RELEVANT, INCLUSIVE, TRUSTED AND OPEN INDICATORS FOR RESEARCH AND INNOVATION POLICY

D2.3 End of Pilot Phase Review

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Reviewers List

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0.2.1	29 July 2019	All Partners	Final Review
0.2.2			

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1.0 Introduction

The Big Data revolution and associated innovations in analytics such as machine learning and artificial intelligence are offering new opportunities to measure Research & Innovation (R&I) activities with more sectoral and geographical detail and increasing timeliness. In support of this, the EURITO project (EU Relevant, Inclusive, Timely, Trusted, and Open Research Innovation Indicators) aims to explore those areas where new data offers the greatest potential for R&I policy, to develop a conceptual model and technical methodology to produce new innovation indicators in response to emerging trends and changes in the science, technology and innovation landscape.

Since the project's inception in January 2018, the EURITO Consortium has developed a robust foundation of knowledge of the R&I policy landscape, and have identified the evidence needs of policymakers that are poorly addressed or remain unanswered with existing data sources and indicators. This work has informed the development of 8 agile data pilots to rapidly determine the potential of different data sources and identify high potential, technically feasible ideas that can be scaled-up, validated and visualised during the next stage of the project.

This document provides an outline of the rationale and decisions made in the selection of the four scale-up themes.

2.0 Summary of Pilots

The complete rationale, methodology and emerging findings for each of these exploratory pilots can be found in D2.2 Pilot Research Results. Below we provide a summary of each of the pilots, summarising its objectives and preliminary findings.

2.1 Pilot 1: Emerging Technology Ecosystems (with an application to Artificial Intelligence)

Technologies such as artificial intelligence are reshaping societies, economies and culture. To manage this global shift, policymakers need to be able to monitor the development and diffusion of transformative technologies, not only to encourage their adoption in sectors with fast growth potential, but also to steer their development in societally desirable directions. Using the case study of the Artificial Intelligence R&D ecosystem, this pilot has used natural language processing methods to analyse various sources of open and web data to measure levels of activity and specialisation in AI research, entrepreneurship and networking in the EU and its member states, to analyse gaps in the AI technological ecosystem in different countries, and to monitor its diffusion in different industries.

2.2 Pilot 2: Nowcasting Business Research & Development

Using Bayesian statistical methods and novel variables such as Economic Complexity Indices, this pilot explores the modelling strategies that can be used to nowcast Business Enterprise Research Development (BERD) at the national and firm level. These analyses demonstrated the challenges and complexities that can arise when using novel data sources with irregular coverage to predict highly uncertain, innovation related outcomes.

2.3 Pilot 3: Technological Change Indicators

The results of this analysis demonstrate how we can capture technological change based on 'semantic' discontinuities in topic co-occurrence, with a case study in the domain of worldwide bioenergy R&D. This pilot demonstrates how such an approach can be used to analyse the historical evolution of the biofuel field to monitor important breaks in technological trajectories, helping to identify the emergence of new ideas, applications or actors which might be of interest to R&I policymakers and investors.

2.4 Pilot 4: Standards as Innovation Diffusion Indicators

This pilot uses data acquired from the International Standards Organisation (ISO) detailing the adoption of various technology standards in business to explore and track process innovations in business to inform productivity, quality and sustainability goals in the EU.

2.5 Pilot 5: Evidence Base for Mission-Oriented Research & Innovation

This pilot prototypes new indicators about mission-oriented R&I policies reflecting their rationale and pathways to impact through network-building and interdisciplinary crossover. Using an approach where mission statements are deconstructed into their components to query innovation databases, measuring potential and active 'mission fields', the pilot develops prototype indicators about the UK's grand challenge mission to "Use data, Artificial Intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030" with research funding data from the UK.

2.6 Pilot 6: Advanced Research & Innovation Funding Analytics

We explore opportunities to apply network science and machine learning to develop indicators of research impact that are more context-aware and able to capture the way in which innovative research transforms the structure of knowledge networks through new recombination's of topics. We build prototypes of these indicators using data about EU funded research projects and outputs from CORDIS and the OpenAIRE repository.

2.7 Pilot 7: Inclusive Innovation

This pilot uses a machine learning algorithm to predict gender and ethnicity of personnel in EU companies from the CrunchBase technology directory. This information is used to produce indicators of socio-demographic diversity in different countries, technology sectors and cities, also considering intersectional metrics capturing specific combinations of socio-demographic attributes.

2.8 Pilot 8: Linkages and Knowledge Exchange Indicators (Healthtech)

This pilot maps the network structure of research projects and outputs in the funding data of a funding agency in Denmark and the CORDIS and OpenAIRE datasets. This pilot demonstrates how these data can be used to generate indicators to increase understanding about the links between research funding and collaboration and knowledge exchange in the EU.

