Big Data and Artificial Intelligence Centres of Excellence Framework

CAPABILITY DEEP-DIVES Part II
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THE BIG DATA AND ARTIFICIAL INTELLIGENCE CENTRE OF EXCELLENCE SERIES

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1 Introduction
The goal of the BDVe project is the further development of the European data ecosystem as a data-driven economy. One objective of the project is to foster collaboration and promote sharing of best practices and know-how among Big Data Centre’s of Excellence and national initiatives, and to provide expert guidance and (non-financial) support to member states looking to establish new National CoE for Big Data and AI. As part of this work, we present in this report a more detailed elaboration of the best practices within the BDAICoE model. This involved identifying specific practices for the capabilities part of our framework. This was achieved by performing a detailed analysis of the case studies and interviews with subject experts. This report details the current best practices for the following capabilities: Intellectual Property and Data Protection, Policy Outreach, Education and Public Engagement, Technology and Knowledge Transfer, and Performance and Impact.

1.1. Big Data and AI CoE Best Practice Framework

The Big Data and Artificial Intelligence Centres of Excellence (BDAICoE) framework is a best practice guide for use in promoting value generation and sharing of ideas within the Big Data and AI innovation ecosystem. The framework was developed following a phased design science process, starting from a literature review to create an initial framework which was enhanced with the findings of a multi-case study of existing successful Centres of Excellence (CoEs). Each case study involved an in-depth analysis and a series of in-depth interviews with CoE leadership.

The BDAICoE framework has three components, and each of these is designed to cover each of the three elements defined in open systems theory that comprises of Input (environment), Transformation (CoE) and Output (impact). Figure 1 shows the main components of the framework. Within the framework, there is a process flow in the form of a value chain starting from the Environment (which supplies input) through the Core BDAICoE capabilities (which processes the input) to the Output represented by the impact of the output received by the society under various categories; economic, scientific and societal. There is a

![Figure 1: BDAICoE Framework](image-url)
backward flow (feedback) of value from the Impact of a CoE back to the research centre and to the Environment in which the centre operates. For example, a CoE may hire personnel it trained as a postgraduate or receive income from services rendered to a partner, which can return value to the CoE. Similarly, the impact created can influence the environment in which it operates, particularly regarding policymaking and funding decisions. The quality of output from a research centre is often the most significant determinant of funding decisions by the funding agencies.

1.1.1. Environment

The context of a COE is heavily influenced by the external forces that demand a response from the centre; these external environmental forces can be divided into three areas:

- **Industry**: Industry is defined as the ecosystem of companies surrounding a BDV CoE, that is associated with the creation of economic value at both national and European levels.

- **Policy**: 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.

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

1.1.2. Core Organisational Model

The main element within the BDAICoE core model are:

- **Strategy**: Strategy represents how a CoE intends to achieve its overall mission and goals.

- **Governance**: Governance in centres of excellence refers to the level of decision-making about strategy and operations.

- **Structure**: The structure is how a CoE is designed (i.e., levels, roles, units, decisions, rights, and accountability).

- **Funding**: Funding refers to the availability, diversity, and sustainability of the monetary support for carrying out research and educational activities in a CoE.

- **People**: People are the human capital required to carry out specific tasks towards the goals of the organisation.

- **Culture**: Culture represents the underlying values, beliefs, and norms that drive the teams and the CoE as a whole.

1.1.3. Capabilities

The framework identifies a set of operational capabilities that are needed to operate a CoE.

- **People** – People are the human capital required to carry out specific tasks towards the goals of the organisation.

- **Process** - Process is the knowledge of procedures and tasks for the achievement of the goals of the CoE.

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

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

- **Collaboration**: Universities-industry collaboration (UIC) refers to the formal and informal engagement and interaction between a higher educational institution and an industry partner to facilitate knowledge and technology
exchange as well as to provide an ad hoc advice and networking opportunity for the professionals. This can be national through the establishment of activities such as collaborative and contract research and the provision of consulting services.

Capabilities are analysed more in Error! Reference source not found..

1.1.4. Impact

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.

- **Economic**: The economic impact is the effect on commerce, employment, or incomes generated from big data research in general and by the CoE in particular.
- **Scientific**: This relates to the influence a research centre has on the entire science and technology communities around the world. It includes the contributions it makes to the invention of novel ideas or concepts and the development of general science and technology principles.

