need to have widespread consultation of stakeholders for strategies being most important strategies
- Insight has KPIs imposed by SFI and does measurement of its performances in terms of stated sets of objectives, goals, mission and vision
- The KPIs cover a lot of the impact areas such as economic, commercialisation, academic, etc.
- NIUG has operationalised plans that include KPIs in them.

Senior Manager
8.2.2 Governance & Structure

- **Governance model:** Insight has established and follows a governance model that emphasises accountability and openness. A *Governance Committee* has strategic oversight of all Centre activities and is formed of predominantly non-academic members, chaired by an external industry representative. The centre has a clear set of objective Key Performance Indicators (KPIs), which are monitored to gauge progress on a continual basis.

- **Governance committee:** A governance committee is primarily responsible for the governance and operational oversight of Insight and it reports to the Presidents of all the co-lead universities. The senior management of the centre reports to the governance committee that further supported by industry advisory committee, scientific advisory committee, and inter-institutional committee. Each of these committees comprises of relevant experts from industry and academia.

- **Organizational Structure:** Insight’s organisational structure adheres to SFI’s guidelines for the Management and Governance of Research Centres. The management structure at Insight has served the centre well – it ensures representation of all of the four co-lead institutions at the European Commission level. Similarly, it allows for business development, management and other functions at each site, while providing centralised coordination and integration of the activities across sites for consistency and synergy across the centre. From a research structure perspective, this organisational structure facilitates collaboration in discipline-specific research groups.

Insight’s organisational structure (Figure 13) adheres to SFI’s guidelines for the Management and Governance of Research Centres. The Centre is managed by the Executive Committee (EC), which is chaired by the Chief Executive Officer (CEO) and includes four Site Directors from the co-lead institutions (DCU, NUI Galway, UCC and UCD), the Business Development (BD) Manager and the Chief Operating Officer (COO), each of whom have their own group roles and responsibilities. The EC is advised by the Industry and Scientific Advisory Committees (IAC and SAC), and the Inter-institutional Committee (IIC) as it fulfils its mandate to manage the Centre on a day-to-day basis. The CEO reports to the Governance Committee, which in turn reports to the Presidents of the four co-lead institutions, who report to SFI, and are ultimately responsible for ensuring that Insight fulfils its contractual obligations to SFI.
The management structure at Insight has served the Centre well – it ensures representation of all of the four co-lead institutions at the EC level. Similarly, it allows for BD, management and other functions at each site, while providing centralised coordination and integration of the activities across sites for consistency and synergy across the Centre.

From a research structure perspective, this organisational structure facilitates collaboration in discipline-specific Research Groups. The Research Group model is agnostic in terms of site – researchers can be associated with any Research Group, regardless of their place of work. Some Research Groups have a majority of members from a single site. This reflects the specific interests and long-term strengths of that particular institution.

From an impact perspective, this structure is also very appropriate and enables the Centre to work as a national-level entity in pursuing new industry collaborations, contributing to policy, developing outreach programmes, etc., while remaining locally-accessible, flexible and agile in response to specific relationships and opportunities.

Executive Committee: The EC includes the CEO, COO, four Site Directors (representing DCU, NUI Galway, UCC and UCD) and the BD Manager. The CEO chairs the EC and is the final decision-making authority on its outputs. Current EC members are:
The EC meets in person on a monthly basis to discuss strategic developments, research and industry partner collaborations, new opportunities, interactions with the Governance Committee, IAC, SAC, IIC and SFI, future plans, human resources and finance, EPE and communications, risk management and any other issues that need to be decided at a Centre-wide level.

Scientific Leadership Group: In order to most effectively manage the broad spectrum of complementary science at Insight, the Centre has a Scientific Leadership Group (SLG), chaired by the CEO, which brings together the research group leaders, PIs and FIs. The members of the SLG are the co-PI’s, Research Group Leaders and their deputies, where appointed. However, the SLG is open to all Insight-funded PIs and FIs, and other Insight researchers invited at each Site Director’s discretion. The SLG prepares proposals on scientific matters for the EC.

The Site Directors are members of the EC, and are responsible for managing all aspects of Insight at their respective sites, including research and operations, with duties including the management of the relationship between Insight and their respective institutions, recruitment, personnel, finance, space and facilities, etc. The Site Directors are the local budget holders for the Insight SFI Grant. Each Site Director is responsible to his/her relevant Institute for all aspects of local Institutional Governance and Management.

The Central Operations, run by the COO, provides operational support services across Insight. Roles include finance management, IP management, reports coordination, administrative support, grants support, website management and the (outsourced) communications team.

The BD Manager has overall responsibility for the BD function of the centre, including managing the implementation of the Centre’s BD strategy, and ensuring achievement of the Centre’s industry cost share and commercialisation targets, goals and objectives.

Figure 14 outlines the Operations organisation structure within Insight.
The Governance Committee is the cornerstone for Governance of the Centre and reports to the four Presidents. A total of 22 Governance Committee meetings have been held, demonstrating the level of commitment of its members. The Governance Committee met on a monthly basis during Insight’s start-up phase, moving to quarterly meetings and now meets at least twice per year. The meetings include a review of the Centre’s progress with the CEO and members of the EC, and covers topics relevant to its bi-annual Governance Committee Report for SFI, including Strategy, Operational Management and Governance, Financial Management, Research Programme, Industry Partner Engagement, NE-NC funding, Technology Transfer, Risk Management, EPE and Communications.

The IAC has also met on a bi-annual basis, since its inception. The IAC has 13 members with a mixture of Irish and international, multinational corporations (MNCs) and SME members. It is Chaired by Ms. Margaret Burgraff, Vice President and General Manager IoT Group at Intel Corporation (USA), with Ciara Clancy acting as Vice-Chair (Beats Medical). Other members include Tony O’Malley (Fujitsu), Keith Griffin (Cisco), Julie Byrne (Nokia Bell Labs), Pat McCarthy (Huawei), Dan Bogue (Compact Imaging), Paddy White (Shimmer), Niamh Scannell (Intel), Stevo Mijanovic (UTRC), Muirne Laffan (RTE), Anne O’Leary (Kinematik) and Tim Hinchevy (Kroenke).

The SAC reviews Insight’s industry partner engagement and commercialisation strategies and advises the CEO and EC accordingly. Following its meetings, it produces a report to the CEO and the Governance Committee.

The SAC has 11 internationally renowned scientists and also meets on a bi-annual basis. It has held joint meetings with the IAC in order to provide a cross fertilization of ideas and strategies for the EC. It is Chaired by Prof. Francesca Rossi (University of Padova, Italy), with Dr. Michael Brodie acting as Vice-Chair (MIT, USA). Other members include Prof. Jim Hendler (Rensselaer Polytechnic Institute, New York), Prof. Michael Trick (Carnegie Mellon University, Pittsburgh), Prof. Muffy Calder (Glasgow University, Scotland), Dr. Tat-Seng Chua (National University of Singapore), Prof. Padhraic Smyth (UC Irvine, California), Dr. Paolo Bonato (Harvard Medical School, Boston), Dr. Asuncion Gomez Peres (Universidad Politécnica de Madrid) and Prof. Karl Aberer (EPFL Switzerland). It advises on the development of research strategy and reviews the research progress of the Centre, and also produces reports for the CEO and Governance Committee. The IIC has provided valuable assistance to the CEO in resolving any inter-institutional issues that have arisen, and meets on a quarterly basis at a minimum. Its membership consists of the VPRs of the four co-lead institutions and the CEO.

### Table 13: Summary of Governance of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keyword</th>
<th>Update source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Governance that emphasises accountability and openness.</td>
<td>Governance is based on accountability and openness.</td>
<td></td>
</tr>
</tbody>
</table>
2. A *Governance Committee (GC)* of mainly non-academic member and chaired by an external industry representative has strategic oversight of all activities on a quarterly basis. Committee oversees activities, uses KPI for performances. GC, CEO and EC meet quarterly to discuss about the centre.

3. B-annual report on strategy, operations, financial & risk management, research programme, industry partners, NE-NC funding, technology transfer, EPE & communications. Bi-annual reporting arrangement.

4. The Industry Advisory Committee (IAC), Scientific Advisory Committee (SAC), and Inter-Institutional Committee (IIC) – all composed of academic & industry experts – support the GC. Each committee has its own role. IAC, SAC & IIC support GC.

- There is frequent feedback (in the case of Insight NUIG) from the Governance Committee through the Centre’s Executives.
- Feedback dissemination is normally done through weekly general meetings.
- Feedback demonstrates to the stakeholders the fulfilment of: accountability, openness & transparency.

### Table 14: Summary of Structure of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Structure ensures representation of the 4 co-lead institutions; allows for business development and management and other functions at each site</td>
<td>institutional representation, business development, management of functions</td>
<td></td>
</tr>
<tr>
<td>2. Structure provides for centralised coordination and integration of the activities across sites for consistency and synergy across the centre sites.</td>
<td>Centralised coordination, integration, synergy &amp; consistency across member sites</td>
<td></td>
</tr>
</tbody>
</table>
3. Structure facilitates collaboration in discipline-specific group

<table>
<thead>
<tr>
<th>Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Structure allows independent organisation of each site</td>
</tr>
<tr>
<td>Structure allows decentralisation of site governance</td>
</tr>
</tbody>
</table>

- Synergy across sites does not eliminate competition within the Insight Centre sites. Yes, it doesn’t, the interviewee reiterated
- SFI may not really be able to prevent Insight Centre sites from doing what they want because they enjoy some level of autonomy.
- SFI can encourage multi-site collaboration
- Structure strongly provides for collaboration between sites

Senior manager

8.2.3 Funding

Insight follows a shared cost model, as defined by SFI since 2013, where 70% of funding is provided by SFI and rest of 30% must be contributed by industry. The industry contribution should be at least 10% in cash total funding and the remaining 20% can be contribution in-kind. All research centres funded by SFI are structured using a hub-and-spoke model (see figure below). In this model, *platform research* in the hub addresses longer-term research goals of benefit to the wider centre membership. The spokes are *Targeted Projects* involving one or more of the industry partners that are focused on delivering technology and intellectual property tailored to the company’s needs.
Besides its core funding of €88 million from SFI, the Insight Centre has a diversified profile of funding sources.

- **Non-Exchequer-Non-Commercial (NE-NC) sources:** Insight has been awarded research income for 44 European research awards. To further increase this in-flow, Insight is actively participates in future proposals and expect to improve the number of awards by the end of 2017. These research awards include projects from Horizon 2020 programme and European Research Council (ERC) awards.

- **Commercial Sources:** Insight receives income from industry in the form of cash in bank and in-kind contributions from contracts that are fully funded by the industry partner. The centre aims to cover 30% of its total funding through such commercial sources.

- **Spin Out Companies:** Insight has eight spinout companies formed.

- **Commercialisation Awards:** Insight researchers have secured 80 Enterprise Ireland (EI) feasibility and commercialisation grants for early-stage, pre-incorporation work. Insight’s use of EI funding schemes for feasibility and commercialisation studies has played a significant factor in enabling a culture of entrepreneurship within Insight.

- **Licence Agreements.** A total of 54 licences have been granted which reflects the applicability and impact of Insight’s research.
Table 15: Summary of Funding of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Employs a business development capability to proactively engage industry</td>
<td>Industry engagement</td>
<td></td>
</tr>
<tr>
<td>2. Provides support to principal investigators to pursue research goals (national &amp; international)</td>
<td>Funding supports</td>
<td></td>
</tr>
<tr>
<td>3. Funding model is for a 6-year cycle and addresses long term objective e.g. core research providing industry partners’ technology &amp; IP needs</td>
<td>Long term funding</td>
<td></td>
</tr>
<tr>
<td>4. Targets a mixed model of diverse funding sources: national, industry and European funding (Exchequer vs. Non-Exchequer)</td>
<td>Funding diversification</td>
<td></td>
</tr>
<tr>
<td>5. Pursues research commercialisation opportunities including licensing and spin-outs</td>
<td>Commercialisation opportunities</td>
<td></td>
</tr>
<tr>
<td>6. SFI ranks as the number one source on funding sources more important to Insight Centre.</td>
<td>Senior Manager</td>
<td></td>
</tr>
<tr>
<td>7. For Insight Galway, the biggest source of funding is the European Commission funded projects, the Enterprise Ireland (EI) and the Irish Research Council in that order.</td>
<td>Senior Manager</td>
<td></td>
</tr>
</tbody>
</table>

8.2.4 Culture

The culture of Insight Centre reflects the various cultural practices of the four support Universities. This means that Insight, Galway culture is an extension of the culture of NUI Galway; that of Insight, Cork reflect the UCC, etc. The definition of culture and related explanations is offered in subsection 6.2.4 of this report. Cultural practices described below are upheld both at UNI Galway and at Insight Centre Galway.

- **Listening lunches**: Insight also promotes family-friendly meeting times to enable staff to balance their professional and home lives, which is of benefit to all staff. Insight initiatives are complemented by institution-led initiatives, such as Listening Lunches, providing a forum for women to share their experience of university culture with the University President and Human Resources Director.
- **Unconscious Bias**: Unconscious bias training for all staff engaged in recruitment and promotion, coaching for Managers on managing family leaves, core hour policies, and returners grants for academic staff. The four co-lead institutions are currently rolling out formal Unconscious Bias training for all of their employees.
8.2.5 Capabilities

8.2.5.1 People

- **Diversity of staff**: Insight employs diverse range of people in terms of research and management level. Nearly half of the staff consists of research students at PhD and MSc level that drives the primary research activities. Nearly one-third of the staff is female and more than one-third of the personnel have non-Irish nationalities. The international staff of Insight constitutes approximately 40% of Insight’s 400 researchers (PhD students to professors) joined from overseas. Insight maintains a supportive and encouraging environment, where researchers are supported in taking increasing responsibility with career progression, pursuing new research directions and building a range of skills, both within and beyond data science. PhD students are managed and supported in completing their research projects through the Graduate Research Committees.

- **Support for Young Researchers**: Postdoctoral researchers are given ownership of research Work Packages (WPs) and industry Targeted Project (TP) responsibility and training and encouraged to apply for grants, form their own research teams and become leaders in their own right.

- **Recruitment excellence**: All of the institutions involved in Insight have achieved the HR Excellence in Research award from the EU in recognition of best practice policies and procedures and these are implemented by Insight in the recruitment of its researchers.

- **Supporting female staff**: Notably, Insight is the first SFI-funded Research Centre to offer maternity leave-type financial support to female PhD students. Furthermore, all co-lead institutions hold the Athena SWAN Bronze award for positive gender practice in higher education.

**Table 16: Summary of People of Insight Centre**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Core HR policies are provided by the host institutes (NUIG, UCD, DCU &amp; UCC)</td>
<td>People</td>
<td></td>
</tr>
<tr>
<td>2. Staff diversity – catering for good gender mix researcher and student and local / international personnel proportions</td>
<td>People</td>
<td></td>
</tr>
<tr>
<td>3. Looks to attract international researchers and develop young researchers.</td>
<td>Admin / Operations</td>
<td></td>
</tr>
<tr>
<td>- Objective is to get the best in terms of skill suitability and enthusiasm of workers into Insight irrespective of race, gender, nationality</td>
<td>Senior manager</td>
<td></td>
</tr>
<tr>
<td>- Quality of personnel, their suitability for the</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
organisation and passion for Data Analytics.

- ‘Unconscious Bias’ training is done in the centre to eliminate preferential treatment
- we advertise in international forums

8.2.5.2 Process

Research Priorities: Insight has clearly identified and stated its priority research areas and their applications domains that are being focused on. In this regard, the executive committee and senior site management regularly hold consultative meetings with staff and external stakeholders to reassess, refine and redefine the priorities.

Good Laboratory Practice: Insight has implemented a series of processes and procedures that mandate the comprehensive recording and documentation of research plans, results achieved, data created, data distribution, IP creation and management, Non-Disclosure Agreements (NDAs), IP assignment agreements, publications protocols, invention disclosure protocols, and other aspects of good research governance.

IP and DP Committee: Insight’s IP and Data Protection (DP) Committee oversees the development, implementation and update of policies and procedures related to IP and DP, including those overlapping with GLP and RRI. The IP and DP Coordinator works with the Site Directors and Site Managers to implement and ensure compliance with these policies and procedures.

Proposal support: Grant Development Managers at the Insight sites provide support at all stages of the project lifecycle from proposal submission, negotiation, implementation and completion.

Project management: A nominated research project manager owns each project, and works closely with the research leader (PI) and the industry partner, to ensure that the project is effectively delivered. All projects have allocated resources, clear objectives, an agreed approach, defined timelines,

In terms of engaging with citizens, Insight takes a bi-directional communication approach.

Data Collection Guidelines: Each of the sites in Insight follows the data collection guidelines as outlined in its parent educational institution while dealing with personal data. INSIGHT NUIG operates under a Research Ethics Committee that safeguards the health, welfare and rights of human participants and researchers in research studies.

Research and Innovation Integrity: RII is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take up of gender and ethics in the research and
innovation content and process, and formal and informal science education.

**Education and Public Engagement:** Insight has a dedicated team for researchers and engagement managers to run multiple activities and projects target at different age groups within public. The list of activities includes, but is not limited to, hackathons and coding clubs, competitions and safety talks. Education and Public Engagement activities (EPE) communicate the value and excitement of science, and of science, technology, engineering and mathematics careers, to the general public, students of all ages (particularly female students) and remote and disadvantaged communities with reduced access to technology. EPE is delivered as a whole-centre component of Insight – while there are local EPE resources at each site, they work in an integrated manner. Academic staff is a critical component of EPE. They deliver many of the events, write much of the media material and provide the data analytics knowledge at the core of most EPE outputs. EPE activities, including those involving academics and more junior researchers, are delivered by and for Insight – the Insight “brand” is respected and promoted. Not only does this communicate the unity of the Insight, it also makes resources and presentation materials more easily reusable.

Insight’s policy activities to date have primarily focused on data ethics. In this regard, Insight is actively contributing towards policy efforts for data protection. For instance,

**Defining Data Policy:** Insight has led the Magna Carta for Data initiative at a European level, establishing a set of common values for data ownership, rights and usage, and exploring the balance between the rights of the individual and the potential societal benefit of data-enabled government and services. This initiative received extensive attention nationally and at European Parliament and Commission level, and is an important input into the on-going evolution of data-related regulations.

**Supporting National Data Policy:** Insight Centre’s data collection, analytic and interpretation capabilities have also been deployed to support the delivery of national policy-making. A key industry collaboration utilised Insight’s capabilities to develop an optimised model for the allocation of healthcare resources, with a view to reducing hospital wait times to meet mandated targets.

**Table 17: Summary of Process of Insight Centre**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Laboratory activities, IP and Data Protection (DP) Policies are overseen by coordinators working with the site Managers &amp; Directors.</td>
<td>Mixed keywords</td>
<td></td>
</tr>
<tr>
<td>2. Research &amp; Innovation Integrity (RII): is implemented as a package that includes multi-actor and public engagement enabling easier access to scientific results, the take up of gender and ethics in the</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. **Education and Public Engagement (EPE):** dedicated team of researchers and engagement managers to run activities and projects targeting different age groups within the public; other communication means include: centre newsletter and student day.

<table>
<thead>
<tr>
<th>Public outreach</th>
</tr>
</thead>
</table>

- RII could be (in relation to the Host Universities’ body of policies including H/S, ISS, duties, protocol, guidelines) under which all staff of the Insight are:
  - employed and guided also in relation to work
  - disclosure of matters of confidentiality.

<table>
<thead>
<tr>
<th>Senior manager</th>
</tr>
</thead>
</table>

---

### 8.2.5.3 Infrastructure

**Excellent infrastructure:** Insight has excellent infrastructure and services, facilitating the delivery of world-class research and professional industry collaborations. The sites have the requisite technical infrastructure, commercial-quality office and laboratory facilities, and ample meeting space and conference rooms. Researchers have easy access to any equipment they require, in a collegiate and supportive environment.