3.0 Development of the Scale-Up Themes

3.1 Rationale for the Development of the Four 'Scale-Up' Themes

While the range of research questions, data sources and methodologies featured in our pilot portfolio demonstrate the breadth of opportunities to use new data sources and methods to develop Relevant, Inclusive, Timely, Trusted, and Open (RITO) indicators for innovation policy in the EU, we have selected four 'scale-ups' for additional data collection, processing, analysis, validation and visualisation in subsequent stages of the project.

To select the scale-up pathways, we reviewed the pilots, paying attention to their themes and findings. Rather than choosing individual pilots to scale and excluding others, our approach was to find common themes that could be used to group them, and then to consolidate and build upon the points of success achieved during the pilot phase. Where this was possible, we were able to produce scale-up themes that make the most efficient use of data sources and methodologies, while maintaining logical thematic areas.

To avoid a situation where these scale-ups are disjointed or siloed we have proposed frameworks that integrate them, illuminating various possibilities to enhance R&I measurement with new methods and helping us to prioritise the types of indicators that we will develop in each scale-up.

The first framework maps the scale-ups against stages of the policy cycle (Agenda setting, Choice evaluation, Monitoring, and Evaluation) and the second against functional use of indicators (Descriptive, Predictive, Analytic or Decision Support) Please see below for some preliminary allocations of themes to frameworks:

	Policy cycle frame	Functional frame
Theme 1: Emerging technology	Agenda setting	Descriptive, analytic
Theme 2: Research Funding Analytics	Choice evaluation	Decision support
Theme 3: Inclusive and Mission-Oriented R&I	Monitoring, evaluation	Descriptive, analytic
Theme 4: Predictive analysis	Monitoring	Predictive

As we enter the next stage of the project we will seek validation from project stakeholders about which of these frameworks are more useful to organise our indicators to inform the development of the data visualisation tools.

In addition to the above frameworks, these four streams of analysis have been classified in two categories from the standpoint of their technical requirements: 'robust and 'exploratory' in order to support the development of data infrastructure. The robust scale-ups are those which require big data technologies or suitable technologies for integration with advanced data visualisation. These will be underpinned by a Data

Analysis and Production System (DAPS), which orchestrates a stable pipeline of data collection, enrichment and machine learning. EURITO's DAPS codebase builds on the existing Nesta DAPS codebase and cloud infrastructure. This allows for us to develop in a stable environment, whilst also meaning that EURITO's outputs are physically separated from Nesta's. In the future this will mean that the infrastructure can be sustained by a third party, outside of the Consortium.

On the other hand, the exploratory scale-ups, rather than expanding the volume of data or imposing significant technical challenges, are those which expand the scope of analysis. In other words, the exploratory scale-ups aim to address more questions, or indeed generate more indicators, based on data which has been validated at the exploration stage.

3.2 Overview of the Four Themes

Below we provide an overview of each of the four scale-up themes, with an overview of the proposals for how these streams of analysis will be updated and 'reconditioned' for the next phase of the project.

3.2.1 Theme 1: Emerging Technology and Mapping

This Theme will combine *Pilot 1: Emerging Technology Ecosystems (Artificial Intelligence) and Pilot 3: Technological Change Indicators* to develop an alternative approach to generate indicators about emerging technology Research and Design (R&D) and its technological innovation system. Furthermore, there is scope to draw upon methods used in *Pilot 5: Evidence Base for Mission-Oriented Research & Innovation* in order to include a dimension of mission mapping to capture where emerging technologies are being used to tackle mission challenges or in support of Sustainable Development Goals (SDGs).

To achieve this, we will use a collection of unstructured data sources that will be queried using an informational retrieval tool that takes an initial seed of keywords and expands it using measures of semantic similarity estimated with machine learning methods. We envisage that such an approach will allow us to measure:

1. Levels of activity in the emerging technology as well as their development and geography
2. State of the technological ecosystem for an emerging technology in different countries and regions, capturing the presence of complementary activities such as research, funding, business activity and networks.
3. Sub-national concentration of activity capturing clustering and spatial disparities in technology development
4. Application domains of the technology being developed, including industrial applications and potential relevance for addressing different Sustainable Development Goals.
5. Structural change in the development of the technology and its components

In order to further develop the preliminary analyses undertaken in each of the aforementioned pilots, scale-up development will include:

- The addition and application of new data sources including patents and publications

- The query system will be further improved and undergo rigorous validation.
- The model used to conduct the labelling of dataset will be further improved and validated.
- Test options to automatically generate keywords enabling the analysis of structural change in new sectors.

3.2.2 Theme 2: New Research Funding Analytics

This Theme will combine *Pilot 6: Advanced Research & Innovation Funding Analytics* and *Pilot 8: Linkages and Knowledge Exchange Indicators (Healthtech)* to develop novel indicators of research diversity, novelty and impactfulness. Furthermore, analyses from *Pilot 4: Standards As Innovation Diffusion Indicators* will be further developed to inform the link between research and standardization.