- **Societal**: This relates to the beneficial impact of the result of a research centre on the entire human society, including the impact on awareness about science and technology development, better life (improved living standard, health, and lifestyle), societal behaviour, improved organisational capabilities, and environmental care.

### Table 1: Core operational capabilities of the BDAICoE framework

<table>
<thead>
<tr>
<th>Operational Capability</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Development</td>
<td>How the centre develops new business opportunities and manages its partnerships</td>
</tr>
<tr>
<td>Collaboration</td>
<td>How the centre enhances Academic to Academic and Academic to Industrial Interactions</td>
</tr>
<tr>
<td>Research Support Services</td>
<td>The local research support services implemented by the centre</td>
</tr>
<tr>
<td>Technical Infrastructure</td>
<td>Computing resources used to support the research and innovation activities of the centre</td>
</tr>
<tr>
<td>Experimentation/Demonstration Platforms</td>
<td>The platforms that support the scientific and innovation activities of the centre</td>
</tr>
<tr>
<td>Intellectual Property (IP) and Data Protection (DP)</td>
<td>How the centre approaches IP management and DP</td>
</tr>
<tr>
<td>Education and Public Engagement (EPE)</td>
<td>How the centre’s dissemination activities inform the public of the science and technology developments</td>
</tr>
<tr>
<td>Policy Outreach</td>
<td>How the centre tried to Influence future policy</td>
</tr>
<tr>
<td>Technology and Knowledge Transfer</td>
<td>How the centre drives the transfer of know-how and adoption of its technology</td>
</tr>
<tr>
<td>Performance and Impact Assessment</td>
<td>How the centre identifies and tracks its performance and impact</td>
</tr>
</tbody>
</table>
2 Intellectual Property (IP) and Data Protection (DP)
IP: The World IP Organisation (WIPO) defines IP as follows:\(^1\):

“IP refers to the creations of the mind: inventions, literary and artistic works, and symbols, names, and images used in commerce.”

The organisation categorises IP into industrial property, including sub-divisions such as patents, trademarks, industrial designs, and geographical locations, and copyright, which covers literary works, films or movies, music, and artistic works\(^1\).

DP: DP is the “legal control over access to and use of data stored in computers”\(^2\) and in organised physical filling systems. This definition is further explained by the DP Act\(^3\) referring to DP “the ways in which information about living people may be legally used and handled. The main intent is to protect individuals against misuse or abuse of information about them”. This kind of protection is also afforded to organisations as legal persons to cover the use, processing, and sharing of their data.

Recently, the EC issued the GDPR document that came into force on 25\(^{th}\) May 2018. This legal document provides for the collection, processing, use, sharing, storage, and retrieval of personal data by any organisation or individual. The practices recommended by this body of laws are enough guides on the ways researchers and research institutions should deal with research data, whether as data input into research processes or as data output from the processes. Thus, with regards to data gathering from literature reviews, surveys, and interviews and the processing of the data and sharing, researchers need to be careful about how they deal with the handling of third-party data. Permission must be obtained from data owners before starting to collect data and processing it. Similarly, appropriate referencing has to be provided in line with research ethics for all third-party materials used for research purposes. In order to meet with some of these obligations, the research institute or university needs to provide some facilitating services – commonly referred to as the research support services in form of relevant training, provision of appropriate training on relevant regulations (e.g. GDPR), tools and platforms to enable researchers to comply with applicable legislation such as GDPR with regards to DP and privacy compliance. DP and security needs should also be considered in case of the protection of research output so that not to allow it to fall into the wrong hands or misused.

**Study Findings**

Every CoE is very careful about the issue of data and IP protection issues. Evidence suggests that institutions do not want to be caught in the troubles of DP infringement. For example, the CoEs’ and universities’ main rules about compliance with plagiarism rules, adoption of a specific citation and referencing style, as well as maintenance of offices of DP and IP arrangement and related matters.

All the centres have 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. Larger centres maintain offices for IP and DP and created the IP and DP Committee respectively to oversee the development, implementation, and update of policies and procedures relating to IP and DP, including Responsible Research and Innovation (RRI).

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Collection Guidelines are provided by each of the parent universities and are drawn in compliance with data privacy and security regulation, which has now been updated to follow the recently implemented GDPR.

One of the smaller centres saw an advantage in having an IP protocol that facilitated a smooth and fast process that encourages partners in a collaboration. The process is completely simplified to facilitate the process completion process in one day to attract potential partners to collaboration.