**Research management systems:** Figure 10.2.7a gives an overview of the management systems used for research projects. JIRA is the repository used for all documentation associated with research deliverables. Each research area reports on this platform. Where plans are deviated from, or in the event of issues being raised on the JIRA system, the research project manager, Research Group Leader, and Site Director (supported, as necessary, by the EC and the Operations teams) are responsible for working with the research project manager to get the research back on track. Gitlab and Bitbucket systems are used for managing code, while project communication uses tools such as Slack and Google’s G-Suite. Issue tracking and progress management utilises additional toolsets, such as JIRA, and Basecamp.
## Table 18: Summary of Infrastructure of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Capability Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insight has excellent and complete infrastructure and services, facilitating the delivery of world-class research and professional industry collaborations (including Test beds, Living labs, etc.)</td>
<td>Research infrastructure, services &amp; platforms</td>
<td></td>
</tr>
<tr>
<td>2. Insight has developed experimentation test labs and living labs including smart building and partnership with cities</td>
<td>Research infrastructure, services &amp; platforms</td>
<td></td>
</tr>
<tr>
<td>3. Research management support systems: source control, business process, issues trending, helpdesk, project management, Jira (repository) &amp; Google suites (project communication)</td>
<td>Research infrastructure, services &amp; platforms</td>
<td></td>
</tr>
</tbody>
</table>

- Insight Centre (like any other centre) is an on-going development of research infrastructure rather than being described as *having excellent infrastructure*
- Interviewee believed something was missing in terms of the infrastructure, experimentation and network of partners.
  - Examples of missing point include the *Hydro-cluster*
  - we try to meet provisions through on-site facilities and cloud-based sources such as *DCOS* which is an example of how we have explored various ways of provisioning for

---

![Network of National BDV Centres of Excellence Best Practice Guide](image-url)

**Figure 16: Research project management tools at Insight**
Funding sources as the limiting factors to develop infrastructure

- SFI is not interested in investing in infrastructure
  - that may become obsolete within a short period of say 3 years,
  - rather on long-lasting bigger infrastructure

8.2.6 Collaboration

Since its inception, Insight has delivered numerous industry projects in collaboration with companies of all sizes from global multi-national companies to local small and medium enterprises (SMEs). Such collaborations have built capacity in both INSIGHT and industry; enabled new products and services; supported job creation and retention; and stimulated international and domestic investment.

Collaborative network: Insight has established a substantial industry network, working directly with over 85 companies in company funded collaborative research projects and, indirectly, with engagement with hundreds more in EU projects, and educational, industry and public forums. Insight has developed solutions for challenges across a broad spectrum of industries, including healthcare and bioinformatics, Smart Cities, telecommunications and networks, financial services, marketing and retail, news and media, services and tourism, e-government, agriculture, manufacturing, transportation and semi-autonomous vehicles, environment, and many more. Collaboration in Insight can be described under two headings:

- Multi-level collaboration: Collaborations at research group level, industry-facing project level, and in the leadership of the Insight all contribute to better understanding and appreciation of the respective skill-sets and resources.
- Cross-discipline collaboration: Within each university, Insight has led to important new collaborations with faculties and disciplines beyond data science, including life sciences, engineering, computer science, and many more. This has been further reinforced by collaborations at centre level (i.e. with other research centres in Ireland) and within the scope of EU and other funded projects.

Strategic partnerships: Insight has established partnerships with companies such as Fujitsu, Novartis, United Technologies and Huawei. This expands to partnership with other CoEs, where Insight participates in multi-industry consortia (such as the Smart Cities ENABLE Spoke). Insight is working with industry networks and Centres in manufacturing, agriculture and financial services to combine expertise into attractive packages for potential industry collaborators.
Technology transfer: Insight have spun out eight high-potential SMEs, and issued 54 licenses of its intellectual property. Insight is also working with a large number of innovative SMEs, with special arrangements and facilities to lower barriers to collaboration.

Source of Learning: Insight offer a Masterclass programme that has taken cutting-edge data science research and results directly to industry partners, exposing and educating on the order of 500 personnel in over 40 companies about the potential of data analytics to benefit their industry.

Business Development: Besides appointing executive officers with industry backgrounds, Insight has created a dedicated role of Head of Business Development to sustain a continuous engagement process with local and international industry.

Table 19: Summary of Collaboration of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cross-discipline collaboration to leverage several skill-sets and resources beyond data science into life sciences, engineering and computing. Collaboration with other research centre in Ireland &amp; EU</td>
<td>Cross-discipline</td>
<td></td>
</tr>
<tr>
<td>2. Industrial collaboration for network &amp; strategic partnership e.g. with over 85 companies and others on EU projects covering many areas e.g. manufacturing, agriculture, financial services, smart cities, etc.</td>
<td>Network &amp; strategic partnership collaboration over 85 companies/institution on multi-disciplinary subjects</td>
<td></td>
</tr>
<tr>
<td>3. Technology transfer &amp; business development – producing spin-outs into SMEs (8), 54 IP licences. Collaboration with industry partners (involving 500 personnel &amp; 40 companies) for data analytics research and business developments</td>
<td>Significant technology transfer, IP licences and Business development with up to 40 companies &amp; involving 500 personnel</td>
<td></td>
</tr>
</tbody>
</table>

- Examples collaboration with Civil Engineering professional of NUI Galway Engineering Department (Waternomics project).
- Collaboration is a part of our strategy for...
8.3 Impact Elements

Insight measures its impact, according SFI’s 8 pillars, to show “demonstrable contribution that excellent research makes to society and the economy”. These pillars are divided in our models 3 broad categories as follows.

![SFI Impact Framework](image)

**Figure 17: SFI Impact Framework**

### 8.3.1 Economic Impact

**Pillar 1 - Economic and Commercial Impact:** Insight’s economic and commercial impact has been substantial. Insight Centre has helped 127 companies to develop new products, services and capabilities through collaborations, knowledge transfer and supply of excellent graduates. While Insight cannot take credit for the presence or scale of its industrial partners, its collaboration has clearly delivered value and helped them to make positive decisions about investment, about expansion and about remaining in Ireland. Other indicators of Insight’s economic impact are:

- over €15m value of industry investment projected (cash plus in-kind by contract value).
- Eight companies spun out from Insight
- Insight has licensed its technologies on 54 occasions.

### 8.3.2 Scientific Impact

The scientific impact of Insight is measured in terms of peer-reviewed journal and conference papers. Following metrics provides evidence of Insight’s scientific impact.

- 400 peer-reviewed journal papers
- 1,000 peer-reviewed conference papers
- 182 conference papers with co-authors from our industry partner base
- hosted and contributed to the running of 200+ conferences
8.3.3 Societal Impact

Pillar 2 - Societal Impact: Insight’s societal impact is primarily in the appreciation of science by society as a whole and by specific target audiences. Demonstrating the value of science, the scientific method and respect for rigorous data and evidence-based decision-making is a key objective of Insight. A more scientifically literate and better-informed society is empowered to take better decisions at all levels, from the individual to government. A second key objective is to communicate to society how important and attractive science is, and how it underpins modern standards of living, products and services. The following metrics demonstrate societal impact:

- 1137 school visits, reaching approximately 28,311 students, of whom 50% are disadvantaged groups. 550 lectures, workshops, demonstrations to public groups were given, of whom 25% are female centric.

Pillar 3 - International Engagement Impact: As a leading data science research centre, international engagement has been (and remains) central to Insight’s mission and activities. In research, Insight has established, or been asked to join, numerous international consortia, to pursue specific research challenges and opportunities. These include international research projects funded by the EU, as well as policy and standards bodies such the Big Data Value Association. In the industrial sector, we have excellent collaborations in place with a wide range of multi-national companies. At the policy level, Insight has made important contributions to European policy and guidelines on data ethics, via the Magna Carta for Data initiative. Another important form of international engagement is Insight’s leadership and participation in international research projects, as demonstrated by following achievement:

- 44 EU projects, 14 EU as coordinator, with a value to Insight of €21.5m and a total value of €200m,
- four MoU with global data science leaders,
- 40% researchers recruited from overseas, and
- 67 researchers from Insight who have been recruited by overseas research groups.

Pillar 4 - Impact on Public Policy, Services and Regulation: Insight has made important contributions to policy and standards, particularly in data ethics. Insight also actively participates in the Open Data Initiative, in eHealth Ireland, and helps to shape public, national and international policy.

Pillar 5 - Health and Well-being Impact: Insight has an entire research domain (‘connected health’) dedicated to the confluence of health, technology and data. The Centre has developed new technologies for health-related monitoring, for behavioural change, for self-management and for improving patient quality of life. Insight’s health-related research is an excellent sectoral fit with respect to Irish industry, given Ireland’s substantial clusters of medical devices and healthcare ICT companies. Insight has worked with over 20 companies within healthcare sector, and is involved in four EU projects in healthcare.
Pillar 6 - Environmental Impact: Insight’s work in the environment has focused on sensor development, resource optimisation (energy, water) and smart environments. This has underpinned projects with industrial partners, with new products and services. It has also contributed to the €12m value ENABLE Spoke, which focuses on Smart Cities, in which Insight plays a leading role. Insight has worked with over 10 companies in environmental sector, and five EU projects in environmental management.

Pillar 7 - Impact on Professional Services: The aggregation, interpretation and management of data are central to many professional services. Insight’s work on data ethics makes an important contribution to the guidelines and recommendations governing such data, as well as to the training and capabilities of professional services practitioners. This is evidenced by four important projects with a global insurance company and a great deal of interest from other insurance companies, in related research areas, and strong prospects of new products and services, and better customer relationships.

Pillar 8 - Impact on Human Capacity: As a major Research Centre, Insight has delivered substantial impact in human capacity. The Centre brings together the leading data scientists from across Ireland, in a single coordinated entity. This facilitates interaction and collaboration, and enables industry collaborations and other outputs that an archipelago of separate sites could not. Summary of relevant metrics is as follows:

- 400+ researchers in a single Centre,
- over 250 planned PhD/MSc students in Insight,
- over 101 internships and placements,
- 27% of graduates who have progressed to industry,
- 40 Masterclasses, reaching over 500 industry employees, and
- 28,311 students reached by Education and Public Engagement.

Table 20: Summary of Impacts of Insight Centre

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>1. 54 license</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Significant industry investments</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. 8 spin-out companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. 44 EU project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. 14 as coordinator with a value to Insight of €21.5m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Examples collaboration with Civil Engineering professional of NUI Galway Engineering Department (Waternomics project).
7. Collaboration is a part of our strategy for existence
8. Industry collaboration is a massive effort and by experience over the years
9. We are seeing the benefits of industry collaboration now particularly since last year (2016) as more people are coming to do business in Galway; in other words, industry collaboration is bringing in industry cash revenues

<table>
<thead>
<tr>
<th>Scientific</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. 400+ peer-reviewed journals</td>
</tr>
<tr>
<td>11. Conference papers 1000+</td>
</tr>
<tr>
<td>12. 182 conference papers with industry co-author.</td>
</tr>
<tr>
<td>13. Contributed to running 200+ conferences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Societal</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. 1137 school visits (approx. 28,311 students)</td>
</tr>
<tr>
<td>15. 550 lectures, workshops, demonstrations to public groups</td>
</tr>
<tr>
<td>16. Research impacts contribute to policies and ethics, health, environment, mobility, etc.</td>
</tr>
<tr>
<td>Promote science, training, policies and ethics</td>
</tr>
</tbody>
</table>

### 8.4 Challenges and Critical Success Factors

#### 8.4.1 Challenges

**Table 21: Summary of Challenges of Insight Centre**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>No findings from case study</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Challenge is to stay as a going concern – sustainability – in the research industry.
2. There is fear not to lose out essential funding to basic research
3. Recruitment and retention of world-class employees have been a challenge
4. Insight Galway might be facing a challenge in terms of staffing also due to the fact that there is not international airport in Galway
5. Hiring on contract basis as opposed to full permanent basis

8.4.2 Success Factors
Summary of success factors of Insight Centre

Table 22: Summary of success factors of Insight Centre

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
<th>Upd. source</th>
</tr>
</thead>
<tbody>
<tr>
<td>No findings from case study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Ability to attract grant funding and that is based also on being known for excellent research outputs</td>
<td></td>
<td>Senior Manager</td>
</tr>
<tr>
<td>2. Language, being English speaking country offers a bit of advantage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Presence of industry big players such as Google, Apple, etc. offers additional advantages for success from collaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Medical device and pharmaceutical companies has been part of key industry player available for collaboration with providing lots of money to sponsor projects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9 Appendix B: CeADAR: Case Study

This section introduces the Centre for Data Analytics Research (CeADAR) as a case study for the validation of BDVCoE model. The objective of this exercise is to provide a starting point of feedback cycles to be conducted as part of the Delphi study. The rest of this section describes CeADAR, Dublin according to the BDVCoE model. Our
main concern for the purpose of validation of the findings of the case study is the core model part of the framework. However, important feedback on environmental factors influencing CeADAR operations as well as the impact areas of the output of the Centre will be included.

The escalation of significant amount of data about people, companies, customers, suppliers and operations has created tremendous opportunities for the Data Analytics industry that Enterprise Ireland (EI) and IDA Ireland continue to address through their technology centres. Based on the above and under the SSTI policy of 2006, the Programme for Government 2011, and the Government Action Plan for Jobs 2012, technology centres were identified as a key component of Ireland’s Economic Development Strategy. Pursuant of the strategy and to facilitate the merging of industrial need and academic know-how, Enterprise Ireland and Industrial Development Agency (IDA) conducted an industry consultation to identify the most pressing needs in Data Analytics and the results were composed into a Detailed Description of Needs (DDN). In response to this DDN, the Centre for Applied Data Analytics Research (CeADAR) was established in 2012. Since inception and funded mainly by Enterprise Ireland (EI) and Industrial Development (IDA) of Ireland, CeADAR is a market-focussed technology centre for innovation and applied research in Big Data Analytics. The centre contributes to the development, deployment and adoption of Big Data Analytics technology for the competitive advantage of its members or stakeholders (CeADAR 2016)

The CeADAR Mission:

---

CeADAR: About CeADAR. Viewed on 10 Nov., 2017 from https://www.ceadar.ie/about-us/
“CeADAR’s mission is to create an internationally recognized, industry-led centre of excellence for innovation and applied research that accelerates the development, deployment and adoption of analytics technology and relevant innovations.”

CeADAR claims that its primary outputs are industry prototypes and demonstrators, producing state-of-the-art reviews of data analytics technology, tools, processes and best practices (CeADAR 2016). The artefacts have been developed in an extensive catalogue of technology demonstrators, IP and big data analytics technology reviews available for evaluation by stakeholders. In addition, CeADAR’s main concern is on thriving data analytics ecosystem delivering seminars, conferences, and members’ networking events throughout the year.

9.1 CeADAR Research Focus

As research centre, CeADAR focus on three core areas of interest and these are summarised below:

1. **Visualisation & analytics interface**: Develop smart analytics tools and techniques to:
   a. Ease interaction with large data and in exploring datasets by non-expert (ease of interaction)
   b. deliver results from analytics processes in the most effective, timely way (change user behaviour)
   c. make analytics outputs more effective (passive analytics)

2. **Data Management for Analytics**: Develop approaches, methods and tools, techniques & demonstrators to:
   a. improve, simplify data management (data mgt. effort)
   b. manage data validity and quality (Data validation).
   c. understand/improve relevance of event on relationships (events & relationships)
   d. determine data usefulness to improve data archiving (data curation)
   e. prevent Straight Through Processing breaks by automatically compensating for changes in data received (adaptive ETL).

3. **Advanced Analytics**: Pursue advanced analytics tools & techniques:
   a. in the areas of accuracy of detection & identification (causation challenge)

---

b. to identify trending scenarios in social networks (trending social network) and to identify and link an individual social media participant across networks (social media identity)

c. to analyse continuous streams of data using complex analytic algorithms (continuous analytics)

Figure 20: CeADAR's industry membership

9.2 Environment

CeADAR centre is located in Ireland; this fact enables us to conclude that it faces the same set of environmental influences that the Insight Centre for Data Analytics faces. We therefore refer to case study for Insight and use its findings to populate the equivalent themes under CeADAR centre.

9.2.1 Industry

Both CeADAR and Insight Centre are exposed to same industry factors, so there is no need to repeat this section, instead we cross-reference to the texts on environment under Insight Centre (See section 8.1.1).

9.2.2 Policy

Refer to Insight Centre Section

Both CeADAR and Insight Centre are exposed to same policy environment, so there is no need to repeat this section, instead we cross-reference to the texts on environment under Insight Centre (See section 8.1.2).
9.2.3 Societal

Refer to Insight Centre Section

Both CeADAR and Insight Centre are exposed to same societal factors, so there is no need to repeat this section, instead we cross-reference to the texts on environment under Insight Centre (See section 8.1.3).

Table 23: Summary of Environmental factors of CeADAR

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>1. Irish industry is dominated by 4 sectors – Pharm, food, computing &amp; chemicals</td>
<td>8th on UN’s dev. Index</td>
</tr>
<tr>
<td></td>
<td>2. Established industrial ecosystem with tech MNCs that invest significantly in R&amp;D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Emerging start up community</td>
<td></td>
</tr>
<tr>
<td>Policy</td>
<td>1. Dedicated agency (DBEI) provides research policies;</td>
<td>23rd on GCI</td>
</tr>
<tr>
<td></td>
<td>2. 14 areas of research areas are identified as national priorities;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Innovation 2020 set 2.5% of GNP on R&amp;D till 2020;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. SFI, EI &amp; IDA are focused on research initiatives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Government funding supports are provided</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Government policy focuses on industrial-academic collaboration with R&amp;I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Focus on increasing enterprise R&amp;D</td>
<td></td>
</tr>
<tr>
<td>Societal</td>
<td>1. Ireland is ranked 8th on UN’s Human Dev. Index</td>
<td>10th on GII, Leads knowledge impact &amp; fusion rankings</td>
</tr>
<tr>
<td></td>
<td>2. 23rd on Global Competitiveness Index</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. 10th on the Global Innovation Index.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Leads knowledge impact &amp; fusion rankings</td>
<td></td>
</tr>
</tbody>
</table>

Following the presentation of the environmental factors affecting research industry to the Centre Director (CD) who was out interviewee, he agreed with the findings but added that Irish industry has a thriving Fintech sector in addition to the 4 sectors listed as the dominant industry in Ireland. In respect of Policy environment, he maintained that Enterprise Ireland (EI) is not just a primary partner, but also sets the key performance indicators with which CeADAR performances are assessed on a 3-month basis. This assessment practices serve as good motivator for the centre. In terms of the societal influence, CeADAR was set up during the last economic recession period in Ireland with the aim to explore the emerging data analytics and artificial intelligence opportunities and to leverage the technologies and expertise to support industry.
9.3 The Core model of BDVCoE

This section provides details of analysis of CeADAR operations and management according to the core elements of BDVCoE model.

9.3.1 Strategy:

*Strategy represents the collection of goals, mission and vision, and the means by which a centre of excellence intends to achieve its overall mission and goals.*

Table 24: Summary of Strategy of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Focused research interests - Visualisation &amp; Analytic Interfaces; Data Management for Analytics &amp; Advanced Analytics</td>
<td></td>
</tr>
<tr>
<td>3. To be involved in Applied R&amp;D exclusively directed at industry challenges</td>
<td>Market-focused</td>
</tr>
<tr>
<td>4. To train Senior R&amp;D staff through (hands-on-the-job) training</td>
<td>Training</td>
</tr>
<tr>
<td>5. To fund &amp; develop demonstrators through rapid prototyping deliverable every 6 months</td>
<td>prototyping</td>
</tr>
</tbody>
</table>

The strategic practices (Table 24) of CeADAR reported in our case study were presented to the interviewee and having read through confirmed that all listed strategic goals of the centre are correct but emphasised the fact that CeADAR does a lot of contract research; delivering new innovative products to industry partners. He added that the centre looks into growing start-ups in the near future; however, CeADAR, at the moment is more concerned with delivering innovative products and services to the industry.

9.3.2 Governance and organisational structure:

*Governance:*

The CeADAR maintain an **Industry Steering Board** that sets the strategic priorities of the Centre and also decides the 20 demonstrators that the Centre delivers annually.

---

Table 25: Summary of Governance of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Industry Steering Board (ISB) which sets the strategic priorities of the Centre (CeADAR 2016)[e1]</td>
<td>Decision-making</td>
</tr>
<tr>
<td>2. ISB decides the 20 demonstrators that the Centre delivers annually (CeADAR 2016)[EC2]</td>
<td>Decision-making</td>
</tr>
<tr>
<td>3. Centre Steering Committee (CSC) is composed of:</td>
<td>Composition</td>
</tr>
<tr>
<td>a. 3 Principle Investigators (PIs) and 6 industry representatives</td>
<td></td>
</tr>
<tr>
<td>b. Observers:</td>
<td></td>
</tr>
<tr>
<td>i. Enterprise Ireland observers (Funder)</td>
<td></td>
</tr>
<tr>
<td>ii. Independent observer</td>
<td></td>
</tr>
<tr>
<td>iii. IDA observer (Funder)</td>
<td></td>
</tr>
<tr>
<td>4. TTO observer (Host Institute)</td>
<td></td>
</tr>
<tr>
<td>5. CSC sets the strategic agenda</td>
<td>Decision-making</td>
</tr>
<tr>
<td>6. CSC monitors the Centre’s KPIs</td>
<td>Decision-making</td>
</tr>
<tr>
<td>7. CSC decides on core funded projects</td>
<td>Decision-making</td>
</tr>
<tr>
<td>8. CSC reflects (reviews) on the composition of the membership</td>
<td>Decision-making</td>
</tr>
<tr>
<td>9. Industry majority to carry CSC decision</td>
<td>Decision-making</td>
</tr>
<tr>
<td>10. Intellectual Property Committee (IPC) is composed of: 2 TTOs and 3 industry representatives</td>
<td>Composition</td>
</tr>
</tbody>
</table>
11. Other role players of CeADAR governance include:
   a. RPOs made up of the management group and the research group
   b. TTO representative

12. A Centre Director supported by Industry Steering Board

13. Executive management team comprises of the Centre Director and an Academic Director, who are responsible for the day-to-day operations of the Centre and its research programmes.

On presenting the Governance practices (Table 4) to the respondent, he clarified the fact that the Industry Steering Board and the Centre Steering Committee are actually the same group and that the group sets the strategic priorities of the centre as noted on the report. Setting the strategic priorities also entails setting the KPIs which we take and operationalised them.

With regards to strategy, the centre has a strategy document called the **Detailed Description of Needs (DDN)** that articulates the strategies which are drawn up by the industry members. The DDN document assembles all we do at CeADAR and is initially prepared by a sub-committee that submits to the ISB that in turn submits to all centre members for deliberation. The result is later presented to the board (CSC or ISB). While he agreed with the other governance practices on the table, he emphasised the very important functions of the Intellectual Property Committee (IPC): The IPC, chaired by the CD, is very useful in making the technology transfer to the industry a reality. The committee comes with novel ways of doing things around IP arrangements taking care of the pricing and monitoring of IP processes and activities.

**Structure:**

![Figure 23: Structure of CeADAR’s Steering Committee](image-url)
Table 26: Summary of Structure of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CeADAR has a Centre Director, PIs and a flat team</td>
<td></td>
</tr>
<tr>
<td>2. Operations support personnel includes:</td>
<td></td>
</tr>
<tr>
<td>a. A Centre Director</td>
<td></td>
</tr>
<tr>
<td>b. 4 Principal Investigators – Lead Investigators and one Principal Investigator for each of the 3 research areas</td>
<td></td>
</tr>
<tr>
<td>c. Two Managers – an Office Manager and a Project Manager</td>
<td></td>
</tr>
<tr>
<td>d. 10 Collaborators – DIT (2), UCD (8)</td>
<td></td>
</tr>
<tr>
<td>e. 20 Researchers – DIT (9), UCD (11)</td>
<td></td>
</tr>
</tbody>
</table>

On presenting Table 26 to the interviewee, he quickly noted that the centre does not normally maintain two managerial positions unless one is on maternity leave. There is either a project manager or an office manager at any one time. However, there is a preference to designate the position as a project manager rather than an office manager. The rest of the project team is assembled on a need basis that means they are temporarily assigned to projects (usually 6-month cycle), as there is no rigid team arrangement at the centre. Having clarified the above, the interviewee who is also the Centre Director agreed with the remaining points on CeADAR structure enumerated in Table 26.

9.3.3 Funding

Funding:

For the development of research capabilities in Big Data domain, Enterprise Ireland invests in data analytics research centres of which CeADAR is one. Others include

- The INSIGHT Centre - The National Centre for Data Analytics
- ICHEC - The Irish Centre for High-End Computing
- TSSG - Telecommunications Software & Systems Group (TSSG)

Furthermore, CeADAR is a partner in the joint initiative namely the Innovation Partnership Programme (IPP) run by EI and IDA from which CeADAR receives funding besides contract research revenues. Under IPP, EI and IDA can provide up to 80% of the needed funds for research project thus supporting industry-research collaboration.

---

45 Mcdonnell.

46 Enterprise Ireland; IDA Ireland, ‘Technology Centre Programme - Get the Competitive Edge Game-Changing Technology Delivers’, 2013 <https://www.enterprise-
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

Table 27: Summary of Funding of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CeADAR is primarily funded by EI &amp; IDA for Big Data research projects – the core funded open-innovation service</td>
<td>Core funding</td>
</tr>
<tr>
<td>2. EI &amp; IDA innovative partnerships involving collaboration Research and consultancy services constitute a funding sources</td>
<td>Other funds</td>
</tr>
<tr>
<td>3. Funds also come from Collaborative Research and Consultancy services under Horizon 2020 instruments</td>
<td>Other funds</td>
</tr>
<tr>
<td>4. Industry Membership model (in collaborative project) provides another source of income for CeADAR</td>
<td>Other funds</td>
</tr>
<tr>
<td>5. Under IPP, EI/IDA provide up to 80% of project cost</td>
<td>Other funds</td>
</tr>
<tr>
<td>6. Government funding for CeADAR is crucial to stimulate research in the correct areas with backing from the industry</td>
<td>Other funds</td>
</tr>
</tbody>
</table>

The first point removed by the interviewee on looking at funding practices on CeADAR case study report (Table 27) was the word ‘Big’ from ‘Big Data’. This was based on the fact that the centre actually does more than just Big Data research. It is involved in not only Big Data but also all other forms of Data Analytics research. Continuing from here, he informed us that the funding CeADAR gets is only partly from EI and IDA. According to him, contract research is another good source with substantial amount for the centre compared with EI and IDA sources. A third source of income is from collaborative research with partners aside of industry membership fees receivable from the industry members on an annual basis. Therefore, considering the value of funding from various sources in descending order, the interviewee believes that the true picture is: government sources (direct funding for tech development by EI/IDA), contract research, H2020, membership fees and national awards.

9.3.4 Culture

Table 28: Summary of Culture of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
</table>

“Our management structure is flat and everyone has a voice, which contributes to the camaraderie and excitement we feel in making tangible impacts in this dynamic field of data analytics”\(^{47}\).

Not much to say about culture in a research centre because it bears not much resemblance to ordinary corporate entity. This was the interviewee first reaction to the question of what cultural practices are typical of his centre. Nevertheless, he agreed with the quoted practice Table 28 as it is not far from reality and he recalled it could a comment on the centre somewhere. To strengthen his opinion on culture, he stated that the environment is more like a start-up environment where the culture of freedom is directed towards helping one another, being supportive without compromising industry needs. There is a strong need to work hard to meet deadlines with the industry members’ requirements and this could substantiate the notion that working at CeADAR is more like working in the industry (maintaining industry professional culture) as opposed to working in an academic environment. We’re always conscious of the time to deliver projects.

### 9.3.5 Outreach

**Outreach:** The collection of information dissemination activities with which the Centre informs the public about the science and technology developments in the centre. The aim is to enable the public appreciate science and technology.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CeADAR has established itself through:</td>
<td>Outreach</td>
</tr>
<tr>
<td>2. Seminars</td>
<td>Outreach</td>
</tr>
<tr>
<td>3. Conferences</td>
<td>Outreach</td>
</tr>
<tr>
<td>4. Consultancy &amp; members’ networking events</td>
<td>Outreach</td>
</tr>
</tbody>
</table>

Talking about CeADAR status within the Data Analytics ecosystem, the interviewee was of the opinion that the centre ‘is trying to establish itself’ rather ‘having established itself’. In agreement with the findings on Table 8, the interviewee reiterated that, CeADAR does organise and participate in considerable number of seminars, conferences and other networking events around the country to provide

\(^{47}\) CeADAR (2013): A unique opportunity for industry-academia-government partnership in Ireland. YouTube video viewed on 14 Nov 2017 at https://youtu.be/yIq1m9Wf1Dk
information on demonstrator innovations as well as provide opportunity for membership collaboration.

**Update of report using information from interview: to begin from here after next interview with CD**

### 9.3.6 Capabilities

**Capabilities:**

Being industry-focused technology centre, it has great initiative for innovation and applied research that accelerates the development, deployment and adoption of Data Analytics technology and relevant innovations for industry applications 48. CeADAR uses its partnership with EI & IDA Innovation and Horizon 2020 (H2020) instruments to engage industry stakeholders in research activities. CeADAR maintains industry membership with the following benefits to participating members 49:

1. Access to an extensive catalogue of analytics demonstrators for evaluation
2. Access to state-of-the-art reviews of data analytics technologies and tools
3. Members can influence choice of demonstrator projects
4. Collaborate with CeADAR in rapid prototype development and other works
5. Engage directly in project work – as in point 4 above
6. Join the data analytics ecosystem in workshops, seminars, conferences, and networking events
7. Leverage CeADAR’s core funds for development of analytics demonstrators
8. Access to national experts in data analytics and visualisation

Have opportunities for placements of postgrad in internships with CeADAR

**Table 30: Summary of Capabilities of CeADAR**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CeADAR doesn’t produce PhDs, but develops experts in Data Analytics and Artificial Intelligence through hands-on-the-job training.</td>
<td>People</td>
</tr>
<tr>
<td>2. Industry partners have opportunities to place their postgrad on internships programme with CeADAR.</td>
<td>People</td>
</tr>
<tr>
<td>3. CeADAR has extensive catalogue of technology demonstrators, IP &amp; analytics technology reviews, all made available to its</td>
<td>Process</td>
</tr>
</tbody>
</table>


49 CeADAR membership: https://www.ceadar.ie/memberships/
4. CeADAR has a network of industry members (> 80) & ecosystem to which it delivers services such as seminars, conferences and consultation.

5. To establish CeADAR-industry collaboration, CeADAR follows this process:
   a. CeADAR issues 2 calls for demonstrator proposal per year
   b. Centre Director & Mgt. Team filters proposals
   c. Proposals are rated by members based on 4 criteria
   d. Centre Steering Committee makes proposal choices

6. The CeADAR infrastructure has developed into high speed & bandwidth data centre which supports real-time processing of large quantities of streaming data.

7. CeADAR maintains its own data centre as well as using webs services from various providers.

8. CeADAR industry membership is drawn from a broad base of industries (Data Analytics domain) in Ireland and abroad.

9. Industry members of CeADAR gain exclusive access to:
   a. extensive catalogue of analytics demonstrators
   b. state-of-the-art reviews of data analytics technologies & tools
   c. experts in data analytics and visualisation, etc.

10. CeADAR participates in demonstrators activities in which it:
    a. Influences choice of demonstrator projects
    b. Leverages it core funds for the development of analytics demonstrators.

11. Industry members collaborate with CeADAR on rapid prototype development.

12. Industry partners come to CeADAR with problem to be solved.

---


51 CeADAR membership: https://www.ceadar.ie/memberships/
9.4 The Impact

Impact refers to the direct and indirect ‘influence’ of research or its ‘effect on’ an individual, a community, or society as a whole, including benefits to the economic, social, human and natural capital. It is the manifestation of the collective outcomes of the research and innovation activities over time as seen on an individual, community or a place. These outcomes can be classified into 3 categories – Economic, Scientific and Societal.

**Economic:** The economic impact is the effect on commerce, employment, or incomes generated from big data research in general and by the centre of excellence in particular.

**Scientific:** The scientific impact of research centre can be measured in terms of peer-reviewed journal and conference papers dealing with the assessment of the scientific impact of a centre of excellence. Numerical indicators can include: number of publications and citations, impact factors of venues, number of download and number of views. Such quantitative and qualitative impact assessment should help funding agencies evaluate returns on investment.

**Societal:** Societal impact can be measured in terms of impact on human lives and health, organisational capacities, societal behaviours and the environment. Societal impact can be reached through various practices that centres of excellent can adopt to influence the relationship between research and the society (non-academic community).

**Table 31: Summary of CeADAR impacts**

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Centre produces technology demonstrators, IP and analytics technology</td>
<td>Technology IP</td>
</tr>
<tr>
<td></td>
<td>2. CeADAR’s research outputs supporting industry and economic development include a range of analytics tools:</td>
<td>Analytics technologies</td>
</tr>
<tr>
<td>Economic</td>
<td>a. customer, real time, contact centre,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. social media, text, location-based,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. sentiment, video &amp; image,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. synthetic data generator, predictive,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. machine &amp; deep learning</td>
<td></td>
</tr>
</tbody>
</table>
3. The scientific outputs of CeADAR below also fit into economic impact because the centre is industry-focused.

Scientific

1. CeADAR’s outputs include prototypes, demonstrators, state of the art reviews of data analytics technology, and best-practices

2. Supports the development of Ireland’s strong international reputation in Data Analytics & AI

3. Paper publications from 2013 to 2016 totalling 11 papers

Societal

1. CeADAR was awarded the 2016-17 Dunn & Bradstreet prize for Best Analytics Research Group Ireland at the DatSci Awards 2016-17

9.5 Challenges and Critical Success Factors

9.5.1 Challenges

Table 32: Summary of Challenges of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CeADAR’s greatest challenge and also opportunity is the huge demand for analytics and data scientists (Republic 2016)</td>
<td>Demand for analytics/ experts</td>
</tr>
<tr>
<td>2. In terms of analytics, for us, it’s a big problem, analytics is complex algorithm and methodology and you have to present information to users – information they can</td>
<td></td>
</tr>
</tbody>
</table>

---

interpret, understand & interact with. Making this simple enough is our biggest challenge\(^5^3\).

9.5.2 Success Factors

Table 33: Summary of Success Factors of CeADAR

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The “\textit{datafication}” of everything in the world which recent statistics reports that about 90% of it was created in the past two years from social media, digitisation of books and documents, sensors in phones, cars, etc.</td>
<td>Data creation &amp; digitisation</td>
</tr>
<tr>
<td>2. Our greatest opportunity is the huge demand for analytics and data scientists needed to reduce Big Data into ‘little data’ to reveal insights from the data(^5^4).</td>
<td>Demand for insights from big data</td>
</tr>
<tr>
<td>3. CeADAR only works on projects that are proposed by industry members. This ensures what’s produced will have an immediate and beneficial impact(^5^4).</td>
<td>Immediate impact output</td>
</tr>
<tr>
<td>4. The produce-for-immediate-impact dynamic is highly motivating for CeADAR to get to work on a huge variety of projects across many industries every six months(^5^4).</td>
<td>Motivation from impact</td>
</tr>
</tbody>
</table>

10 Appendix C: KNOW CENTRE: Case Study

This section introduces the KNOW Centre (www.know-center.tugraz.at) as a case study for the validation of BDVCoE model. The objective of this exercise is to provide a starting point of feedback cycles to be conducted as part of the Delphi study. The rest of this section describes KNOW Centre situated in Austria, according to the BDVCoE model elements. Our main concern for the purpose of validation of the findings of the case study is the core model part of the framework. However,


\(^{5^4}\) CeADAR (2013): A unique opportunity for industry-academia-government partnership in Ireland. YouTube video viewed on 14 Nov 2017 at https://youtu.be/yiQ1m9Wf1Dk
important feedback on environmental factors influencing KNOW Centre operations as well as the impact areas of the outputs of the Centre will be included.

The KNOW-Centre was established in 2001 as a part of Graz University of Technology and has since then developed into Austria’s top research centre for data-driven business and big data analytics\textsuperscript{55}. The Know-Centre operates in close collaboration with the Institute of Knowledge Technologies within the Graz University of Technology; involved in conducting applied and interdisciplinary computer science research. KC is both academic and industry focused – producing expertise with master’s degrees and PhDs, books and papers as well as forming a link between science and industry; participating also in the research of Industry 4.0 and Big Data\textsuperscript{56}. The Know-Centre is an innovation hub that connects science and industry together through the conduct of application-oriented research in collaboration with academic institutions and companies\textsuperscript{57}. “As an associated research institution and excellence centre within the Austrian Competence Centres for Excellent Technologies (COMET program), Know-Centre conducts fundamental researches and is involved in numerous EU projects”\textsuperscript{58}.

The Know Centre mission: The mission of the centre is reproduced here as stated on its website includes\textsuperscript{59}:

- We increase the appeal of the business location Styria by pooling the applied IT research competences and linking them with companies.
- We improve the competitiveness of our business partners and customers by helping to develop innovation in companies.
- We obtain EU funds in order to work on new research and innovation topics and help our business partners to be well-positioned in the future.
- We foster knowledge transfer and network creation between science and industry, for example, via our annual congress i-KNOW.
- We cooperate with international scientific institutions and publicize the latest results, e.g. in our journal J.UCS (www.jucs.org).
- We contribute to increasing the qualification level in Styria by developing highly qualified human resources in science and economy.

\textsuperscript{55} Rolf Hoffman (n.d.). Know-Centre Graz: Europe needs more courage. Viewed on 19 Nov., 2017 from https://www.academics.de/wissenschaft/data_science_an_der_tu_graz_58400.html


The Know Centre Vision: From Data to intelligence

Specialisation:
The focus areas are in the fields of data-driven business, big data and cognitive computing. Specific specialisation involves the search technologies, machine learning methods or knowledge extraction from large databases. KC works on the presentation and visualization of Information Mountains, the efficient handling of information in social media channels as well as the contextualization and personalization of information. Specific categories of research fields include:

1. **Cognitive Computing Systems:** Enabling data-driven business through the combination of human and machines capabilities, development of business models and processes.

2. **Knowledge Discovery:** Includes research activities and the handling of large amounts of data. It involves the development of automated methods for analysing, enriching and linking large complex data sources for knowledge discovery. KC Knowledge Discovery specific competences include: Big Data Management, Knowledge Discovery, Machine Learning, Information retrieval, Natural language processing, (Real-Time) Sensor Analytics and Artificial Intelligence.

3. **Knowledge Visualization:** The task is to gain insights into the interrelationships between complex data in order to understand and represent the information and the interrelationships. To do this task, KC employs "Knowledge Visualization" using innovative methods of visualization that provides innovative methods for analysing & visualising large quantities of data in order to enable users understand the context behind them. The goal is link different sources of information into meaningful visualizations, promote visual thinking, and aid the sense-making process. Specific competences include: Data and Information Visualization, Visual Analytics, Projection and Layout Algorithms, Augmented reality and Human-computer interaction.

4. **Social Computing:** The impact of social medial or social networks shape communication and knowledge exchange more than before in our current world. Social computing tries to find the added values these communication and knowledge exchange formats offer corporate bodies and institutions. It deals with the questions around topics such as knowledge extraction, construction and utilization of social network data with the aim of providing relevant information for companies and their users. The ultimate goal is to harness digital resources for people. Specific competences include: Network & Web Science, Science 2.0, Predictive Modelling, Social Network Analysis, Information Quality Assessment, User Modelling, Machine Learning and Data Mining, Semantic technologies and Collaborative systems.