Other centres pursued an IP model with the aim to support open knowledge on which commercial solutions can be built. The guiding principles for managing IP-results from laboratory activities are automatically defined as laboratory results of which the National funding Agency funds the generic components, and they 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.

Error! Reference source not found. shows a summary of IP and DP good practices.

### Table 2: Good practices in IP and DP

<table>
<thead>
<tr>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create awareness about the regulations (e.g. GDPR) and provide training and tools for researchers to facilitate their compliance.</td>
</tr>
<tr>
<td>Simplify IP and DP compliance processes to facilitate the adoption and achievement of goals.</td>
</tr>
<tr>
<td>A dedicated coordinator oversees IP and Data Protection Policies.</td>
</tr>
<tr>
<td>Research Integrity is supported by the Host Universities’ policies and is implemented as a package that includes multi-actors and public engagement, enabling easier access to scientific results, the consideration of gender and ethics in innovation concerning content and process, and formal and informal science education.</td>
</tr>
<tr>
<td>A Data Protection Manager role helps strengthen the implementation of data protection policies.</td>
</tr>
<tr>
<td>Highly simplify the IP process into a one-page document and same-day process.</td>
</tr>
<tr>
<td>An open knowledge intellectual property model supports commercial solutions development.</td>
</tr>
<tr>
<td>Two licences – the LGPL or Apache, and the use of any of these licences permits free integration of ‘as-is’ situation with proprietary software.</td>
</tr>
</tbody>
</table>
3 Policy Outreach
These are outreach activities designed to create a community impact sufficient to influence the government’s decision to create, change, or adopt a policy or directive that supports certain practices in society. EPE practices are primarily designed to take research results to the community and to make them become role players in the use and innovation cycle of scientific inventions. However, it is also aimed at producing a long-term impact for which the government is compelled to use policy enactment for support so that the desired outcome can be achieved and sustained.

**Study Findings**

**Influence National Policy:** Through EPE and outreach activities, many centres have succeeded in influencing policymaking. For example, through data collection, analytics and interpretation capabilities deployed to support optimisation of the allocation of healthcare resources, the government has been influenced to make provisions for this need in the national body of policies. Similarly, a policy backing has been created to support the introduction of the computer science subject into the secondary school curriculum as a result of a centre’s coding programmes designed for young students in secondary schools. Many of the centres play a key role in supporting the national and European policies for Digital Economy, Industry 4.0 and the Data Economy.

**Research Integrity:** Typically, centres uphold national policy demands such as gender balance in workplace and research domain-specific policies such as research and innovation ethics on content and process as well as formal and informal science education. Some centres employ a multi-actor arrangement for public engagement in research and innovation, which enables easier access to scientific results. One example of a national policy on Research Integrity is the Irish Universities Association (IUA) National Policy Statement on Ensuring Research Integrity in Ireland4. Four commitment areas provided by the National Forum on Research Integrity in Ireland5 underpin research integrity in the country:

1. **Standard** – a commitment to ensure the highest standards of integrity via enforcement of basic principles of good research practices.
2. **Education** – activities of education and promotion of good research practices.
3. **Collaboration for continuous improvement** – a commitment to teamwork to reinforce, review, and safeguard integrity.
4. **Action to address misconduct** – employment of transparent, fair, and effective processes to deal with research misconduct.

**Table 3: Good practices in Policy Outreach**

<table>
<thead>
<tr>
<th>Practice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Influences policy areas (i.e. education, health) making at National and European level.</td>
<td></td>
</tr>
<tr>
<td>Influences a research and innovation policy at both national and European levels, including Digital Economy, Digitisation of Industry (Industry 4.0), and the Data Economy.</td>
<td></td>
</tr>
<tr>
<td>The centre is a member of relevant associations for the European level activity (i.e., BDVA, ETP4HPC, and AIOTI) H2020.</td>
<td></td>
</tr>
</tbody>
</table>

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Education and Public Engagement (EPE)
Education and Public Engagement (EPE) is a term that brings together some diverse 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 to appreciate science and technology and the CoE. EPE communicates the value and excitement of science, and science, technology, engineering and mathematics careers, to the general public.

Study Findings

Findings from current research reveal that outreach programmes are taken as serious activities in some centres because through these programmes, the research output is publicised to the outside world. It is an important strategy to make the results of research known not just to partners of a research institution, but also to the funding agencies, an important avenue by the CoE to disseminate information into local and international science and technology research communities as well as to youngsters in colleges and high schools. Some researcher organisations have designed EPE into a package of events that include voluntary training of high school pupils and community programmes that bring awareness to various demographics levels. Some of the EPE programmes aim to create inclusivity whereby members of the community are motivated to take advantage of technology tools on offer and contribute to the adoption of technology. Other practices aim to create awareness about problems and unwanted outcomes of science so that the use of results of technology tools do not fall prey to the negative impact of science and technology such as cybercriminals. In this context, outreach also discourages science research into technology that supports weapons of mass destruction, environmental degradation, etc., by way of support to give to policy-makers the ability to provide appropriate policy restrictions.

Good Outreach practices should help a CoE to:

-Expose its research results to the wide community like researchers (local and international communities), industry partners and the young people
- Make the centre popular among others
-Should help drive interest in science and technology particularly among young people who should become the following generation of researchers
- Include all demographics in the awareness and use of technology tools
- Bring the outcomes to local communities and help them take advantage of the outcomes of research
- Participate in conferences and workshops organised for researchers including the supply of papers to journals
- Discourage negative science research – research that leads to the development of ‘bad technology’
- Follow the Create, Include and Question approach to outreach practices
- Build outreach activities into KPIs

Outreach activities are activities that bring science and innovation development to public awareness. These activities enable researchers to interface directly with science and technology output users and teach them how science is developing innovative products to which they must align with, test, use and adapt in their everyday life. CoEs commonly indulge in presentations of their work in seminars and conferences, the publication of science paper and books. However, some create specific avenues for uniquely disseminating their
research outcomes for maximum impact in the society. The centres typically target their outreach activities to three specific stakeholder groups:

- The academic community
- The industry and
- The national and international environments

It is believed that messages directed at the target audience in each of these communities would be slightly different to achieve the desired goals. One centre developed a structured process for outreach; EPE messages and activities are designed and carried out considering three principles, which include – Create, Include and Question. The create approach holds the view that activities should be designed to get people involved in scientific activities. The inclusive approach means activities should adequately target everyone and involve them in outreach programmes – that is activities should consider reaching out for age groups, gender, educational levels, racial communities, business, and social arenas as well as rural and urban considerations. The question approach enlightens scientists and everyone in the society to query, investigate and interrogate what goes under scientific research and what comes out from scientific research. In other words, is scientific investigation or science research producing useful science and technology for humanity, or is it producing dangerous and harmful outcomes for humanity? This is a very laudable principle that is aimed at ensuring science research does not get out of hand into the production of destructive technologies such as technologies dangerous to the environment, support for mass destruction, and cyber-attacks for humanity.

4.1. Example EPE Strategy from Insight

Insight Centre has a dedicated EPE team that is centrally coordinated with EPE experts at each site. A dedicated team for researchers and engagement managers to run multiple activities and projects targeted at different age groups within the public. The list of activities includes, but is not limited to, hackathons and coding clubs, competitions and safety talks. 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 because they deliver many of the events, write many of the media materials 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 the Insight Centre.

The first point is that there are three underlying principles in EPE at Insight: (1) **Create**, (2) **Include** and (3) **Question**. The second point is the overall policy of SFI (Insight’s main funder) which is not to only make Ireland’s populace scientifically aware but also to engage members of the populace in scientific and technological outcomes including knowledge, products and services. The EPE programme is very important because science and technology outcomes should reach all sectors of society, from young to older adults. The goal is to have a smart economy by 2020, where all people are expected to be part of it (and not isolated from it). The aim is to enable everyone to contribute to science and technology as producers and users. This new EPE principle requires researchers to embed EPE into all aspects of research. EPE should not be looked upon as additional work but considered as part of the fabrics of what constitutes a CoE. In other words, staff, students and researchers in a CoE will now be more involved in EPE programmes going forward.

EPE has many facets, including:

- School engagement talks to a lay audience or a professional audience.
- Influencing and changing government policy.
- Demonstrating research outcomes within the Insight Centre or at public engagement events, such as science festivals.
The core principles of the Insight EPE approach is create, include and question.

1. The Create approach: This is to empower people, particularly young people, to create models, activities and processes based on the research outcomes of the Insight Centre and in general science. The coding programmes is a very creative learning process for young people organised by the Insight Centre. By this programme, the Insight Centre has made a fundamental change in Irish research and science programmes by influencing government policy to introduce the computer science subject into the school curriculum. Furthermore, the new directive from the funding agencies demands that everybody in the Insight Centre should be engaged in EPE in one way or another to give research projects some EPE support.