---

5. **Ubiquitous Personal Computing**: "Ubiquitous Personal Computing" investigates ways to develop technologies that enable flexible support in working, learning and creative thinking. KC’s Ubiquitous Computing team designs innovative interaction concepts that take into account the complex work processes and the potentials of ubiquitous personal computing (ICT) technologies adaptable to smart devices so that these can further support better communication systems. *In this unit of KC the team put people first because they believe people should be supported in their work, study and creative thinking using the Ubiquitous Personal Computing technologies.* This approach assumes dual forms – first, it provides direct support termed “*Performer Support Action*” for work performers and second, a follow-up support termed “*Performer Support After Action*”. Specific competences of KC in this area include: Stakeholder-oriented interaction design, ICT evaluation in organizations, Computer-aided (collaborative) work, Computer-based work-integrated learning, Ubiquitous Sensing, Self-Tracking and Ubiquitous Personal Computing application development.

6. **Services & Development (Support Unit)**: The "Services & Development" team is concerned with the design, development of quality assurance, operation and documentation of software components and services. Being the direct interface with users, it stands at the heart of many projects of the nature of apps, desktop computer programs or complex search tools. A dedicate area at KC has been set up to handle “Services & Development” customer issues on behalf of the rest units thereby offering a kind of **contact centre expertise** for the units. The main aim Service and Development unit is to provide Know-Centre with appropriate professional level support as well as maintain and develop the internally existing components and frameworks. Specific competences include: Software Design & Implementation, Big Data Software Development, Service-Oriented Architectures, Test-Driven Development and Exploration of Research Components for Business Applications.

### 10.1 Environment

**10.1.1 Industry**

**10.1.2 Policy**

**10.1.3 Societal**

Table 34: Summary of Environmental Influences on KC

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>
10.2 BDVCoE Core Model

This section provides details of analysis of KC’s operations and management according to the core elements of BDVCoE model above (Figure 7)

10.2.1 Strategy

We viewed the information under KNOW-Centre’s Mission statement as also appropriate for reproduction under the strategy of the centre particularly for the fact that the centre does not maintain a publicly accessible version of the centre’s strategies. Table 35 below summarises these strategy statements:

Table 35: Summary of Strategy of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To increase the attractiveness of Styria as a business location by developing IT research competences &amp; linking them with companies.</td>
<td>Attract investment</td>
</tr>
<tr>
<td>2. To improve the competitiveness of business partners and customers by helping to develop innovation in companies.</td>
<td>Competitiveness</td>
</tr>
<tr>
<td>3. To obtain EU funds in order to work on new research &amp; innovation topics &amp; help business partners to be well-positioned in the future.</td>
<td>Funding</td>
</tr>
<tr>
<td>4. To foster knowledge transfer and network creation between science and industry, e.g., via annual i-KNOW congress.</td>
<td>Knowledge transfer</td>
</tr>
<tr>
<td>5. To cooperate with international scientific institutions and publicise the latest results in journals e.g. J.UCS (<a href="http://www.jucs.org">www.jucs.org</a>).</td>
<td>Collaboration</td>
</tr>
<tr>
<td>6. To contribute to increasing the qualification level in Styria by training qualified human resources in science and economy.</td>
<td>Human capital</td>
</tr>
<tr>
<td>7. To assemble know-how in Big Data research to develop innovative tools for companies to create value for customers.</td>
<td>Human capital</td>
</tr>
</tbody>
</table>

10.2.2 Governance & Structure

Governance

---

The KNOW Centre has several committees which are maintained to tally with the various units of the centre. In other words each units has a governing committee in addition to the head and the deputy head. The committee is designated as the scientific committee in the case of each of the research units. The centre’s overall Scientific Committee (which is a unification of the research units’ Scientific Committees) consists of ten research professionals in knowledge technologies and knowledge discovery. There are two people in each of the unit level Scientific Committee and two also for the Services and Development unit Committee. All Committee members are included in the Scientific Advisory Board with a total of ten people. The Scientific Advisory Board members are said to be internationally recognised experts in the field of knowledge technologies and knowledge development. For KC, the board decides and defines the content and direction as well as coordinate/synchronise with the latest international developments - see Table 36.

Table 36: Summary of Governance of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Scientific Advisory Board:</td>
<td>Centre Governance</td>
</tr>
<tr>
<td>a. Decides and define the content &amp; direction of KC and</td>
<td></td>
</tr>
<tr>
<td>b. Continuously synchronizes KC’s developments with the latest international developments</td>
<td></td>
</tr>
<tr>
<td>2. KC has a Board of Directors of 3 members from the following director groups:</td>
<td>Centre Governance</td>
</tr>
<tr>
<td>a. Managing &amp; Scientific Director (also Centre Head)</td>
<td></td>
</tr>
<tr>
<td>b. Director Finance &amp; Administration</td>
<td></td>
</tr>
<tr>
<td>c. Director Business &amp; Markets</td>
<td></td>
</tr>
<tr>
<td>3. The composition of the scientific Committee (committee of committees) is ten people, 2 from each committee below:</td>
<td>Centre Governance</td>
</tr>
<tr>
<td>a. Strategy Committee</td>
<td></td>
</tr>
<tr>
<td>b. Knowledge discovery Committee</td>
<td></td>
</tr>
<tr>
<td>c. Knowledge Visualisation Committee</td>
<td></td>
</tr>
<tr>
<td>d. Social Computing Committee</td>
<td></td>
</tr>
<tr>
<td>e. Ubiquitous Personal Computing Committee</td>
<td></td>
</tr>
</tbody>
</table>

Structure


Table 37: Summary of Structure of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>KC governance structure is made up of:</td>
<td>Governance structure</td>
</tr>
<tr>
<td>1. A Board of Directors</td>
<td>Governance structure</td>
</tr>
<tr>
<td>2. Centre Director</td>
<td>Governance structure</td>
</tr>
<tr>
<td>3. Functional Directors – 3 (Managing/ Fin &amp; Admin/ Business &amp; markets)</td>
<td>Governance structure</td>
</tr>
<tr>
<td>4. Chief Technology Officer &amp; Business Dev.</td>
<td>Governance structure</td>
</tr>
<tr>
<td>5. Head of marketing/PR &amp; Business Dev.</td>
<td>Governance structure</td>
</tr>
<tr>
<td>6. Business Dev. &amp; Marketing / Internationalization</td>
<td>Governance structure</td>
</tr>
<tr>
<td>7. Research area Heads and Deputies</td>
<td>Governance structure</td>
</tr>
<tr>
<td>8. Area Services and Development Head &amp; Deputy</td>
<td>Governance structure</td>
</tr>
<tr>
<td>9. Managing Director (also the Scientific Director) = 1</td>
<td>Mgt / Science</td>
</tr>
<tr>
<td>1. Director Business &amp; Markets</td>
<td>Business Dev &amp; Marketing</td>
</tr>
<tr>
<td>2. Head of Marketing &amp; PR, Business Development</td>
<td>Business Dev &amp; Marketing</td>
</tr>
</tbody>
</table>

---

64 A visual Representation of KC Teams (created by author) as seen on KC website viewed on 19 Nov., 2017 from [http://www.know-center.tugraz.at/en/team/](http://www.know-center.tugraz.at/en/team/)
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

| 3. | Chief Technology Officer & Business Development | Business Dev & Marketing |
| 4. | Deputy Head of Knowledge Discovery & Business Dev. | Business Dev & Marketing |
| 5. | Deputy Head of UPC & Business Development | Business Dev & Marketing |
| 7. | Business Development & Marketing = 7 people | Business Dev & Marketing |
| 8. | Centre Administration = 14 (plus Director of Fin. & Admin and 12 Admin Officers) | Administration |

10.2.3 Funding

Relying on its multidisciplinary research expertise, KC designs added value for business out of internal and external data sources. The data-driven methods raise valuable knowledge in different industries and applications such as Industry 4.0, mobility or Life Sciences. These avenues earn KC revenues to part-finance its research activities. In this sense KC serves as a bridge between science and industry, contributing significantly to the value creation processes in companies. Through projects such those from EU H2020 and Framework FP7, KC generates more revenues for financing its activities. Example is “MATURE”, a large integrated project, which is partly funded under the framework FP7 of the European Union.

Table 38: Summary of Funding of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Financed by the Austrian Competence Centres for Excellent Technologies (COMET) program</td>
<td>Main funding</td>
</tr>
<tr>
<td>2. Funding from a network of industry stakeholders by developing added value for local &amp; international businesses of over 40 companies &amp; 100 international scientific institutions</td>
<td>Other funds</td>
</tr>
<tr>
<td>3. KC obtains EU H2020 funds in order to work on new research and innovation topics &amp; to help partners’ business.</td>
<td>Other funds</td>
</tr>
<tr>
<td>4. Revenues from consulting services to companies</td>
<td>Other funds</td>
</tr>
</tbody>
</table>

10.2.4 Culture

---


10.2.5 Capabilities

People
The Know-Centre assembles know-how in the Big Data research field to develop innovative tools for companies. As an educational institution, KC makes talent development a priority through training of young professionals to enhance their scientific skills and acquire hands-on experience in data sciences. In addition, it maintains over 80 highly qualified employees in Austria working to give Austrian companies competitive advantages.

The services and development unit team put people first because they believe people should be supported in their work, study and creative thinking using the Ubiquitous Personal Computing technologies. The unit provides direct support for workers (Performer Support Action) and a follow-up support (Performer Support After Action). The Services & Development deals with customer issues on behalf of the rest units using its contact centre expertise.

10.2.5.1 Process
10.2.5.2 Infrastructure
10.2.5.3 Collaboration

KC’s collaborators may be grouped into categories as in Figure 25

![Collaborator Groups]

Figure 25: Groups of Collaborators

---


KC provides useful values for partners in collaboration by offering them business benefits and international visibility through a wide network and excellent research services as leading Europe’s research centre for data-driven business and knowledge technologies. Know-Centre offers its partners insight into the latest research and innovation themes\(^6^9\). Through cooperation with companies and exploring the knowledge gained from research projects, KC produces insights from big data and develops intelligent applications and systems to help users identify, visualize, structure and transfer knowledge in social networks and mobile working situations or personalized according to the specific requirements of individual user\(^7^0\).

### 10.2.5.4 Outreach

The 16-year International Conference on Knowledge Technologies and Data-driven Business (i-KNOW) is in these fields. It brings together the best minds from science and industry annually to shaped research and practices on how to leverage knowledge technologies and data in business and industry, and to understand how knowledge technologies shape this relationship\(^7^1\).

#### Table 40: Summary of Capabilities of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. KC develops talents through in-house training of professionals to improve scientific skills and experience</td>
<td>People</td>
</tr>
<tr>
<td>2. KC makes talent development a priority through training of young professionals to enhance scientific skills and acquire hands-on experience to become data scientists</td>
<td>People</td>
</tr>
<tr>
<td>3. The <em>Services &amp; Development</em> team puts people first because people should be supported in their work, study and creative thinking using the Ubiquitous Personal Computing technologies offering <em>contact centre expertise</em> to customers</td>
<td>People</td>
</tr>
<tr>
<td>4. KC created a state-of-the-art training ground for young researchers to ensure sustainable expansion knowledge for the future(^7^2).</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>5. KC is a part of the network of more than 100 research institutions worldwide</td>
<td>Network</td>
</tr>
<tr>
<td>6. KC collaborate with a network of industry stakeholders: over 40 companies and over 100 international scientific institutions(^5^5)</td>
<td>Collaboration</td>
</tr>
</tbody>
</table>

---


\(^7^1\) KNOW-Centre: i-KNOW 2017. Viewed on 19 Nov., 2017, from [https://i-know.tugraz.at/](https://i-know.tugraz.at/)

D4.1: Network of National BDV Centres of Excellence Best Practice Guide

7. KC gets involved in collaborative researches using i-Know conference; provide a link with the industry to attract partners
   Collaboration

8. KC collaborate with other research centres in data technologies
   Collaboration

9. To become a B2B relationship partner of KC, a company:
   a) purchases various services or
   b) enters into a long-term partnership via the COMET program.
   Process

10. For a long-term economic partnership a company
    a) Establishes connecting factors in the first research project proposal.
    b) If partner is accepted, the cooperation agreement will be recorded in a framework agreement
    c) Then the company can benefit from all advantages of the cooperation with Know-Centre.
   Process

11. KC uses i-Know conference as a link between science & industry in order to promote knowledge about science and technology
   Outreach

12. i-KNOW conference brings together the best minds from science and industry (about 500 in 2017) to
    a) shaped research & other practices on knowledge techs & data
    b) leverage knowledge techs and data in business and industry,
   Outreach

13. KC organises / participates in many other conferences, workshops and lectures e.g. Open Science in Practice; Big Data and Data-Driven Business, science workshops on big data, health digitisation, data economy, ‘World Usability Congress’, etc.
   Outreach

10.3 Impact

KNOW Centre has a remarkable impact on both industry (economy) and the scientific world. Being a research centre supplying both academic and industry services, it has established significant ties with stakeholders in both sectors as well as the entire society producing expertise in the data-driven economy, creating innovative productive for important sectors such as health, social computing, ubiquitous computing according to available information at the centre website.

Table 41: Summary of Impacts of KC

---


D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
</table>
| Economic    | 1. Through collaboration and consulting services, KC provides business solutions and researches results with a network of industry stakeholders  
2. KC provides useful value to partners by offering them business benefits and international visibility  
3. Offers its partners insight into the latest research and innovation themes, e.g. at i-Know conference\(^{75}\)  | Services to firms                                                                                |
| Scientific  | 1. KC research staff has given about 216 lectures since 2002 at various locations\(^{76}\).  
2. A good number of scientific theses has been written at KC\(^{77}\)  
3. KC participated in delivering “The Role of Recommendations in Predictive Analytics” at the Predictive Analytics Conference in Vienna, Oct. 2017  
4. Publications\(^{78}\):  
   b. Others are conference (376), Journals (42), Books (103) and Lectures (218)  | Publications Lectures conferences                                                                   |
| Societal    |                                                                                                                                                                                                          |                                                                                                    |

10.4 Challenges and Critical Success Factors

10.4.1 Challenges

Table 42: Summary of Challenges of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
</tbody>
</table>


10.4.2 Success Factors

Table 43: Summary of success factors of KC

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “Together with our partners, we develop innovative solutions and translate our competencies into competitive advantages for the economy.”</td>
<td></td>
</tr>
</tbody>
</table>

11 Appendix D: SIRIUS: Case Study

SIRIUS Lab is a centre for Scalable Data Access in the Oil and Gas industry involved in the conducts of interdisciplinary researches to produce innovative solutions that advance and support digitisation in the oil and gas industry. SIRIUS only began operations in late 2015, however, it has gathered a portfolio of projects that enables the establishment of understanding between the centre researchers and its industrial partners. SIRIUS finances its research activities through funds obtained from public funding sources for basic research and funding from its industrial partners in an eight-year programme of industrial and research-based innovation. Examples of SIRIUS’ partners and collaborators include companies from the oil and gas value chain such as Statoil, Schlumberger and DNV-GL, and IT companies e.g. Computas, Evry, Dolphin Interconnect Solutions, fluid Operations AG, IBM, Kadme, Numascale and OSISoft. To work with these companies, SIRIUS Lab provides researchers from the University of Oslo, NTNU, University of Oxford and Simula Research Laboratories. SIRIUS aims to expand to intellectual hub for applied industrial IT in Norway collaborating widely with both national and international stakeholders.

Vision: To accelerate the development and adoption of innovative data access technology in the oil & gas industry via a broad-based collaboration with a short feedback loop across the whole value chain.

The vision is geared towards the accomplishment of the following (somewhat) mission statements below as seen on SIRIUS’s Annual Report.


82 SIRIUS, ‘SIRIUS Annual Report 2016’.
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

**Mission:**

- To produce smart ways of finding and getting data from new and existing data sources
- To serve Oil companies, service companies, IT vendors and universities
- To carry out Industry-near research and innovation: experiments, prototypes and pilots
- To be involved in exploration, field development, operations and downstream

As vibrant hub for research-driven innovation, SIRIUS mission is to foster innovation that can enable exploitation of data across the industry. Focusing on digital transformation, SIRIUS is to deliver innovative solutions that can effectively expose and exploit data across silos and thereby rethink the interplay between people, enterprises and technology. SIRIUS facilitates digital transformation in industry through a programme for scientific excellence.

**Specialisation:**

SIRIUS Centre applies capabilities in knowledge representation, natural-language technologies, databases, scalable computing, execution modelling and analysis and working practices in the oil and gas industry. It enables industry stakeholders to find better access to and use the massive amounts of data that are generated in exploration, projects and daily operation. SIRIUS finds solutions to data problems in the industry through combination of interdisciplinary capability methods that lead to the development of technically innovative solutions although many of its outputs are used outside the oil and gas industry such as Healthcare, Energy, Manufacturing and Public Administration.

**11.1 Environment**

**11.1.1 Industry**

**11.1.2 Policy**

**11.1.3 Societal**

---

### 11.2 BDVCoE Core Model

This section provides details of analysis of SIRIUS’s operations and management according to the core elements of BDVCoE model.

#### 11.2.1 Strategy

The strategies enumerated in the table below are stated under the objectives in SIRIUS centre’s document available to us.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accelerate the process of data access in the oil and gas domain</td>
<td>Data access</td>
</tr>
<tr>
<td>2. Transfer knowledge &amp; expertise via feedback loop in the innovation cycle</td>
<td>Expertise</td>
</tr>
<tr>
<td>3. Transform end-user work practices</td>
<td>Transformation</td>
</tr>
<tr>
<td>4. Deliver scalable Information System to access disparate data sources</td>
<td>Information systems</td>
</tr>
<tr>
<td>5. Deliver a scalable, efficient and robust computational environment</td>
<td>Efficient computation</td>
</tr>
<tr>
<td>6. Reinforce mutual understanding and shared vision</td>
<td>Shared vision</td>
</tr>
<tr>
<td>7. Establish SIRIUS as an internationally recognised centre of excellence</td>
<td>Growth</td>
</tr>
<tr>
<td>8. Implement prototype in industrial pilots &amp; research results in commercial products of SIRIUS partners.</td>
<td>Prototyping</td>
</tr>
<tr>
<td>9. Identify constraints in existing tools; identify opportunities for changes in work practices. Demonstrate use of tools of partners in prototypes.</td>
<td>Identify partners’ constraints</td>
</tr>
</tbody>
</table>

---

84 SIRIUS, ‘SIRIUS Annual Report 2016’.
10. Identify technical, social and cognitive barriers to use of technology. Identify ways to assess operational uncertainties.

11. Integrate access to text, semi-structured and streaming data. Allow scalable access to large volumes of data, such as seismic data. Allow scalable access to real-time streams of sensor data.

12. Make complex data accessible through end-user interfaces. Reduce the cost and risk of maintaining and changing systems.

13. Allow scalable processing and storage of big volumes of data. Process real-time streams of sensor data and exploit affordable hardware platforms.


15. Attract additional funding (e.g. from EU programmes). Influence future research directions and funding policy. Influence society on big data, data access and digitalisation.

16. Set up a PhD track that combines research and industry skills. Influence the international research community.

### 11.2.2 Governance & Structure

**Governance**

**General Assembly (GA):** The central and top-most governing body of SIRIUS centre is named the General Assembly and it makes the final decisions on behalf of the centre. It is a representation of the high-level officials of each partner of the centre.

---

Figure 26: SIRIUS general governance structure

The Strategy Board (SB): Chaired by the Centre Leader of SIRIUS, the SB with its observers is composed of the Deputy Centre Leader, Operations Manager and Scientific Coordinator, the Faculty Research Strategist, Pilot Strategy Coordinator and the Intellectual Property Manager, the Mentor and Education Coordinator as well as the leader of the Strategy Work-package. It is the responsibility of the SB to draw the strategic plan of the centre used in approving projects at the centre.

Table 46: Summary of Governance of SIRIUS

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The General Assembly consisting of high-level officials of the centre and of its centre partners</td>
<td></td>
</tr>
<tr>
<td>a. GA makes the final decisions for the centre.</td>
<td>Decision-making GA</td>
</tr>
<tr>
<td>b. The members are Centre Leader, the Operations Manager and perhaps includes members drawn from Strategy Board, Strand and Work Package groups, Administration Managers (i.e. Project Managers and Project Steering Committees)</td>
<td></td>
</tr>
<tr>
<td>2. The Strategy Board draws the strategic plan of the centre used in approving projects at the centre</td>
<td>Strategic board</td>
</tr>
<tr>
<td>3. The Strategy Board is composed of Centre Leader Deputy Centre Leader, Operations Manager and Scientific Coordinator, the Faculty Research Strategist; Pilot Strategy Coordinator and the Intellectual Property Manager, the Mentor and Education Coordinator.</td>
<td>SB composition</td>
</tr>
</tbody>
</table>

Structure

Operations Board / Centre Management: The Operations Board (or Centre Management team) is chaired by the Operation Manager, is responsible for the day-
to-day operations of the centre – making the plans for project works as well as the implementation of the decisions of the Strategy Board. Operations Board consists of the Centre Leader, Administration Manager, Mentor and Education Coordinator, Work Package Leaders and Strand Leaders.

Table 47: Summary of Structure of SIRIUS

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Operation Board takes care of the daily operations of the centre from project planning to implementation of the decision of the strategy board</td>
<td>Operation board’s role</td>
</tr>
<tr>
<td>2. The operation board is composed of the Centre Leader, Administration Manager, Mentor and Education Coordinator, Work Package Leaders and Strand Leaders.</td>
<td>Operation board’s composition</td>
</tr>
</tbody>
</table>

11.2.3 Funding

SIRIUS finances its research activities through funds obtained from public funding sources for basic research and funding from its industrial partners in an eight-year programme of industrial, research-based innovation. It could be taken for granted that some of the PhD positions in SIRIUS Centre are funded by the Faculty of Natural Sciences, University of Oslo but these programmes are restricted to the area of applied logic and semantic technologies.

Table 48: Summary of Funding of SIRIUS

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SIRIUS funds come from both public funding sources for basic research and funding from its industrial partners in an eight-year programme</td>
<td>Public &amp; research funding sources</td>
</tr>
<tr>
<td>2. Generic components resulting from laboratory works are funded by Research Council of Norway.</td>
<td>Main funding source</td>
</tr>
<tr>
<td>3. SIRIUS undertakes EU FP7 projects deriving funds from its works.</td>
<td>FP7 project funds</td>
</tr>
<tr>
<td>4. SIRIUS gets funding from the University of Oslo for some of its PhD positions.</td>
<td>Funds from training programmes</td>
</tr>
<tr>
<td>5. The Innovation Forum attracts membership registration fee and companies and individuals can participate</td>
<td>Forum membership registration fee</td>
</tr>
<tr>
<td>6. The University of Oslo funds the infrastructure used by SIRIUS⁸⁷</td>
<td>Infrastructure funding</td>
</tr>
</tbody>
</table>

11.2.4 Culture and Outreach

**Culture**

SIRIUS’ **Onboarding** programme is a cultural practice aimed at providing new in-takes a detailed orientation experiences and support to adjust to the all-inclusive working environment. The process is well structured and documented and consistently implemented for all hires whereby each new hire is assigned to a ‘buddy’, typically a post doc or a PhD student. With the first 3 months of entry, the buddy is responsible for supporting and guiding the hire to understand life at SIRIUS: the day-to-day activities of working at SIRIUS, culture and connection, organizational structure, the department, mentoring and educational programs, introduction to co-workers and partners and information sources. This practice strengthens and contributes to SIRIUS culture and social working environment.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. SIRIUS’ Onboarding programme is a cultural practice aimed at providing new in-takes detailed orientation experience and support to adjust to the working environment.</td>
<td>Culture</td>
</tr>
<tr>
<td>4. Under Onboarding, an assigned ‘buddy’ (a Post-doc or a PhD student) offers orientation and mentor support to a new in-take</td>
<td>Culture</td>
</tr>
</tbody>
</table>

**Outreach**

SIRIUS Centre targets three outreach areas to disseminate information.

1. **Academic community:** aggressive promotion is employed to disseminate information to attract collaboration with international research community.

2. **Industry:** Besides partners, dissemination activities directed at other industry players are to ensure the widest uptake of SIRIUS’ outputs. Typically, SIRIUS engages with relevant target groups, including industry-based researchers and potential users of SIRIUS’ technologies in national and international meetings, industry fairs and industry seminars. It also arranges tutorials and training courses addressing industry needs.

3. **National and international meetings:** The activities in this group include presentations in conferences and seminars e.g. Semantic Technology Conference (SemTech) in San Jose, California; industry seminars such the BAE systems, IBM, Microsoft, Oracle, Samsung and Statoil seminars.

---

For the success of gender equality initiative, SIRIUS joined the *Oda-Nettverk* – an organisation that is Norway’s leading women IT network. Securing membership in this network is seen as an outreach strategy to bring appealing messages of science and technology to the female gender and to entice them to take up positions in SIRIUS. Furthermore, the centre uses dedicated work package on outreach to make visible how the innovations in SIRIUS bring major impact and contribute to more efficient exploration and safer operations, and thereby a cleaner and more sustainable Oil & Gas sector 89.

**Table 50: Summary of Outreach of SIRIUS**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Major areas covered by dissemination activities include:</td>
<td>Outreach</td>
</tr>
<tr>
<td>a. <em>Academic community</em>: promotions to attract researchers for collaboration</td>
<td>Outreach</td>
</tr>
<tr>
<td>b. <em>Industry</em>: activities to ensure that companies adopt SIRIUS’ results.</td>
<td>Outreach</td>
</tr>
<tr>
<td>c. <em>National and international meetings</em>: presentations in conferences &amp; seminars e.g. Semantic Technology Conference (SemTech) &amp; industry seminars, membership in Big Data Value Association (BDVA), Subsea Valley Conference, etc.</td>
<td>Outreach</td>
</tr>
<tr>
<td>2. SIRIUS’ membership in the <em>Oda-Nettverk</em> is an outreach strategy to attract females to science and technology and to accept positions in SIRIUS</td>
<td>Outreach</td>
</tr>
<tr>
<td>3. It uses dedicated work package on outreach to make the centre’s innovations visible and to show major impacts on efficient, cleaner, safer and sustainable exploration operations in the Oil &amp; Gas sector.</td>
<td>Outreach</td>
</tr>
</tbody>
</table>

**11.2.5 Capabilities**

**People**

Being both training and science research focused, developing solutions for industry uses, SIRIUS centre assembles students and researchers from three groups at the University of Oslo. Since 2016, the aim has been to build a common team identity through the creation of an enabling environment using regular lunch seminars to which partners’ representatives have also been invited. The result of this team development strategy has been found successful in the first two quarters of 2017.

---

**Mentoring Programme:** This is a one-on-one programme whereby a mentor facilitates the development of a mentee in order to contribute to the professional and personal development of both mentees and mentors. Expanded objectives include to:

- Offer each researcher a personalised development strategy and to train future research leaders in academia or industry.
- Shape SIRIUS centre identity by exchanging expertise, values, skills, perspectives, and attitudes through networking.
- Increase *mutual understanding between SIRIUS, industry and academia to foster collaboration, engagement, and build career competence on both sides* of the mentoring relationship.
- Promote and harness the full potential of diversity in SIRIUS – that is, culture, age, gender and expertise.

**Equal Opportunity:** The mentor program above is designed to train and promote future female research leaders giving attention to female mentees to occupy as many as 68% positions in the 2017/2018 mentoring program. To support sustainability and quality mentorship, SIRIUS established collaborative relationship with *Oda-Nettverk*: Norway’s leading women IT network just to provide access to a wider female network for SIRIUS IT women.

**Table 51: Summary of People of SIRIUS**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SIRIUS centre assembles students and researchers from three groups at the University of Oslo.</td>
<td>People</td>
</tr>
<tr>
<td>2. <strong>Regular lunch seminars:</strong> through this seminar since 2016, the centre is building a <em>common team identity</em> consisting of students, researchers &amp; partner’s reps by creation of an enabling environment</td>
<td>People</td>
</tr>
<tr>
<td>3. SIRIUS provides Norwegian language training for our workers aside of the normal technical expertise training.</td>
<td>People</td>
</tr>
<tr>
<td>4. SIRIUS provides a range of international media news e.g. the Economist, Harvard Business Review etc. for employee’s awareness in relevant domain developments.</td>
<td>People</td>
</tr>
</tbody>
</table>
| 5. **Mentorship programme:** is personalised for each intake of students and researchers.  
  a) Mentor-mentee matching is based on their profiles.  
  b) Mentors are industry leaders drawn from SIRIUS’ partners | People |

---


6. **Gender equality:** Mentorship programme is design to support females in IT supported by collaboration with Women IT network, e.g. *Oda-Nettverk*.

### Process

The Scientific Director of SIRIUS centre once stated in an interview:

> "My approach to research has always been driven by use cases and applications, despite being often viewed as an arch-theoretician. Theory should be the servant of applications. Theory enables us to specify precisely what an application is supposed to do and verify that it actually does it – i.e., that the content of the tin corresponds to the label."\(^\text{92}\)

This statement underpins the centre methodology in research endeavours. Thus SIRIUS Lab has developed a user-centric methodology with which the centre approaches it tasks.

![Figure 27: SIRIUS Innovation Cycle](image)

**The Scalable Innovation Cycle (SIC)** is an innovation cycle methodology that enables SIRIUS to engage in user-led innovations for quick generation of ideas and for validation of results (Figure 27). The iterative, three-stage process is used in combination with a shared laboratory (as its core). The method, takes its root from the recent insights from innovation studies design to overcome the gap between end-user’s needs and cutting-edge IT research and development.

---

\(^{92}\) Ian Horrocks is the Scientific Director of SIRIUS centre. This was Ian’s response an interview taken from SIRIUS Annual Report of 2016.

\(^{93}\) Excerpt from SIRIUS Annual Report, 2016, page 15.
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

All work in SIRIUS is aligned with end-user-centric methodology and the innovation cycle; in other words, research is done through either laboratory or innovation projects, depending on the scope of projects and intellectual property requirements. The granularity of innovation cycle involves processes categorised under: Experiments, Prototypes, Pilots and Intellectual Property. The practice of the Innovation Cycle demands that project work packages are designed to combine cutting-edge research with real-world deployment to meet real business problems. The methodology requires an iterative feedback loop between pilots, prototypes and experiments to identify new challenges and gaps in current solutions that could be upgraded by targeted research and development actions \(^94\). The SIC categorised procedures and processes include:

2. **Experiments**: Within this scope, software components (a combination of generic & open-source tools with vendors’ software technologies) and methods are developed, configured & evaluated in laboratory

3. **Prototyping**: Basically involves activities within partners’ products: implementing access to new information sources, using semantic technologies as an integration middleware, developing novel approaches that reduce the cost of owning the products & improving deployment models and software scalability through use of cloud storage & processing. Tasks include tracing and optimising the complex interplay between technology and work practices.

4. **Pilots**: Partner or problem owner sets the agenda of pilots that are software demonstrators and methods developed by SIRIUS centre to solve real business problems.

5. **Intellectual Property**: The guiding principles for managing IP – results from laboratory activities are automatically defined as laboratory results of which the generic components are **funded by the Research Council of Norway** and are therefore released using one of two suitable open-source licenses (LGPL or Apache). Using any of these licenses permits free integration, as-is, with proprietary software.

Table 52: Summary of Process of SIRIUS

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The <strong>Scalable Innovation Cycle (SIC)</strong> – an iterative, three-stage process; innovation cycle methodology) enables SIRIUS to engage in user-led quick generation of ideas &amp; validation of results.</td>
<td>Process</td>
</tr>
<tr>
<td>2. Works in SIRIUS are aligned with end-user-centric methodology and the innovation cycle; i.e., research is done either in lab or through innovation projects</td>
<td>Process</td>
</tr>
<tr>
<td>3. <strong>SIC</strong> demands project work be designed to combine research with real-world deployment to meet real business problems</td>
<td>Process</td>
</tr>
<tr>
<td>4. <strong>SIC</strong> requires an iterative feedback loop between pilots, prototypes &amp; experiments to identify new challenges &amp; gaps</td>
<td>Process</td>
</tr>
</tbody>
</table>

\(^94\) SIRIUS, ‘SIRIUS Annual Report 2016’. 
5. SIC categorised processes include experiments, prototypes, pilots and IP processes.

6. SIRIUS uses two licences – the LGPL or Apache; and the use of any of these licences permits free integration of ‘as-is’ situation with proprietary software.

**Infrastructure**

As a solution to the challenge arising from the huge demand of computing resources by the algorithms used to access data and analyse data, SIRIUS has developed a term to describe its infrastructural power: Scalable Computing is a term defines the provision of the right computing resources to give users the answers they need quickly, when they need them and without delay. Furthermore, successful piloting of scalable computing methods for data access requires that they run fast enough to provide answers within the user’s limits of patience; in other words, scalable data access needs scalable, high-performance hardware, networks and memory. The Scalable Computing methods is a combination of the High-Performance Computing strand (tools, research areas & hardware) and the Cloud Computing strand at SIRIUS Lab.

The SIRIUS’ accommodation provides workstations for all University of Oslo researchers and visiting researchers from partners and collaborating institutions. The centre has developed intellectual property model designed to support open knowledge on which commercial solutions can be built.

**Table 53: Summary of Infrastructure of SIRIUS**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SIRIUS’ open knowledge intellectual property model supports commercial solutions development</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>2. Has dedicated premises in the Department of Informatics at the University of Oslo that provides workstations for all researchers from partners and collaborating institutions.</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>3. Shared laboratory is central (core) to the operations of SIRIUS</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>4. <strong>Scalable Computing</strong> is the provision of the right computing hardware resources to provide quick answers challenges. It combines High-Performance Computing strand with the Cloud Computing strand</td>
<td>Infrastructure</td>
</tr>
</tbody>
</table>

**11.2.6 Collaboration**

---

^95^ SIRIUS, ‘SIRIUS Annual Report 2016’. 
From the business impact viewpoint, SIRIUS discovered that finding and accessing high volumes of data can improve the organizational effectiveness of companies in the oil and gas industry because by implementing new digital tools and systems that aid access to, and manipulation of data, companies empower their employees to work more effectively and make better decisions at speed. The obstacle to the above is that companies will not benefit from the data if the tools are not used and this is in agreement with a study which concluded that up to 75% of all implementation efforts fail to deliver desired results (ibid). Consequent upon the above, SIRIUS work Practices are designed to help partner companies optimize their adoption of the novel technologies developed within the centre by building upon research methods, concepts and experiences from digital transformation processes in organizations using these methods to inform technology implementation, adoption, and use. SIRIUS Lab collaborates with both technology developer and technology user organisations under two methods:

**Method 1:** Reliance on demands and requirements arising from client’s dissatisfaction of the performances of its existing solution,

**Method 2:** Applying the methods for implementation processes evaluation, SIRIUS creates prototypes of the technologies developed by SIRIUS’ partners. This is then used to generate feedback from actual use in order to inform the process of modifying and adjusting the technology to practical needs.

In SIRIUS Lab the European Union project programme such example the EU FP7 are undertaken. Such projects, characterised by outstanding international networks and tight collaboration between academia and industry, have led to potential breakthroughs in key scientific domains for SIRIUS and also for on-going efforts to create spin-offs. By collaborating with industry partners to identify new and relevant research problems or questions, SIRIUS centre gains opportunity not only to do excellent research but also to influence the international research agenda.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SIRIUS engages on both national and international collaborative projects</td>
<td>Collaboration</td>
</tr>
</tbody>
</table>

---

2. SIRIUS collaborates with both tech developer & technology user organisations under two methods:
   a. Reliance on demands and requirements arising from partner’s dissatisfaction with existing solution
   b. Creation of prototypes of partner’s existing solutions; use prototypes to generate feedback from actual use in order to understand how to upgrade the solution

3. Also collaborate with women IT network in support of females in IT, e.g. Oda-Nettverk.

4. The main scientific collaborators or host academic entities of SIRIUS are the University of Oslo, NTNU, University of Oxford and Similar Research Laboratories where most of SIRIUS Lab researchers come from.

5. It participates in the EU FP7 & project series in collaboration with academia and industry partners

6. SIRIUS collaborates with industry partners to identify new & relevant research problems in order to influence the international research agenda.

### 11.3 Impact

SIRIUS participates in European Union FP7 project programmes in collaboration with academia and industry, and have led to potential breakthroughs in key scientific domains for SIRIUS and the create spin-offs. \(^98\)

**Table 55: Summary of Impacts of SIRIUS**

<table>
<thead>
<tr>
<th>Area</th>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
</table>
| Economic | 1. Under EU FP7 research projects in collaboration with academia and industry, SIRIUS has produced potential breakthroughs in key scientific domains as well as in the bid to create spin-offs.  
2. SIRIUS work Practices are designed to help partner companies optimize their adoption of technologies developed within the centre |          |
| Societal | 4.                                                                                                                                                                                                     |          |

\(^{98}\) SIRIUS, ‘SIRIUS Annual Report 2016’. 
11.4 Challenges and Critical Success Factors

11.4.1 Challenges

In its broadest sense, SIRIUS envisions three gaps existing between Information Technology (IT), Academic IT and Business problems (Figure 28). Rearranged further, SIRIUS leaders think that the gaps actually situate between IT (academic and commercial) and business problems with additional problems of research into these domains. The concerns of SIRIUS centre therefore, is how to bridge these gaps which essentially culminate into the challenges faced by the centre aside of its limited resources.

Despite planning to improve activities, scientific content and to upgrade the centre infrastructure, SIRIUS still faces challenges that need to be taken seriously:

1. The important partners are located in Stavanger and Bergen. This physical remoteness limits easy access to each other and hence the barrier must be reduced to improve interaction between them for better understanding.
2. The second challenge is how to facilitate open discussion of technology and solutions in SIRIUS, considering the limited resources of each partner.
3. The capability to provide assurance to partners that SIRIUS centre will help them solve the improvement challenges that they seek.

---

4. The on-going struggle of matching business demand with technology supply. We want to present problems where this centre has viable and relevant capability to solve them. Furthermore, to do this, SIRIUS staff needs to understand what the capabilities are which again calls for the need to continue and expand the kind of structured dialogue that requires academics to try to set themselves into the mind-set of the problem owners.

“Recent falls in oil price and an awareness of the need for a green shift in the Norwegian economy raise the need to reallocate technical resources and knowledge from oil and gas to other economic sectors”\textsuperscript{102}. This shift of resource allocation may have affected SIRIUS and thus prompted the diversification of SIRIUS’ attention towards organising a portfolio of cross-domain projects by applying the scalable data access methods in areas such as health, energy and public administration – giving room for possible cross-fertilization of ideas and methods between the oil and gas sector and health sector.

The use-case- and application-driven approaches to research investigation at SIRIUS centre present a couple of challenges\textsuperscript{92} in practice. First, it requires a huge range of skills, beyond the capacity of a single person or even a research group. The challenge is therefore to bridge between the people knowledge of application requirements and those with deep knowledge of theory. Second and based on the first, we need a “food chain” of at least three roles: the practical worker, the theoretical worker and the broker in the middle. Lastly, we have to make this process a two-way cycle.

\textbf{Table 56: Summary of Challenges of SIRIUS}

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical separation from important partners limits interaction and knowledge of themselves</td>
<td></td>
</tr>
<tr>
<td>2. How to facilitate a flowing, open discussion of technology and solutions between SIRIUS and partners</td>
<td></td>
</tr>
<tr>
<td>3. Capability to provide assurance to partners that SIRIUS centre will help them to solve their improvement challenges</td>
<td></td>
</tr>
<tr>
<td>4. The on-going struggle of matching business demand with technology supply which calls for the needs to understand: o what capabilities the centre possesses, and o the nature of partners’ challenges</td>
<td></td>
</tr>
<tr>
<td>5. How to bridge the knowledge gaps existing between academic IT, commercial IT with the associated research and business problems</td>
<td></td>
</tr>
<tr>
<td>6. The drop in oil price &amp; the campaign for green energy raise the need to reallocate technical resources and knowledge from oil and gas to other economic sectors have been a challenge for SIRIUS</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{102} SIRIUS, ‘SIRIUS Annual Report 2015’.