There are now about 15 important metrics for measuring EPE activities to be adopted by the Insight Centre under the new EPE directive from SFI. Over time, all SFI funded researchers and staff should be involved in EPE. Before this, the EPE activities for researchers were primarily focused on:

- Participation in public Science, Technology, Engineering and Mathematics STEM festivals, coding sessions in schools, and app development workshops for second-level college workshops at the Insight Centre.
- Speaking in Thesis-in-3 (Threesis) competitions.
- Supporting digital makers, groups, and school career talks.
- Input into Apps4Gaps (national app making competition).
- Open Data hackathons, organising/mentoring female empowerment STEM seminar.
- Social Inclusion programmes.

Although these activities have been largely successful and have earned Insight a national reputation status for its outreach programmes, the centre is further committed to expand EPE programmes through embedment in all research projects using a wide range of options, including communications training, dialogue with policymakers, stakeholder capacity building, development of demonstrations for schools and general public, and having researchers maintain online profiles.

From 2017, the new directive also mandates measurement of EPE performances using selected Key Performance Indicators (KPIs) metrics, that is, each researcher or staff of the Insight Centre must be involved in at least four of them per annum, and that the Centre must record a 25% personnel involvement by 2019. The 15 metrics for measuring EPE activities are enumerated below:

1. Contributions to online communications
2. Development of online resources
3. Communications/Engagement training
4. Collateral for a lay audience
5. Development of school interactions
6. Teaching materials/methods
7. Festivals/events in institutions
8. EPE activities with museums, galleries or public access venues
9. Citizens’ science experiments or research
10. Contribution to broadcast or media productions
11. STEM EPE activities
12. Dialogue with policy makers
13. Public education
14. Public consultation
15. Stakeholder capacity building
2. The Include approach: This approach states that all sectors of the society will be part of the EPE target audience. The Insight Centre has to engage with all sectors of the economy, including areas such as social deprivation, inner-city, geographically isolated schools in the island, different ethnic groups and age groups, professional bodies, businesspeople, and students. This is highly inclusive particularly because the programme is targeting areas where support is needed, e.g., schools outside the technology corridors, away from main cities such as Galway City, into communities that would not ordinarily have the opportunity to engage with science and technology.

To reach remote locations, the Insight Centre uses a strategy that simplifies scientific and technological concepts to an understandable, useful and applicable level in the context of the target audience. For instance, when working with a small village community in a rural area, members of the Insight Centre may look at relevant themes such as the local heritage data. A project, such as data collection and analysis can be designed to use the data to develop an online archive of the community history made up of photographs, films, and podcasts. Furthermore, all children are now allowed to learn how to code and so in a small school of about one or two teachers, who probably do not know how to code, the Insight Centre introduces the mentoring programme as an indoor activity. This is expected to become a part of the fabric of teaching in that community. This approach involves teaching the teachers through the centres but also involves work in the classrooms to show the teachers how the activities are done. This is a part of the primary requisite to train the trainers, who are working in government education centres. Besides working through educational centres, the Insight Centre also works directly in schools. As part of these engagements, the Insight Centre’s EPE programme demonstrates to people how science and technology are changing and the importance of taking ownership of the change and becoming active participants in new or emerging technologies.

Outreach activities affect the operation of the Insight Centre in many ways. Firstly, the activities help to develop science-oriented future researchers of the Insight Centre and of course other centres. In other words, the activities are geared towards up-skilling of people for research works in the future. Secondly, the outreach target audience is taxpayers whose money is used to finance the activities of the Insight Centre. For transparency, the Insight Centre is required to show taxpayers the value for their tax money. Thirdly, with the way science and technology are developing, there will be opportunities for decentralisation. For instance, working from home will demand improved means and a sense of connectivity. Also, other science research domains at the Insight Centre such as Web Analytics, etc., whether applicable in Agriculture or Fishery; they are parts of the research efforts beneficial to the society.

3. The Question approach: This dwells on the understanding that everything done in science should not be taken for granted as beneficial. In other words, every outcome of scientific investigations should not be assumed to benefit society. The fact that scientific results will be beneficial is far from reality; particularly in the 20th and 21st centuries – the era of the modernised industrial revolution, high-level technology and science have been used to destroy the world in so many ways. For instance, human societies are contributing to climate change through the burning of fossil fuels at a huge rate. Scientific research has led to the development of weaponry (e.g. nuclear weapons) that can destroy the planet. For too long, technology has been used to destroy people and the world. Therefore, people should not take it for granted that everything from science and technology development is good and would necessarily benefit humanity. The Internet, for example, is a great development for humanity; however, it has also brought cyberbullying and loss of privacy. People should not ignore the big issues associated with science; instead should question the importance, benefits and issues of science,
and also question how to improve on the outcome of positive scientific research.