\textsuperscript{92}
7. The use-case- and application-driven approach present a couple of challenges:
   a. It needs a range of skills, beyond the capacity of a person or research group
   b. The need to bridge the gap between the people with knowledge of application and those with knowledge of theory.
   c. The need to find & combine expertise involving: the practical worker, theoretical worker and the mediator among them.
   d. Then need to make this process a two-way cycle

### 11.4.2 Success Factors

#### Table 57: Summary of success factors of SIRIUS

<table>
<thead>
<tr>
<th>Practice</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SIRIUS’ partners contribute their time (in-kind) to projects execution and that is essential to the success of the centre.</td>
<td>Partners’ contribution</td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
</tbody>
</table>

### 12 Appendix E: CoE Literature Overview

This appendix provides materials for further reading to gain additional or expanded knowledge of the Big Data Values Centres including academic (research)-industry collaboration that aids the transfer of knowledge developed in research centres.

Papers to include:


#### 12.1.1 The SAGE Handbook of Research Management

**IMPROVING YOUR RESEARCH MANAGEMENT**

---

**12.2 Survey of Material for Running Research Centres**

*Creation of Technical University Center of Excellence, Aleksey N, Kirill S, Irina N, Nikita V, 2015*


The paper outlines the experience of organizing a Center of Excellence at Tomsk Polytechnic University, goals to achieve in order to create a Center and its work principles. The key idea for Centres of Excellence is a deep connection between scientific and educational processes. This idea is put into practice by integrating the information on state-of-the-art achievements in different fields of science in curriculum.

*Participation in university-based research centers: Is it helping or hurting researchers?, Meghna Sabharwal and Qian Hu, 2013*


This paper examines how affiliation with a research center in the United States can impact research productivity, collaboration, and careers of faculty members in the multidisciplinary field of learning sciences. This study utilizes data from a curriculum vitae (CV) analysis of 402 faculty members who are employed at research universities. The results indicate that, on average, the research productivity of faculty members affiliated with a research center is higher than non-center affiliated faculty members. The effects, however, disappear when controlling for factors such as years since Ph.D., gender, post-doctoral status, quality of publications, and quantity of other research outputs. Senior tenured faculty members appear to benefit greatly from affiliation with a research center, while center affiliation does not positively correlate with the productivity of junior faculty members.

*Developing an Analytics Center of Excellence, Charles D. Kincaid, Experis Business Analytics Practice, Portage, MI, 2012*


The paper gives insight into some of the challenges of building an Analytics Center of Excellence and guidance in ways to overcome them.

*Influencing scientists’ collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital, Branco L. Ponomariov, P. Craig Boardman, 2010*

The paper analyzes the effect of university research centers on the productivity and collaboration patterns of university faculty. The paper measures the productivity and collaboration patterns of university researchers affiliated with a relatively large-scale and “mature” university research center to discern the effects, if any, of the center mechanism on individual scientists and engineers. Based on an analysis of longitudinal bibliometric data, the results from this case study demonstrate affiliation with the center to be effective at enhancing overall productivity as well as at facilitating cross-discipline, cross-sector, and inter-institutional productivity and collaborations.

Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers, P. Craig Boardman, 2009


This paper uses data from a national survey of academic researchers in the US to detect how different types of university research centers affect individual-level university–industry interactions. The analysis takes the “scientific and technical human capital” approach, which draws from theories of social capital and human capital and proves useful for framing the institutional and resource-based perspectives that characterize much of the literature on university–industry interactions. The paper discusses also the implications for policy and management as well as for future applications of the scientific and technical human capital approach.

RESEARCH CENTER MANUAL: Starting and Operating a Georgia Tech Research Center, GEORGIA INSTITUTE OF TECHNOLOGY, 2006


This report provides a resource for those interested in starting a new research center with industry memberships, as well as for current Center Directors and management of research centers with industry memberships. This manual includes a description of the process for starting such a center along with the necessary approval procedures. It provides ideas and best practices for organizational structure, financial management, industry relations, marketing, and advisory boards. The report also provides some suggestions on education, outreach, diversity, and knowledge transfer and commercialization programs found in the appendices. Special cases such as partnering with other universities to form centers and the “Umbrella Center” concept are also noted and discussed.

Policy learning in Swiss research policy—the case of the National Centres of Competence in Research, Dietmar Braun, Martin Benninghoff, 2003

The article tackles the problem of “rationality” in learning processes in research policies. The paper takes as example the setting-up of the “National Centres of Competence in Research” (NCCR) in Switzerland and analyses the processes that have contributed to the acceptance of this funding measure. The finding is that Switzerland has introduced some “rationalising devices” but that these devices are still insufficiently institutionalised and can be further elaborated. In addition, it is made clear that goal-oriented problem-solving and interests are closely intertwined and cannot be dissociated from another. This may have distorting effects on the rationality of the learning process.

**Centres of Excellence as a Tool for Capacity Building, Tomas Hellström, 2013**


This synthesis report of the CoE study presents an overview of the CoE concept for research funding and capacity building in research for developing countries. It provides a framework for the description and analysis of CoE schemes to support the selection of such schemes. This report also provides an overview and detailed empirical accounts of 12 CoE schemes, following this analytical framework, and analyses these schemes in terms of capacity building in developing countries.

**In Search of Centre of Excellence: Network Embeddedness and Subsidiary Roles in Multinational Corporations, Ulf Andersson and Mats Forsgren, 2000**


In this paper the authors explore the role of a subsidiary as a centre of excellence within the multinational corporation (MNC). It is argued that such a role can be based on the characteristics of a subsidiary's internal resources, its relationships with the rest of the MNC and the business context of which the subsidiary is a part. Through an analysis of 98 subsidiaries the importance of the subsidiary's embeddedness, in terms of business relationships with specific customers and suppliers for its role as a centre of excellence, is investigated.

**Knowledge development and sharing in multinational corporations: The case of a centre of excellence and a transnational team, Maria Adenfelta, Katarina Lagerströmb, 2006**


The paper explores the impact of different organisational mechanisms on knowledge development and sharing. Using case-study data to explore two different organisational mechanisms, a Centre of Excellence and a transnational team, the findings illustrate how multifaceted knowledge development and sharing are. The organisational structure of the two organisational mechanisms partly determines whether knowledge development occurs locally or globally.
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

Centres of Excellence in Multinational Corporations, Tony S. Frost, Julian M. Birkinshaw, Prescott C. Ensign, 2002


This paper seeks to understand the conditions under which ‘centers of excellence’ emerge in foreign subsidiaries of multinational firms. Drawing on overlapping research in international business and strategic management, authors argue that the formation of centers of excellence is shaped by conditions in the subsidiary’s local environment as well as by various aspects of the subsidiary’s relationship with other parts of the multinational firm. Based on a survey of 99 foreign units in Canada, the results highlight the fundamental role played by parent firm investment as well as the role of internal and external organizations in the development of subsidiary capabilities. Performance implications of the center of excellence phenomenon are also explored.

Making a difference? Evaluating an innovative approach to the project management Centre of Excellence in a UK government department, Tim O’Leary, Terry Williams, 2008


This paper presents a case study of an innovative approach to the introduction of a CoE for IT-enabled change projects that includes a central team of highly skilled, experienced managers to intervene directly as required in problematic projects. The positive impact of this approach is compared with that of a previous conventional CoE focused mainly on ‘best practice’ process implementation, where no direct impact could be seen.

Regionalizing “mode 2”? The adoption of centres of excellence in Swedish research policy., Lundequist, Per, and Anders Waxell., 2010


By using Sweden as an example and providing an overview and critical discussion concerning Swedish research policy during the period 2001 to 2007 the paper shows that the rhetoric within research policy has changed and become increasingly intertwined with innovation policy. In practice, however, this is not as evident. The study draws on (a) an analysis of policy literature pointing out regulatory and organizational changes concerning the increasing emphasis on linking research to competitive industrial milieus, and (b) a comprehensive database including 110 CoEs, presenting a detailed picture of university-industry collaboration, cross-disciplinarity, and prioritized sectors. Authors find that the CoEs account for a relatively small share of government funding, but may however have a strengthening impact on particular research milieus and industries, especially in the life sciences.

Persistent factors facilitating excellence in research environments, Evanthia Kalpazidou Schmidt and Ebbe Krogh Graversen, 2017
The paper maps both internal elements and those in the framework of the environments that influence research performance and identifies persistent factors in dynamic and innovative research environments, using a model for studies of research environments that was constructed and used in the Nordic countries. The findings add how to improve the overall ecology of knowledge production and create optimal conditions that support research environments in pursuing and ensuring excellence. Implications for further research and policy are discussed.

The Organisational Embedding Of Expertise: Centres of Excellence, Harald A. Mieg, 2014

The paper introduces research on embedded expertise in the case of centres of excellence; it integrates and generalises findings from research on excellence within three domains: (1) elite sport; (2) the institutionalisation of environmental science expertise in Switzerland; (3) top inventors. The core part of the paper is conceptual, defining institutional levels of embedded expertise and different logics for the selection of excellence. From this empirical and conceptual base, the paper draws lessons for centres of excellence and reviews their various strategies.

12.3 Survey of Material for Running Networks of Research Centres

The materials hereunder provide additional knowledge on how to manage Big Data Centres for optimum result.

How complex international partnerships shape domestic research clusters: Difference-in-difference network formation and research re-orientation in the MIT Portugal Program, Mackenzie D. Hird and Sebastian M. Pfotenhauer, 2017

The paper proposes a novel approach to study the impact of complex international capacity-building partnerships as an emerging policy tool at the crossroads of research policy trends. Authors combine bibliometric network analysis with difference-in-difference program evaluation, statistical matching techniques, and system architecture analysis to evaluate complex research partnerships. They apply their method to one national flagship policy initiative – the MIT Portugal Program – where they compare program participants to a carefully assembled peer group of non-participant Portuguese researchers to assess the impact of MIT-Portugal with regard to idiosyncratic, more structurally oriented, and arguably less conventional program goals.
D4.1: Network of National BDV Centres of Excellence Best Practice Guide

Knowledge acquisition and complementary specialization in alliances: The impact of technological overlap and alliance experience, Korcan Kavusan et al., 2016


The paper examines how technological overlap and alliance experience – widely recognized antecedents of external knowledge utilization – influence the extent of knowledge acquisition and complementary specialization in alliances. The analyses of 841 two-partner technology alliances within the ICT industry indicate that alliances between firms with moderate-to-high degrees of technological overlap favor high levels of knowledge acquisition across partnering firms while alliances among firms sharing either low or high levels of technological overlap are well-suited for complementary specialization.

The role of interpartner dissimilarities in Industry-University alliances: Insights from a comparative case study, Isabel Estrada, 2016


The paper examines the role of interpartner dissimilarities in Industry-University (IU) alliances. Authors propose a conceptual distinction between routine-based dissimilarities (differences in partners’ behaviour) and orientation-based dissimilarities (differences in partners’ goals and expectations), illuminating their joint implications for collaborative processes and outcomes over time.

The direction of firm innovation: The contrasting roles of strategic alliances and individual scientific collaborations, Jan Hohberger et al., 2015


The paper derives hypothesis on the role of R&D alliances and individual scientific collaborations in influencing a firm’s innovative direction and its position relative to the industry’s innovation focus. The analyses of patent and alliance data show that biotechnology firms that rely on external individual scientific collaborations are likely to grow closer to the future focus of innovation, while firms that emphasize R&D alliances grow more distant from the future industry focus.

International research networks in pharmaceuticals: Structure and dynamics, Uwe Cantner and Bastian Rake, 2014


The paper studies cross-country research networks. Based on a unique dataset of scientific publications related to pharmaceutical research and applying social network analysis, authors find that both the number of countries and their connectivity increase in almost all disease group specific networks. The cores of the networks consist of high-income OECD countries and remain rather stable over time. Using network regression techniques to analyze the network dynamics the results indicate that accumulative advantages based on connectedness and multi-
connectivity are positively related to changes in the countries’ collaboration intensity.

**Co-authorship networks and research impact: A social capital perspective**, Eldon Y. Li, 2013


The paper proposes the use of social capital embedded in a social structure is an effective way to achieve more research impact. The contribution of this study is to define six indicators of social capital and investigate how these indicators interact and affect citations for publications. A total of 137 Information Systems scholars from the Social Science Citation Index database were selected to test the hypothesized relationships. The results show that betweenness centrality plays the most important role in taking advantage of non-redundant resources in a co-authorship network, thereby significantly affecting citations for publications.

**When birds of a feather don’t flock together: Different scientists and the roles they play in biotech R&D alliances**, Annapoornima M. Subramanian et al., 2013


The paper examines the heterogeneity within the firm's scientific human capital, emphasizing the distinct role of ‘bridging scientists’ who engage in two related but dissimilar scientific activities: patenting and publishing. Using a panel dataset of 222 firms in biotechnology between 1990 and 2000, authors show that bridging scientists have a positive and significant impact on patent performance relative to other scientists within the firm.

**Learning dynamics in research alliances: A panel data analysis**, Tomaso Duso et al., 2010


The paper empirically tests the determinants of Research Joint Ventures’ (RJVs) group dynamics. Authors develop a model based on learning and transaction cost theories, which represent the benefits and costs of RJV participation, respectively. According to the proposed framework, firms at each period in time weigh the benefits against the costs of being an RJV member.

**A hidden cost of strategic alliances under Schumpeterian dynamics**, Jeho Lee et al., 2010


Recently, proponents of interfirm R&D collaboration have emphasized its benefits. The paper develops a model of Schumpeterian competition to examine the long run benefits of interfirm R&D collaborations. Authors find that such collaborations are
more likely to be a losing strategy when partners decide to reduce R&D costs. On the other hand, success factors include partners’ synergy in accessing each other's complementary assets/capabilities. The study suggests that firms should not use strategic alliances merely to reduce R&D costs in a catch-up situation or to avoid head-on competition with rivals.

**An empirical investigation of knowledge management and innovative performance: The case of alliances, Xu Jiang and Yuan Li, 2009**


This paper examines inter-firm collaborations and the implications of strategic alliances on knowledge sharing and creation using knowledge management practices. The analysis of 127 German partnering firms shows that joint ventures as opposed to contractual alliances are more effective and influential in facilitating knowledge sharing and creation. On the other hand, the scope of alliance activities has no direct impact on knowledge creation. Furthermore, the study also finds that knowledge sharing, knowledge creation and their interaction significantly contribute to partner firms’ innovative performance.

**University research centers and the composition of research collaborations, P. Craig Boardman and Elizabeth A. Corley, 2008**


The paper studies the research centers attributes that facilitate the research collaboration at the individual level. More specifically, the paper looks at how affiliations of researchers affects their collaborative behaviours. Indicators that used in this paper include the center multidisciplinarity, size, and center ties to private firms and to federally funded centers programs on the time allocated to collaboration with researchers from industry, other universities, government laboratories, and abroad. The analysis compares center to non-center scientists and also addresses within-group differences among center scientists. The findings demonstrate some center-level attributes to map to the expected collaborative behaviours while other center-level attributes do not.

**Technological flows and choice of joint ventures in technology alliances, Esteban García-Canal, 2008**


This paper analyses the influence of technological flows in the choice of joint ventures as a governance form of technology alliances, using a theoretical framework based on Transaction Costs Economics and the Economics of Intellectual Property Rights. Authors argue that the formation of a joint venture is only necessary in situations for which technological flows make the monitoring of alliance activities and the distribution of cooperation rents difficult. Authors’ hypotheses have been confirmed using a sample of technology alliances created by companies from the European Union between 1992 and 1999.
Where do alliances come from?: The effects of upper echelons on alliance formation, Jerry W. Kim and Monica C. Higgins, 2007

The paper builds on existing organizational research examining the effect of upper echelons on attracting powerful intermediaries to understand how young biotechnology firms create alliances with established organizations. Authors test hypotheses regarding the extent to which young firms and partners match along specific homophily dimensions. Their findings from an event-history analysis of 3,200 career histories of managers who took biotechnology firms public between 1979 and 1996 show that alliance formation is related to status homophily and role-based homophily between young and established organizations.

Termination outcomes of research alliances, Jeffrey J. Reuer and Maurizio Zollo, 2005

The paper examines how alliance experience accumulation at the parent firm level and alliance features at the transaction level jointly and interactively shape the favorability of research alliances’ termination outcomes. Fifteen percent of the examined terminated alliances were successful, 34% were failures, and 51% experienced an intermediate outcome. Authors found that the effect of partner-specific experience on the favorability of termination outcomes is greater for non-equity alliances than for equity structures affording stronger formal governance mechanisms. Furthermore, authors find evidence in partial support of both evolutionary and transaction cost based arguments for the explanation of termination outcomes in research alliances.

Technological globalisation and innovative centres: the role of corporate technological leadership and locational hierarchy, John Cantwell and Odile Janne, 1999

The paper analyses the data on patents granted in US to the largest EU owned firms for research carried out in EU locations. The results confirmed that multinational corporations emanating from the most important locations in their industry are more likely to evolve towards technological strategies of geographically differentiating their innovative activities abroad. Furthermore, multinational corporations originating from weaker centres in the same industry tend rather to evolve towards a strategy of replicating in the profile of their technological development abroad the pattern of their home country specialisation.
12.4 Academic Industry Collaboration

The material provided here are specifically dealing with academic/research centre collaboration with industry participants. They provide further knowledge on the synergy that can be harnessed to create values for both participants in the collaboration partnership.


http://dx.doi.org/10.1016/j.scaman.2015.02.003.

Abstract: Universities-industry collaboration is increasingly viewed as a means to enhance innovation through knowledge exchange as result of significant increase in studies that investigate the topic from different perspectives. Despite the above advantage of collaboration, this body of knowledge has not been given sufficient exposure and comprehensive review. This paper makes the move to address the gap, by employing a systematic procedure to review available literature on universities-industry collaboration (UIC). The result is an isolation of five key aspects, which underpinned the theory of UIC. The authors integrate these key aspects into an overarching process framework, and couple with the review, they provide a substantial contribution in form of an integrated analysis of the state of literature concerning the UIC concept.


Link: http://repository.cmu.edu/cgi/viewcontent.cgi?article=1287&context=sei.

Abstract: This is a preliminary business model for collaboration between universities and industrial partnerships in projects. The important aspects and dimensions of this model include the analysis result of data obtained through observation applied to public information and market research. The study was conducted nationwide. This model is the companies’ response to market demand. This model proposes a general framework for the creation of successful collaboration between universities and businesses. The industrial partners do not necessarily have all the competencies to perform each operation in-house for the development of competitive products. Therefore, collaboration with universities helps them in researching the problems that cannot be solved individually. In this sense, universities could be considered as partners for industries. The analysis undertaken shows that how the two entities, the university and industry collaborate, very much fits with the framework for collaboration shown. Although the open innovation model does not apply significantly and primarily in these entities, there is a high potential for its implementation and the creation of added value.
Link: http://dx.doi.org/10.1016/j.respol.2012.09.007.

Abstract: A considerable body of work highlights the relevance of collaborative research, contract research, consulting and informal relationships for university–industry knowledge transfer. We present a systematic review of research on academic scientists’ involvement in these activities to which we refer as ‘academic engagement’. Apart from extracting findings that are generalisable across studies, we ask how academic engagement differs from commercialisation, defined as intellectual property creation and academic entrepreneurship. We identify the individual, organisational and institutional antecedents and consequences of academic engagement, and then compare these findings with the antecedents and consequences of commercialisation. Apart from being more widely practiced, academic engagement is distinct from commercialisation in that it is closely aligned with traditional academic research activities, and pursued by academics to access resources supporting their research agendas. We conclude by identifying future research needs, opportunities for methodological improvement and policy interventions.

Link: http://dx.doi.org/10.1016/j.jbusres.2015.01.023.