The approaches to EPE are interrelated. The first two approaches ‘create’ and ‘include’ can be regarded as external activities. The last one, which is ‘question’, is internal since it focuses on ways to connect the scientific community with the positive needs of the society. The ‘question’ approach also involves external activities such as bringing awareness about unintended scientific outcomes not only to researchers but also to consumers alike. For example, the Insight Centre provides lectures to people on how to avoid and how to report cyber-bullying problems – an important aspect of the science outreach responsibility.

The important issues being tackled by the ‘questioning’ outreach strategy is how to overcome the negative results of science and technology research. While efforts are geared towards educating the user community, policymakers are inclusive. EPE is not only about talking to the grass-roots individuals, but also the government and policymakers as an important part of society. As an example of policy change, the coding programme mentioned earlier was initially done by volunteers from the Insight Centre and other organisations involved in mentoring in the classroom and through the after-school volunteer CoderDojo clubs. Currently, a policy change had been achieved in support of computer subjects in schools.

**Recommendation for New Centres**

High performing CoEs do not only use outreach to educate the public about scientific development but also they design outreach to popularise their output within the various demographic strands of the society, within the economic, business and educational sectors, social and political environments as well as in the local and international communities where possible. They invest time, money, and expertise in programmes that introduce science awareness and direct leaving certificate students towards the stem subjects to ensure there is a good interest in sciences at college levels. In some cases, the CoE tries to influence national policy-making through recommendations on subjects that should be introduced into the post-secondary school level with the hope that it could drive interest in science and technology subjects. Such initiative helps to put the CoE in the news due to media publicity.

### Table 4: Summary of Public Outreach

<table>
<thead>
<tr>
<th>Practice</th>
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<tbody>
<tr>
<td>A dedicated public outreach team.</td>
</tr>
<tr>
<td>All researchers collaborate with a public outreach expert to bring the EPE programme to target different age groups in public outreach.</td>
</tr>
<tr>
<td>The three principles of the public outreach approach:</td>
</tr>
<tr>
<td>• Create – an approach to get people involved in scientific activities.</td>
</tr>
<tr>
<td>• Include – make all sectors of the economy, community, and the society the target for EPE activities.</td>
</tr>
<tr>
<td>• Question – teaches the idea that science and technology research should be evaluated to understand whether outcomes are beneficial to humanity or not.</td>
</tr>
<tr>
<td>Public Outreach performances to be measured using KPI for each researcher or staff member.</td>
</tr>
<tr>
<td>To attract collaborators, the centre promotes three key areas: within the academic community, in the industry, and national and international environments.</td>
</tr>
<tr>
<td>Membership in external networks to promote the participation of women in IT, science, and technology.</td>
</tr>
</tbody>
</table>
5 Technology and Knowledge Transfer
Many definitions of the concept exist without a clear consensus on the nature of the transfer process; thus, the context tends to underpin the process as well as the definition of the term technology and knowledge transfer\(^6\). An example cited by the above author is that in developed countries, the concept often refers to “the process whereby universities or CoEs provide access to technologies created there through a variety of mechanisms for interaction with market operators”\(^6\). Similarly, the term may also refer to the process by which an across-sectoral or cross-national boundary transfer of technology and know-how could involve commercial and non-commercial activities, movement of technical information, physical material assets, and immaterial elements, persons with specific capabilities\(^6\). While technology per se has been defined as “the systematic knowledge for the manufacture of a product, for the application of a process or the rendering of a service, including any integrally associated managerial and marketing techniques”\(^7\).

The WIPO\(^8\) plays key roles in support of a mutually beneficial technology transfer through the arrangement of patent information services, innovation support programmes and tools, projects, and activities. Using its committees, WIPO delivers BDV PPP and dispute resolution services and organises knowledge transfer-related activities, including capacity building and training on transfer of technology\(^8\).