Abstract: Technology Transfer Offices (TTOs) are the main institutions responsible for the establishment of university–industry partnerships. R&D contracts exemplify the indirect mechanisms through which enterprises and universities collaborate on a win–win basis. This study addresses organizational and institutional aspects that act as drivers for the establishment of successful university–industry partnerships. First, a series of regression models explain the determinants of R&D contracts. These models include two main dimensions: the university and the technology transfer office. Second, further analysis empirically explores whether universities in regions with a favorable environment enjoy greater active involvement in this particular knowledge transfer mechanism. The empirical study analyzes 2010 data for Spanish public universities. Results indicate that successful R&D contracts depend on university and TTO characteristics, and the university’s location. The paper also presents a set of managerial implications for improving the establishment of university–industry partnerships.

Citation: Lin, J.Y., 2015. Balancing industry collaboration and academic innovation: The contingent role of collaboration-specific attributes. Technological Forecasting and Social Change, 123, pp.216–228.
Link: http://dx.doi.org/10.1016/j.techfore.2016.03.016.
Abstract: This study highlights the effects of industry collaboration in enhancing academic innovation output. We exploit a unique longitudinal dataset on the 110 top U.S. research universities for the last 19 years. Our empirical findings confirm that the relationship between the number of industry collaborations and academic innovation is curvilinear. Moreover, we hypothesized and found that university contribution, collaboration breadth and knowledge capacity moderate the curvilinear relationship between the number of industry collaborations and academic innovation. Poisson, negative binomial and generalized negative binomial regressions are used to test the hypotheses in a panel data of 2090 university-year cases. Our results are robust to the three econometric methods, measures of variety of academic innovation and the findings support our prediction.

Citation: Edmondson, G. et al., 2012. MAKING INDUSTRY-UNIVERSITY PARTNERSHIPS WORK Lessons from successful collaborations. Business Innovation Board AISBL, pp.1–52.

Link: www.sciencebusiness.net/innovationboard

Abstract: Universities and industry have been collaborating for over a century, but the rise of a global knowledge economy has intensified the need for strategic partnerships that go beyond the traditional funding of discrete research projects. World-class research universities are at the forefront of pioneering such partnerships. They are designed to run longer, invest more, look farther ahead and hone the competitiveness of companies, universities and regions. In short, they transform the role of the research university for the 21st century, anchoring it as a vital centre of competence to help tackle social challenges and drive economic growth.

12.5 Instances of Big Data Centres of Excellence in Europe

Table below show selected BDCoE in European regions; the table also provides information categories.

Table 58: Examples of BDVCoE in Europe

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of centre and Centre focus</th>
<th>BDVA member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insight Centre for Data Analytics</td>
<td>The Insight Centre for Data Analytics is one of Europe’s largest data analytics research organisations, with 400+ researchers, more than 80 industry partners and over €100 million of funding. Insight is made up of four main centres: Insight@DCU, Insight@NUI Galway, Insight@UCC and Insight@UCD as well as a number of affiliated bodies. The organisation’s key areas of priority research include: Machine Learning &amp; Statistics, Semantic Web, Linked Data, Media Analytics, Optimisation &amp; Decision Analysis, Personal Sensing and Recommender Systems.</td>
<td>Full</td>
</tr>
<tr>
<td>Centre of Excellence</td>
<td>Description</td>
<td>Active in:</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>Digital Catapult’s Data Catalyser</td>
<td>The Digital Catapult’s Data Catalyser is a suite of services enabling organisations to create value from mixing closed datasets. This includes the provision of expertise, a secure platform or a secure physical environment.</td>
<td>IoT, Energy &amp; Environment, eGov, Smart Cities, Connected Health, Smart Enterprise</td>
</tr>
<tr>
<td>Deutsches Forschungszentrum für Künstliche Intelligenz</td>
<td>The German Research Centre for Artificial Intelligence is the leading German research institute in the field of innovative software technology. In the international scientific community, DFKI ranks among the most recognized “Centres of Excellence” and currently is the biggest research centre worldwide in the area of Artificial Intelligence and its application in terms of number of employees and the volume of external funds.</td>
<td>Smart Data &amp; Knowledge Services, Cyber-Physical Systems, Multilingual Technologies, Interactive Textiles, Robotics, Embedded Intelligence, Agents and Simulated Reality</td>
</tr>
<tr>
<td>Big Data Center of Excellence</td>
<td>Big Data CoE Barcelona provides tools, data sets and value-added Big Data capabilities to enable companies on defining, testing and validating Big Data models before its final implementation. The centre also offers training services for professionals looking for specialization within the field and a dissemination programme focused on showing trends and Big Data success cases to spread among businesses a new culture based on the value of the data.</td>
<td>Knowledge generation, Service provision for Big Data Value, Training, Dissemination</td>
</tr>
<tr>
<td>Smart Data Innovation Lab</td>
<td>SDIL bridges the gap between cutting-edge research and industrial big data applications. The Smart Data Innovation Lab (SDIL) offers big data researchers unique access to a large variety of big data and in-memory technologies. Industry and science collaborate closely to find hidden value in big data and generate smart data. Projects focus on the strategic research areas of Industry 4.0, Energy, Smart Cities and Personalized Medicine.</td>
<td>Yes (through membership of some core stakeholders)</td>
</tr>
<tr>
<td>Finnish Centre of Excellence in Computational Inference Research</td>
<td>The Finnish Centre of Excellence in Computational Inference Research (COIN) develops methods for transforming the data produced by the current data revolution into useful information. The key methodology for achieving this goal is statistical and computational inference based on the data. The emphasis is on large data collections and computationally demanding modelling and inference algorithms. The mission is to push the boundary towards both more complex problems, requiring more structured data models, and towards</td>
<td>None</td>
</tr>
<tr>
<td><strong>D4.1: Network of National BDV Centres of Excellence Best Practice Guide</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Consorzio Interuniversitario del Nord Est Italiano Per il Calcolo Automatico (Interuniversity Consortium High Performing Systems)</strong></td>
<td>extremely rapid inference. COIN brings in expertise on several different approaches to inference, with a unique opportunity to address the core computational challenges with combinations of machine learning, computational statistics, statistical physics, and constraint-based search and optimization.</td>
<td>Full</td>
</tr>
<tr>
<td><strong>Cineca</strong></td>
<td>Cineca is a non-profit Consortium, made up of 70 Italian universities*, 8 Italian Research Institutions and the Italian Ministry of Education. Today it is the largest Italian computing centre, one of the most important worldwide. With more than seven hundred employees, it operates in the technological transfer sector through high performance scientific computing, the management and development of networks and web based services, and the development of complex information systems for treating large amounts of data. Active in: High performance computing, Biotechnology, Nanoscience, Biomedicine</td>
<td>Full</td>
</tr>
<tr>
<td><strong>Teralab</strong></td>
<td>TeraLab is an initiative of two founding partners whose mission is to support the economic development by education, research and innovation. Institut Mines-Télécomand GENES, Groupe des Ecoles nationales d’économie et de statistique TeraLab has been designed to provide an immediate answer to the needs of researchers, teachers and companies to develop their knowledge and innovation using Big Data analytics. Active in: Big Data Analytics as a Service (&quot;CAP&quot;), Connected fabric (&quot;CareWare&quot;), Energy (&quot;SEAS&quot;)</td>
<td>Full</td>
</tr>
<tr>
<td><strong>Centre of Excellence and Technological Innovation in Bioimaging</strong></td>
<td>The centre focuses on providing a databank of medical imaging to support research and development and achieve technological advances for medical imaging.</td>
<td>Yes (through membership of some core stakeholders)</td>
</tr>
<tr>
<td><strong>IT for Innovative Services</strong></td>
<td>Committed to multidisciplinarity, LIST’s IT for Innovative Services (ITIS) department conducts research to develop models, methods, software and devices for smart systems, fusing human and technological aspects. Its ambition is to build trust around services, to develop new services with high level of informatics and to support innovation of IT-based services. Active in: Business analytics, Decisional knowledge dynamics, Trusted service systems</td>
<td>None</td>
</tr>
<tr>
<td>Centre Name</td>
<td>Description</td>
<td>Membership Status</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Cartif Technology Centre</td>
<td>CARTIF is a horizontal, private and non-profit technology centre. Its mission is to offer innovative solutions to companies to improve their processes, systems and products, improving their competitiveness and creating new business opportunities. CARTIF develops R&amp;D projects, directly funded by companies or public funds raised through competitive calls for national and international level. CARTIF also advises public authorities (municipalities and regional governments) in the planning and development of innovative projects with high economic value. Active in: 3D Scanning, Biotechnology, Characterization of biomass, Materials.</td>
<td>None (Membership planned)</td>
</tr>
<tr>
<td>Big Data Value Center</td>
<td>The Big Data Value Center (shorted: BDVC) is a unique 'open innovation platform' with a physical place in Almere, The Netherlands. In the Big Data Value Center, they create more value out of (big) data. Together with the ‘A-Team’, companies can experiment with their and other datasets in a save and inspirational place. The experiments result in new or improved business cases. The Big Data Value Center is founded by the Economic Development Board Almere in collaboration with TNO, SURFsara, eScience Center, Amsterdam Economic Board and Economic Board Utrecht.</td>
<td>Yes (through membership of some core stakeholders)</td>
</tr>
<tr>
<td>Berlin Big Data Center</td>
<td>The Berlin Big Data Center is pursuing the following seven objectives: - Pooling expertise in scalable data management, data analytics, and big data application - Conducting fundamental research to develop novel and automatically scalable technologies capable of performing “Deep Analysis” of “Big Data”. - Developing an integrated, declarative, highly scalable open-source system that enables the specification, automatic optimization, parallelization and hardware adaptation, and fault-tolerant, efficient execution of advanced data analysis problems, using varying methods (e.g., drawn from machine learning, linear algebra, statistics and probability theory, computational linguistics, or signal processing), leveraging our work on Apache Flink - Transferring technology and know-how to support innovation in companies and start-ups. - Educating data scientists</td>
<td>None</td>
</tr>
<tr>
<td>CeADAR: National Centre for Applied Data Analytics</td>
<td>CeADAR is a market-focused technology centre for innovation and the application of Big Data Analytics and Visualisation. We drive the accelerated development, deployment and adoption of Big Data Analytics technology for the competitive advantage of our member companies Active in: Visualisation &amp; Analytic Interfaces, Data Management for Analytics, Advanced Analytics</td>
<td>Associate</td>
</tr>
<tr>
<td><strong>Datalab</strong></td>
<td>The Data Lab enables industry, public sector and world-class university researchers to innovate and develop new data science capabilities in a collaborative environment. Its core mission is to generate significant economic, social and scientific value from big data.</td>
<td>None</td>
</tr>
<tr>
<td><strong>Big Data Institute</strong></td>
<td>The Big Data Institute (BDI) is a state-of-the-art building at Oxford University's Old Road Campus. This interdisciplinary research centre focuses on the analysis of large, complex, heterogeneous data sets for research into the causes and consequences, prevention and treatment of disease. To this end, BDI researchers develop, evaluate and deploy efficient methods for acquiring and analysing information for large clinical research studies. These approaches are invaluable in identifying the associations between lifestyle exposures, genetic variants, infections and health outcomes around the globe. Active in: genomics, population health, infectious disease surveillance, and methodology (including informatics, statistics, and engineering).</td>
<td>None</td>
</tr>
<tr>
<td><strong>The Alan Turing Institute</strong></td>
<td>The Alan Turing Institute is the national institute for data science, headquartered at the British Library. Five founding universities – Cambridge, Edinburgh, Oxford, UCL and Warwick – and the UK Engineering and Physical Sciences Research Council created The Alan Turing Institute in 2015. Core areas of their research range from data-centric engineering, high-performance computing and cyber-security, to smart cities, health, the economy and data ethics. They apply their data science research to real-world problems, working with partners in industry, government and third sector.</td>
<td>None</td>
</tr>
<tr>
<td><strong>Business and Local Government Data Research Centre</strong></td>
<td>The Business and Local Government Data Research Centre is leading the way in advanced analytics to help companies, local authorities and academics use data more effectively. Funded by the Economic and Social Research Council (ESRC), the Centre provided unique data services and a world-class facility that brings together the expertise of academic researchers, social scientists, data scientist and statisticians across universities in the East of England to enable better decision-making and help organisations solve real issues. Active in: Local Economic Growth, Support for Vulnerable People, Mapping Public Access to Green Infrastructure, Methodologies for Big Data Analytics</td>
<td>None</td>
</tr>
<tr>
<td><strong>Information Technologies Institute - Centre for Research and Technology Hellas</strong></td>
<td>The Information Technologies Institute (ITI) was founded in 1998 as a non-profit organisation under the auspices of the General Secretariat of Research and Technology of Greece, with its head office located in Thessaloniki, Greece. Since 10.3.2000 it is a founding member of the Centre of Research and Technology Hellas (CERTH) also supervised by the Greek Secretariat of Research and Technology. ITI-CERTH is one of the leading Institutions of Greece in the fields of Informatics, Telematics and Telecommunications, with long</td>
<td>Associate</td>
</tr>
</tbody>
</table>
experience in numerous European and national R&D projects. ITI-CERTH has participated in more than 50 research projects funded by the European Commission (IST FP5-FP6) and more than 85 research projects funded by Greek National Research Programmes and Consulting Subcontracts with the Private Sector (I&T Industry). In 2006, the Informatics and Telematics Institute attracted an income of 5.6 M€ from National and European competitive R&D projects.

<table>
<thead>
<tr>
<th>The Data Science Institute at the Imperial College London</th>
<th>Active in: Visualisation, Analytics, Bioinformatics, Image Informatics</th>
<th>Associate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINI &quot;Big Data&quot; Laboratory</td>
<td>The CINI &quot;Big Data&quot; Laboratory aims to be an Italian expertise centre for the development of knowledge and technologies in the fields of Big Data and Data Science, which are of strategic importance in decisional processes within companies and government agencies, as well as for the analysis of large-scale social behaviours and for the solution of complex scientific problems. Active in: Data modelling, Information extraction, Mining and analytics, Big open data</td>
<td>Full</td>
</tr>
<tr>
<td>Know-Center GmbH</td>
<td>Austria’s leading research centre for data-driven business and big data analytics. They invent innovative cognitive computing systems. They develop innovative solutions and smart services for the industry. Active in: Cognitive Computing Systems, Knowledge Discovery, Knowledge Visualization</td>
<td>Full</td>
</tr>
<tr>
<td>Complexity Science Hub Vienna</td>
<td>The Hub is a node in a network of international partner institutions, including the Santa Fe Institute, the Complexity Institute of Nanyang Technological University Singapore, Arizona State University, and the Institute for Advanced Study Amsterdam. Through this network a lively exchange of researchers, question posers, students, and postdocs are envisioned, enabling the most important ingredient to tackle the challenges we face: the evolution of fundamentally new ideas. The objective of the hub is to host, educate, and inspire complex systems scientists who are dedicated to collect, handle, aggregate, and make sense of big data in ways that are directly valuable for science and society. CSH is a joint initiative of AIT, IIASA, Medical University of Vienna, TU Graz, TU Wien, and Vienna University of Economics and Business. Active in: smart cities, internet of things, networks, medical systems, ecological systems</td>
<td>None</td>
</tr>
</tbody>
</table>
## D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th>Competence Center</th>
<th>Description</th>
<th>Active in</th>
<th>Associate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data and Web Science Group, University of Mannheim</strong></td>
<td>The Data and Web Science Group conducts research on methods for managing, integrating and mining large amounts of heterogeneous information within enterprise and open Web contexts. Active in: Web-based Systems, Data Analytics, Computer Vision, Web Data Mining, Natural Language Processing, Artificial Intelligence</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Frankfurt Big Data Lab</strong></td>
<td>The objective of the Frankfurt Big Data Lab is to carry out research in the domains of big data and data analytics from the perspective of information systems and computer science. The approach is based on the interdisciplinary binding between data management technologies and analytics. Active in: Data Analytics / Data Science, Digital Humanities and Linked Open Data (LOD)</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Competence Center for Scalable Data Services and Solutions</strong></td>
<td>ScaDS Dresden/Leipzig was officially launched on 13 October 2014 and has laid the foundations for the creation of a national competence centre for Big Data. The research project is intended to run for a period of 4 years and is driven by the partners Dresden University of Technology (TUD), the University of Leipzig (UL), the Max-Planck-Institute for Molecular Cell Biology and Genetics (MPI-CBG) and the Leibniz-Institute for Ecological and Regional Development. The competence centre covers thematically important research challenges in data acquisition, handling and utilization of large data sets for a broad spectrum of users. Active in: Efficient Big Data Architectures, Knowledge Extraction, Visual Analysis, Life Sciences, Material Sciences, Environmental and Transport Sciences</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Data Science Center Eindhoven (DSC/e)</strong></td>
<td>The Data Science Centre Eindhoven (DSC/e) is TU/e’s response to these challenges and possibilities. By bringing top scientists and students from over thirty research groups from different TU/e departments together on specific topics, they can tackle the most challenging scientific and societal challenges. They have connections to world-class researchers across the world, but also with (local) governments, knowledge institutes and companies (from SMEs to large multinationals). Active in: Information systems, Business process design, Cardiovascular Biomechanics, Cognitive Internet of Things (CIoT), Computational biology, Gaming, Energy systems, Security</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Delft Data Science</strong></td>
<td>Delft Data Science (DDS) is TU Delft’s coordinating initiative for research, education and training in data science and technology. In close collaboration with stakeholders in various domains, DDS will supply research-based solutions. DDS will also play a unique role in bridging the gap between development and actual implementation of these new technologies. Active in: Computer Engineering, Computer Graphics and</td>
<td>Associate</td>
<td></td>
</tr>
</tbody>
</table>
## D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th>Centre</th>
<th>Mission</th>
<th>Active in</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam Data Science</td>
<td>The mission is to develop world-class data science talent and technology within the Amsterdam region. The focal point is on research, innovation and education.</td>
<td>Social and behavioural science, Life science, Business analytics, Digital humanities, Deep Learning, Semantic technologies</td>
<td>None</td>
</tr>
<tr>
<td>Leiden Data Science</td>
<td>The Leiden Centre of Data Science (LCDS) is a network of researchers from different scientific disciplines, who use innovative methods to deal with large amounts of data. Collaboration between these researchers leads to new solutions for problems in science and society.</td>
<td>Statistics, Physics, HPC for Data Science &amp; Astrophysics, E-medicine</td>
<td>None</td>
</tr>
<tr>
<td>DAnish Center for Big Data Analytics driven Innovation</td>
<td>The vision of DABAI is to place world-class computer science Big Data analysis research and innovation at the core of an effort to seize opportunities in domains of importance to Danish businesses and society. With a 17 million Euro budget DABAI will discover Big Data-based solutions for issues such as predicting floods, ensuring more efficient patient journal handling and providing better traceability of foods over the next four years.</td>
<td>Big data analysis algorithms, Machine learning, Interactive visual analytics</td>
<td>None</td>
</tr>
<tr>
<td>Big Data DTU</td>
<td>Establish an offer for DTU as a whole that can be used to support ongoing and planned Data Science research projects throughout DTU. Create and maintain Data Science courses offered to students as well as supplementary training activities, for example those aimed at the business community.</td>
<td>-</td>
<td>Associate</td>
</tr>
</tbody>
</table>
## D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th>Centre for Scalable Data Access in the Oil &amp; Gas Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SIRIUS</strong></td>
</tr>
</tbody>
</table>
| *SIRIUS* is a Norwegian Centre for Research-driven Innovation that addresses the problems of scalable data access in the oil & gas industry. The centre combines public funding for basic research with funding from its industry partners into an 8-year programme for industrial innovation.*  
*The centre aims to provide the oil & gas business with better ways to access and use the massive amounts of data that are generated in projects and daily operation. Problems with data access are made more acute by the rise of big data, the internet of things and digitalisation of enterprises. SIRIUS approaches these problems using an interdisciplinary approach, as successful innovation depends on the combination of technologies.*  
*SIRIUS aims to be an intellectual hub for applied industrial IT in South-Eastern Norway. It has dedicated premises in the Informatics Department at the University of Oslo and collaborates widely, both nationally and internationally. Many of the results generated by the centre will also be of relevance outside the oil and gas industry. The centre is therefore also active in communicating and applying its results to other areas such as Healthcare, Manufacturing and Public Administration.* |  
| None |