By reference to the definition of technology and knowledge transfer, certain categories of transactions constitute technology transfer\(^6\). Consequently, the activities leading to the identified transactions can be accepted as facilitators of technology transfer:

- The assignment, sale and licensing of all forms of industrial property, except for trade/service marks and trade names;
- The provision of know-how and technical expertise in the form of feasibility studies, plans, diagrams, models, instructions, guides, formulae, designs, specifications and equipment for training, services involving technical advisory and managerial personnel, and personnel training for the installation, operation and functioning of plant and equipment, and turnkey projects;
- The provision of technological contents of industrial and technical cooperation arrangements.

Based on extensive literature review on Sub-Saharan African economies, authors assert that governments targeting Foreign Direct Investment (FDI) and focusing on implementing development objectives has a set of factors to facilitate technology and knowledge transfer\(^9\). The factors that influence technology and knowledge transfer include effective industry institutions, education effectiveness, and the joint presence of high government policy incentives, effective industry institutions, and educational effectiveness. The substance in this assertion centres around the number of institutions involved, the quality and quantity of local firms, the human resource management, and the general policy framework and regulations designed to influence the quality of technology and knowledge transfer\(^9\).

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Study Findings

All centres work with industrial and other partners in various sectors to deliver technology and knowledge transfer services and products. Within industry-focused CoEs, they look to marrying technology transfer with IP arrangements by simplifying both the pricing and monitoring of IP processes and activities. As a further way to facilitate technology transfer, the IPC brings together the TTOs and its partner universities into the management of IP created by the centre to simplify the IP process.

Industry-focused centres employ use cases and applications to bring their theoretical know-how into tangible, practical solutions for its partners in a joint effort. Theoretical knowledge enables the centre to design customised applications as problem solutions and to validate the solutions as best-fit solutions for the partners' specific business challenges. Many centres are using a staged-gate model within research and innovation activities to support the way they transfer technology and knowledge to end-users. Centres use a range of techniques including processes, experiments, prototypes, pilots, and IP to transfer knowledge. Some centres include a feedback loop like two-way knowledge transfer of real-world scenarios and real business problems.

Error! Reference source not found. provides a summary of the best practices of technology transfer.

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<th>Practice</th>
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<td>Delivery of partner-centric solutions, being industry-focused in research methodology promotes technology development with industry relevance.</td>
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<td>Usage of the feedback cycle to understand industry need as a guide to the design and development of effective solutions that can be passed to partners benefits and technology and knowledge transfer.</td>
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<tr>
<td>Use of the iterative cycle of experiments, prototypes, pilots, and IP with feedback loop in the iteration can promote relevant technology development.</td>
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<td>Simplification of the IP process.</td>
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<td>Innovation Cycle demands the project work be designed to combine research with real-world deployment to meet real business problems.</td>
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<tr>
<td>Innovate with industrial partners to follow a cycle of short-term use-case-based activities with knowledge feedback into the projects.</td>
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<tr>
<td>Projects are developed and approved using a standard stage-gate model for innovation through the development of technology roadmaps used to define areas of interest to the centre.</td>
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<tr>
<td>Catalogue of technology demonstrators, IP and Analytics technology reviews, state-of-the-art reviews of data analytics technologies and tools, experts in data analytics and visualisation, etc., all made available to its members.</td>
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<tr>
<td>To establish industry collaboration, the centre has calls for demonstrator proposals; selection of the proposal, rating based on criteria and decide on the best choices of proposals.</td>
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<tr>
<td>Transfer knowledge and expertise via a feedback loop in the innovation cycle</td>
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<tr>
<td>- Implement a prototype in industrial pilots and research results in products of industry partners.</td>
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<tr>
<td>- Identify constraints in existing tools; identify opportunities for changes in work practices. Demonstrate the use of tools of partners in prototypes.</td>
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6 Performance and Impact Assessment
One of the definitions of a CoE in the context of project management is that it creates an environment to deliver a continuous stream of successfully managed projects the success of which is measured by having achieved performance that is in the best interest of the whole company as well as the specific project. The knowledge of the requirement is to be subjected to performance appraisal as the centre’s policy creates an impetus that drives a harder work environment and, consequently, an improved level of achievement. This applies to the individual staff/researcher level as well as the organisational level from funding agencies.

Findings from literature and this research suggest that to meet high targets often demanded of CoEs, the goals must be broken down into manageable sizes, operationalised into daily activities, and imbedded into KPIs with metrics to measure progress in the centres towards the set goals, periodically. The management must be familiar with their unique set of success factors or enablers and should make an effort to harness them even deeper.