<table>
<thead>
<tr>
<th>Research Division in Information and Communication Technology for Industry and the Public Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SINTEF Digital</strong></td>
</tr>
</tbody>
</table>
| *SINTEF Digital is a research division in SINTEF, located both in Trondheim and Oslo with around 300 employees. SINTEF Digital carries out research in Information and Communication Technology for industry and the public sector. We cooperate closely with the Norwegian University of Science and Technology (NTNU) and the University of Oslo (UiO).*  
*SINTEF Digital offers high levels of skills and state-of-the-art technology within SINTEF’s areas of focus: Renewable energy, climate and environmental technology, Oil and gas, Ocean space technology, Health and welfare and Enabling technologies.* |  
| Full |

<table>
<thead>
<tr>
<th>Research Alliance Consisting of 30 Institutes Bundling their Cross-Sector Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fraunhofer Big Data Alliance</strong></td>
</tr>
</tbody>
</table>
| *The Fraunhofer Big Data Alliance consists of 30 institutes bundling their cross-sector competencies. Their expertise ranges from market-oriented big data solutions for individual problems to the professional education of data scientists and big data specialists.*  
*The Fraunhofer Big Data Alliance sees itself as an independent big data process chain adviser providing technological support to partner businesses from the initial roadmap to the effective roll-out of specific solutions – in business processes, in production and logistics and research and development.*  
*Active in: Production / Industry 4.0, Logistics and Mobility, Life Science.* |  
<p>| Full |</p>
<table>
<thead>
<tr>
<th>Centre of Excellence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SICS</td>
<td>RISE SICS is a leading research institute for applied information and communication technology in Sweden, founded in 1985. RISE SICS is a research institute in the most expansive area of industry this century: the total digitalization of products, services and businesses. SICS is in the midst of this revolution, boosting the competitive strength of Swedish industry and the quality and efficiency of Sweden’s public sector. We contribute with cutting edge technology within the fastest growing and most relevant areas for this revolution to happen, including big data analytics, automation, security, and internet-of-things. RISE SICS is non-profit and carries out advanced research in close collaboration with Swedish and international industry and academia. Active in: Big data analytics, machine learning and optimization, Security, trust, privacy and integrity, Internet of Things, Automotive and Rail, Block Chain.</td>
</tr>
<tr>
<td>Agrimetrics</td>
<td>Agrimetrics is a big data centre of excellence for the whole agri-food value chain, from farm through to consumer. They are creating a secure data hub for the agri-food community that adds value and improves access to publicly funded data sources. We can advise, develop and implement knowledge-based services that build resilience and sustainability in the agri-food industry.</td>
</tr>
<tr>
<td>Inria</td>
<td>Inria, the French National Institute for computer science and applied mathematics, promotes “scientific excellence for technology transfer and society”. Inria transfers expertise and research results to companies (startups, SMEs and major groups) in fields as diverse as healthcare, transport, energy, communications, security and privacy protection, smart cities and the factory of the future.</td>
</tr>
<tr>
<td>Excite</td>
<td>EXCITE brings together the top-ranked ICT research groups in Estonia to work jointly on a focussed, yet broad and extendable, research programme. It will capitalize on the existing expertise to create synergies on the rich but fragmented landscape of the Estonian ICT research.</td>
</tr>
</tbody>
</table>

| Associate | Full | None |
The MTA SZTAKI is a research institute, governed by the Hungarian Academy of Sciences. Upon the charge by the Secretary-general of the Academy, the supervision of the scientific activity pursued at the Institute is provided by the Board of the Institute.

The fundamental task of the Institute is to perform basic and application-oriented research in an interdisciplinary setting in the fields of computer science, engineering, information technology, intelligent systems, process control, wide-area networking and multimedia.

Contract-based target research, development, training and expert support for domestic and foreign industrial, governmental and other partners are important activities at the Institute.

Active in: Engineering and business intelligence, Machine perception and human-computer interaction, Vehicles and transportation systems, Security and surveillance
An organizational model is a representation of an organization that helps us to understand more clearly and quickly what we are observing in organizations. More specifically such a model helps:

- To enhance our understanding of organizational behaviour.
- To categorize data about an organization.
- To interpret data about an organization.
- To provide a common, short-hand language.

This section provides an overview of chronological development of organization diagnostic models in literature [30]. The majority of organizational models are based on the open systems theory, with Bruke-Litwin model being the most recent and well-recognized model [31]. Based on a conceptual analysis of existing organizational models, a detailed model is proposed to examine BDVCoEs and good practices that help in their success.

### 13.1.1 Force Field Analysis (1951)

Introduced by Kurt Lewin in his research on social psychology, Force Field Analysis was initially used as a framework for the identification of factors (forces) of influence in certain social situations [32]. The model has been later used in other fields such organisational design and more specifically for dealing with decisions regarding change management. The core idea suggests that a desired state of affairs is maintained by an equilibrium between forces that drive change and others that restrain change as shown in Figure 2. In order to take a decision to apply a certain change, the driving forces must be strengthened or the restraining forces weakened.

![Figure 29: Force Field Analysis](image)

### 13.1.2 Leavitt’s Model (1965)

Leavitt’s Model, also called Leavitt's Diamond, is an approach used to analyse the impact a change can have on an organization [33]. The model assumes that organizations have four interdependent components: Task, People, Technology and Structure (see Figure 3).
Tasks refer to all tasks or subtasks that are carried out in order to achieve the organisational goals. People are the human capital required to perform those tasks. Technology refers to the resources in terms of equipment required for the execution of tasks and structure represents the workflow within the organisation.

Any change at any level of these components will affect the other ones. In this regard, before applying any change, managers need to evaluate its impact on the other components to make sure that a balance is maintained. Whether for doing a simple process redesign or a complete organisational restructure, Leavitt's Model suggests a two-step process: identification of the four components (i.e., Task, People, Technology and Structure) and the analysis of the impact of the proposed change. Results of this analysis can be later used in the strategy for change.

13.1.3 Likert System Analysis (1967)

Likert, in 1967, proposed a framework of four different types of management systems within organisations on the basis of seven organisational dimensions: motivation, communication, interaction, decision-making, goal setting, control and performance [34]. The four systems are:

- **Exploitative Authoritative**: the leader has a low concern for lower-level employees and uses his full authority in taking all decisions
- **Benevolent Authoritative**: less controlling, allowing lower-level employees to be involved in policy-making decisions but limited by a framework defined by the upper-level management
- **Consultative**: full freedom for lower-level employees to take specific decisions that will affect their work only
- **Participative Group**: full freedom to participate in decision making through horizontal communication

The objective of these four systems is to identify the relationship, involvement, and roles of managers and subordinates within an organisation. This is done via a 43-item survey instrument with questions regarding seven organisational dimensions. An example of such questions related to communication is given in Figure 4.
Various traditional organisational models and theories assume that organisations are closed systems: autonomous and isolated from the outside world. Such theories failed to take into account many environmental impacts that have strong influence on efficiency of organisations. Consequently, the Open Systems Theory emerged as holistic ideology supporting the belief that organisations should be structured around their environment by accommodating its unique problems and opportunities.

The Open Systems Theory was formalised around the idea of organisations being social systems that are dependant upon their environment that provides various inputs. Open Systems Theory enables repetitive cycles of input, transformation, output through a feedback loop from output to the renewed inputs (See Figure 5).

Weisbord’s Six-Box Model (1976)

[37] proposed the Six-Box Model that is used for analysing the organisation internal issues through six interdependent organisational concepts (or boxes): purposes, structures, relationships, leadership, rewards and helpful mechanisms (see Figure 6):

- **Purposes**: mission and goal
- **Structures**: organisation schemes (e.g., by function, product, project, etc.)
- **Relationships**: interactions between people, units and technology
- **Leadership**: typical leadership tasks
- **Rewards**: intrinsic and extrinsic rewards people associate with their work
- **Helpful mechanisms**: useful for planning, controlling budgeting and information systems
In addition to these boxes, Weisbord identifies the environment as an additional concept in his model that is linked to the other boxes via the input and output of resources such as money, people, ideas, machinery, etc. Together with his model, Weisbord proposes a set of questions that help organisational managers diagnose their organisations.

### 13.1.6 Congruence Model for Organization Analysis (1980)

The Congruence Model, as proposed by [38], is a refined and a more comprehensive version of the Open Systems Theory model. It specifies the input, transformation and output concepts while maintaining consistency with Levitt’s and Weisbord’s models. Various assumptions are considered by this model (see Figure 7):

- Organisations are *open social systems*
- Organisations are *dynamic entities*
- Organisational behaviours occur at the *individual, group and system levels*
- *Interactions* occur between the individual, group and system levels

These assumptions are common to modern organisational diagnostics models and are implicitly considered in the models reviewed in this deliverable.

McKinsey 7S Framework indicates that there are seven elements within organisations that have to be aligned for an organisation to be successful [39]. These elements have also to be consistent for implementing any change. These 7S elements are:

- **Strategy**: determines how the organisation distinguish itself in achieving its goals
- **Structure**: defines the hierarchy or the organisation chart
- **Systems**: include the resources and procedures used by people to do their work
- **Shared values**: determine how the work is done and how problems are solved
- **Skills**: includes all the skills and competencies within the organisation
- **Style**: defines the style of leadership adopted in the organisation for decision making
- **Staff**: represent employees and human capabilities

The 7S elements are divided into two categories: soft and hard. The three hard elements are Strategy, Structure and Systems. The four soft elements are Shared values, Skills, Style and Staff. As depicted in Figure 8, Shared values are in the centre of the elements as it helps determine how people behave within the organisation.
All these 7S elements are interdependent, any changes applied to one of them impacts the other ones. Before applying any change, analysing these elements helps to clarify the current situation of the organisation: identify weaknesses and strengths and where a change needs to be applied and how it impacts the other elements to start making adjustments ahead of time.

13.1.8 Tichy’s Technical Political Cultural (TPC) Framework (1983)

Tichy’s TPC framework is another refined and a more comprehensive version of the Open Systems Theory model [40]. It specifies the input, transformation and output concepts while focusing on the key organisational elements that need to be considered in the change management process. As shown in Figure 9, the input concept includes the environment, history and resources as major elements. The transformation concept includes mission/strategy, tasks, prescribed networks, people, organisational processes and emergent networks. Finally, the performance and impact on people are the major elements of the output concept.
This model indicates how organisational change requires taking decisions at the technical, political and cultural levels. When an organisation focuses exclusively on one or two of these elements, the change is not complete. For a successful change, managers have to align the technical, political and cultural systems in the organisation for taking decisions in each of the areas outlined above as to how much change is needed.

### 13.1.9 High-Performance Programming (1984)

The High-Performance Programming Framework has been introduced to assess the level of performance of organisations in order to identify a roadmap to help them move to the next level towards high performing systems [41]. The model suggests four developmental levels: reactive, responsive, proactive, and high performing. These levels are incremental as each level builds on lower ones. A high level description of these levels is given below:

- **High-performing (level 4):** High-performing organisations achieve high standards of excellence. Their focus is on excellence and their are continuously looking for new opportunities and innovations.
- **Proactive (level 3):** Proactive organizations are strategic, goal oriented, and focused on the greater good and results. Higher-level managers have trust and mutual respect for each other. Lower-level employees take responsibility for their own success.
- **Responsive (level 2):** Responsive organizations focus on the present with a hierarchical structure and a leadership style of management. It is focused on near-term goals and motivates with rewards.
- **Reactive (level 1):** Reactive organization can be qualified as survival...
organisations and operating in the past. They operate with force-fed communication, top-down leadership, and fragmented infrastructure.


The model for Diagnosing Individual and Group Behavior aims to represent organisations as open systems with limited boundaries with the external environment [29]. The environment represents the resources, including human resources, and feedback loops from prior outcomes of the organisation. The organisational elements shown in the model in figure 10 are conceptualized at the individual, group and organisation levels. The performances of organisations are highly impacted by the outputs related to the outcomes of the individual performance, the group performance and the quality of work life.

![Figure 10: Diagnosing Individual and Group Behavior](image)

Individual output or performance depends on the individual characteristics, attributes, beliefs and motivation while the group output or performance depends on its composition, structure, technology of the organisation, group behavior, processes and culture.

**13.1.11 Burke-Litwin Model of Organizational Performance & Change (1992)**

The Burke-Litwin model of Organizational Performance and Change exhibits the different drivers of change [31]. The model includes twelve constructs hierarchically ranked in terms of importance: *external environment, mission and strategy, leadership, culture, structure, management practices, systems, work group climate, skills, motivation, individual needs and values, and performance*. The top-level elements have the most important factors that drive changes within organisations. As shown in Figure 11, environmental factors are considered the most important drivers of change. Indeed, important elements of organisational success, such as mission and strategy, leadership and organisational culture, are often subject to changes triggered by external factors. Each of these elements has a direct impact on
other elements. As example, the performance element impacts the external environment via its products and services. Similarly the individual and organisational performance is impacted by requirements from the external environment.

![Burke-Litwin Model](image)

**Figure 11: Burke-Litwin Model**

13.1.12  **Falletta’s Organizational Intelligence Model (2008)**

Falletta’s Organizational Intelligence Model, as depicted in Figure 12, is a relatively new organizational model introduced as a framework to facilitate the design and interpretation of most employee and organisational survey efforts [42]. It includes eleven organisational elements that have direct impact on the employee engagement and organisational performance. It defines the important factors and relationships to consider during an organisational change initiatives or HR strategic planning.
The IT-CMF [43] [44] is an integrated management toolkit covering 36 capabilities associated with the better management of IT (Fig. 13). Each capability is broken down into a series of capability building blocks, and has an associated five-level maturity profile and a comprehensive body of knowledge to drive improvement. This includes indicative improvement practices, outcomes and metrics, capability performance indicators, and supporting management artefacts. Currently, organizations are using IT-CMF to support the improved business management of IT. This use in turn helps inform the on-going development of IT-CMF, which leverages an open innovation and collaborative research approach between academic researchers and industry-based practitioners – ensuring the principles underpinning the framework are informed by leading insights and best-known practices.
13.2 Cross-Model Concept Analysis

This section provides a cross-model analysis of models and concepts presented in previous section. The analysis is performed along three dimensions: focus of the models, organizational elements used in the model, and the features of external environments as defined by a model. The objective of this analysis is to identify common elements across existing models of organizational diagnostics and understand their relevance to the concepts of centre of excellence.

<table>
<thead>
<tr>
<th>Model</th>
<th>Focus</th>
<th>Organisational Elements</th>
<th>External Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force Field Analysis (1951)</td>
<td>Analysis of the driving and restrained forces to move from the current state to an equilibrium state</td>
<td>- Driving forces&lt;br&gt; - Restraining forces</td>
<td>The environment can take part of either driving or restraining forces</td>
</tr>
<tr>
<td>Leavitt’s Model (1965)</td>
<td>Identification of change effects on the 4 organisational elements</td>
<td>- Task&lt;br&gt; - Structure&lt;br&gt; - Technology&lt;br&gt; - People/Actors</td>
<td>Not represented in the model</td>
</tr>
<tr>
<td>Likert System Analysis (1967)</td>
<td>Analysis of the organizational elements to determine what type of management an organisation is adopting: Exploitative-authoritative, benevolent-authoritative, consultative and participative group</td>
<td>- Motivation&lt;br&gt; - Communication&lt;br&gt; - Interaction&lt;br&gt; - Decision making&lt;br&gt; - Goal setting&lt;br&gt; - Control&lt;br&gt; - Performance</td>
<td>Not represented in the model</td>
</tr>
<tr>
<td>Open Systems Theory (1966)</td>
<td>This is a theory rather than a complete model. It suggests that modern organisations are social systems which are dependant upon their environment</td>
<td>- Input&lt;br&gt; - Transformation&lt;br&gt; - Output</td>
<td>The interaction with the environment is present through inputs and outputs</td>
</tr>
<tr>
<td>Weisbord’s Six-Box Model (1976)</td>
<td>Measure the effectiveness of organisations through the analysis of the gaps between the organisational elements</td>
<td>- Purposes&lt;br&gt; - Structure&lt;br&gt; - Relationships&lt;br&gt; - Leadership&lt;br&gt; - Rewards&lt;br&gt; - Helpful mechanisms</td>
<td>The interaction with the environment is present through inputs and outputs</td>
</tr>
<tr>
<td>Model/Literature</td>
<td>Focus</td>
<td>Inputs</td>
<td>Outputs</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Congruence Model for Organisation Analysis (1977)</td>
<td>Analysis of the level of “congruence” or “fit” between the organisational elements to evaluate if there are gap in the entire organisation structure</td>
<td>1. Input: - Environment - Resources - History - Strategy</td>
<td>3. Outputs - Individual - Group - System</td>
</tr>
<tr>
<td>Tichy’s TPC Framework (1983)</td>
<td>Analysis of the technical, political and cultural elements before undertaking a change within organisations</td>
<td>1. Input: - Resources - Human Resources</td>
<td>2. Transformation Process: - Mission/strategy - Organisational processes - Tasks - People - Emergent networks - Prescribed networks</td>
</tr>
<tr>
<td>Diagnosing Individual and Group Behavior (1987)</td>
<td>Analysis of the performance of the organisations with respect</td>
<td>1. Input: - Resources - Human Resources</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>Analysis</td>
<td>Outputs</td>
<td>Interaction with Environment</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
</tbody>
</table>
| Burke-Litwin Model of Organizational Performance & Change (1992) | Analysis of the organisational element to identify the impact of change one element on the other ones | - Throughput at the organisation, group and individual levels
  1. Inputs:
  - Group performance
  - Individual performance
  - Quality of Work Life outcomes
  2. Outputs:
  - Group performance
  - Individual performance
  - Quality of Work Life outcomes
 | The interaction with the environment is present through inputs and outputs |
| Falletta’s Organizational Intelligence Model (2008) | Analysis of the organisational elements to identify employee engagement and organisational performance | - Leadership
  - Strategy
  - Culture
  - Structure and Adaptability
  - Information and Technology
  - Direct Manager
  - Measures and Rewards
  - Growth and Development
  - Employee engagement | The interaction with the environment is present through inputs and outputs |
| IT-CMF (2007) | Identification of four macro capabilities to engagement improve IT organisational performance | - IT Business Management
  - IT Budget Management
  - IT Capability
  - Business Value | Not represented in the model |

The following table provides a frequency analysis of organizational concepts, listed above, against the all models.
# D4.1: Network of National BDV Centres of Excellence Best Practice Guide

<table>
<thead>
<tr>
<th></th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mission/Strategy/Goal/Focus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leadership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure/Formal &amp; Informal Arrangements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Practices/Control/Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems/Technology/Helpful Mechanisms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Group Climate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation/Reward</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual needs and values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance (individual/group or organisation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People/Human Resources/Staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactions/Relationships/Shared Values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of Work-life outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Frequency of Occurrence

| Force Field Analysis (1951) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| Leavitt's Model (1965)      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Likert System Analysis (1967) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Open Systems Theory (1966)  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Weisbord's Six-Box Model (1976) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Congruency                  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

---

[Big Data Value eCosystem Logo]
<table>
<thead>
<tr>
<th>Model for Organisation Analysis (1977)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>McKinsey 7S Framework (1981-1982)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Tichy’s TPC Framework (1983)</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Performance Programming (1984)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Diagnosing Individual and Group Behavior (1987)</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burke-Litwin Model of Organizational Performance &amp; Change (1992)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Falletta’s Model (2008)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>IT-CMF (2007)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
14 References


[55] “Governance in higher education.” .


[68] W. J. Sutherland, D. Goulson, S. G. Potts, and L. V. Dicks, “Quantifying the impact and relevance of scientific research,” *PloS one*, vol. 6, no. 11, p. e27537, Nov. 2011.