The impact assessment may be improved through practices that also create a direct interaction between the CoE and society. For example, one centre has been given an expanded mandate to the measurement of EPE performances using selected KPI metrics. This directive makes it compulsory for each researcher or staff of the centre to be involved in at least four of EPE programmes per annum, and that the centre must record a 25% personnel involvement by 2019. Some of the recommended activities include the following:

1. Contributions to online communications
2. Development of online resources
3. Communications/Engagement training
4. Collateral for a lay audience
5. Development of school interactions
6. Teaching materials/methods
7. Festivals/events in institutions

**Study Findings**

This study reveals that a couple of challenges affect the performance of research instructions in terms of operations, organisational autonomy, operations. All these challenges and impacts more the CoEs’ output, according to findings. Firstly, the Big Data industry directly affects the strategy and performance of the BDAI-CoE, and secondly, another industry status with regards to their relative strengths or weaknesses can impact negatively on the core elements of the BDAI-CoE model. In a nutshell, an industry status has been argued to represent a significant influence on the research performance of academics. Besides, the lack of adequate funding, the need to meet extra high-level targets, etc., often put most CoEs under pressure of performance. Another constraining challenge is the conflicting interests of stakeholders arising from the fact that funding agencies are usually in the public or academic sector while the users of their research outputs are usually in the industry, the private sector.

To ameliorate some of these challenges, a few centres create an Industry Advisory and Scientific Advisory Committee to oversee performances in line with their KPIs. Other strategies have been suggested as possible ways of improving performances and operational efficiency: For example, decision-making based on meritocracy should positively affect funding decisions, performance evaluations, and rewards. For example, one centre measures its performances bi-annually and has operationalised KPIs to cover

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a lot of the impact areas, such as economic, commercialisation and academics. Another centre monitors its performance and impacts through KPI review on a monthly basis internally and quarterly with external funders.

Error! Reference source not found. shows a summary of good practices in performance and impact assessment for a CoE.

### Table 6: Good practices in performance and impact assessment

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<td>Break high-target goals into manageable sizes, create KPIs, operationalise and measure periodically.</td>
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<tr>
<td>Management should familiarise with enablers/success factors and harness adequately.</td>
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<tr>
<td>Create direct interaction between centre and society through enlightenment programmes and training and use policies to backup participation where necessary.</td>
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<tr>
<td>To improve performance:</td>
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<tr>
<td>- ameliorate challenges through the use of dedicated committee to oversee performances of centre</td>
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<tr>
<td>- apply meritocracy to decision-making, particularly on funding decisions.</td>
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7 About
7.1. About BDVe
The goal of BDVe project is to support the Big Data Value Public-Private Partnership (BDV PPP) in realising a vibrant data-driven EU economy by effectively combining in a consortium Large Enterprises, SMEs and Academia.

7.2. Big Data and AI Centres of Excellence
The BDV PPP is furthering the development of the European data ecosystems as a data-driven economy. One key action is the work to support a network of BDAICoE to foster collaboration, share best practices and know-how among centres, facilitate meetings of the network participants and provide expert guidance and support for the establishment of new CoEs in Europe.

7.3. Big Data and AI CoE Best Practice Framework
A best practice framework for BDAICoEs has been developed through an extensive survey of existing CoEs in Europe, identification of their challenges and opportunities, as well as their best practices and guidelines. The framework has been enhanced by feedback from experts within CoEs.

7.4. Persons of Excellence
We conducted interviews with a wide range of experts within the CoEs, from the top executives and academic leadership involved in daily operations, management decisions and strategic decision-making processes to specialists in areas such as academic-industry collaborations.

7.5. Call to Action
- Are you a Big Data and Artificial Intelligence Centre of Excellence and want to share your best practices?
- Are you a senior manager or director of a Big Data and Artificial Intelligence Centre of Excellence and want to be interviewed?
- Are you a new Big Data and Artificial Intelligence Centre of Excellence or you know of any that seeks support?

Please do not hesitate to contact us at: edward.curry@insight-centre.org

7.6. BDAICoE Framework Team
- Edward Curry
- Edo Osagie
- Niki Pavlopoulou
- Atiya Usmani
- Umair ul Hassan
- Wassim Derguech

7.7. About Insight
The Insight Centre for Data Analytics is a joint initiative between researchers at Dublin City University, National University of Ireland Galway, University College Cork, University College Dublin and other partner institutions. Insight brings together more than 400+ researchers from these institutions, 100m+ funding, and with over 80+ industry partners, to position Ireland at the heart of global data analytics research.