To achieve this, this scale-up will use complex networks analysis and machine learning techniques to build the following policy-relevant indicators:

1. By connecting projects, organisations, researchers and their research outputs, we will form a complex network of R&I ecosystems to be able to describe these entities through their connectivity with those ecosystems. This will allow us to identify the most central entities in the ecosystem and compare this centrality to the funding they are associated with.

2. Using citation counts to measure the impact of funded research projects typically leads to significant biases: older publications have had more time to accumulate citations; citation rates differ between disciplines; the absolute number of references made between publications changes over time. This scale-up will develop a normalized citation index, which could be used as an additional dimension to assess the output of research projects.

3. We will analyse combinations of keywords related to academic publications to evaluate publications in accordance with their 'novelty' and 'multidisciplinary diversity.'

To ensure that the aforementioned indicators are accessible and useful to the relevant users via interactive visualisations this scale-up aims to develop an in-depth understanding of what levels of aggregation in terms of unit of analysis and geography will be useful to stakeholders.

3.2.3 Theme 3: Inclusive and Mission-Oriented R&I

This Theme will further develop analyses conducted in *Pilot 7: Inclusive Innovation* in combination with *Pilot 5: Evidence Base For Mission-Oriented Research & Innovation* in order to build the evidence base on the socio-demographic diversity of R&I activities in different locations and technology sectors. This will provide policy and decision makers intending to implement mission-oriented policies with indicators to support the design of bolder and directed initiatives.

In this scale-up, we will build on the exploratory work conducted, using a combination of network analysis, machine learning and natural language processing techniques to develop the following indicators:

1. Levels of activity/funding by mission area
2. Evolution of activity by mission
3. Disciplinary breakdown/composition of mission research
4. Distribution of outcomes across missions
5. Active actors (established and new entrants) in mission fields
6. Gender balance of actors in mission fields

3.24 Theme 4: Predictive Analysis

This scale-up will use all the data produced across Themes 1-3 to perform predictive analyses of relevant innovation variables. In particular, it will initiate the triangulation between the indicators based on novel data and methods and traditional data sources such as publications, patents and standards, that will be the focus of the validation work package.

Building upon the methodology used in *Pilot 2: Nowcasting Business Research & Development* this stream of work will develop a robust predictive nowcasting methodology for the sparse data regime we are likely to find with many innovation variables of interest, and that can be generalised across multiple R&I indicators which suffers from as few shortcomings as possible.

3.3 Stakeholder Engagement and Validation of the Scale-Up Themes

As transparency is a core value of the EURITO project, we implemented a structured process for stakeholder engagement to support the validation process for the selection of these four streams of analysis. During the period between April - June 2019, we brought together members of our R&I Policy Stakeholder and Knowledge Stakeholder Groups to obtain feedback for the selected scale-ups with the following questions used as a guiding framework:

- What policy agendas might the proposed scale-ups inform?
- What indicators should the scale-ups produce in order to inform policy?
- Who would use these indicators, and what pathways to their adoption and sustainability exist?
- Are there any other projects and stakeholder groups that the EURITO consortium needs to engage during the development and implementation of the scale-ups?

As a result of the workshop we obtained relevant feedback to reorient, redesign and reconsider some aspects, data sources, methodologies and potential applications that were not taken into account during the preliminary process design of the scale-ups, while validating and improving the design of the work developed; with the aim of identifying and defining those indicators that will support better decisions with bigger (and better measured) impacts in R&I policy making, and the best ways of visualising them increasing their usefulness and trustability within the different users profiles. Reports from each of these meetings can be found in the appendices (Appendix 1 and Appendix 2) of this document.

4.0 Next Steps: How Will These Learnings Influence the Next Phase of the Project?

We will use the technical input to review the methodology for the scale-ups. This includes incorporating additional data into the analysis and updating the analytical methods that we use.

1. We have identified key stakeholders for all the themes who we will be engaging with for the rest of their development and validation. Some of these stakeholders are technical experts who will provide input into the methodology, and others are domain and policy experts who will help us validate the findings and steer the development of indicators to maximise their value.
2. We have initiated the user research process to identify suitable strategies to communicate our indicators to policy audiences.

Furthermore, learnings from the Pilot Phase were used as an input for deliverables D3.1 “Design of data collection phase”, D3.2 “Quantitative Methods” and D3.3 “R&I performance indicators”, where requirements for data infrastructure, used analytical methods and the final indicators are outlined.

Appendix 1

EURITO Pilot Scale-Up Validation Workshop
30 April 2019, 09:30 -12:30
Brussels, Belgium

Workshop Briefing Note

This note describes the context, goals and agenda of the EURITO scale-up validation workshop taking place in Brussels on the 30th April 2019.

Context

EURITO is a 3-year H2020 project that has the goal of developing Relevant, Inclusive, Trusted and Open (RITO) indicators for Research and Innovation (R&I) policy in the EU. The EURITO consortium involves Nesta (the project lead), DTU (Denmark), Fraunhofer FOKUS (Germany) and COTEC (Spain).

The project started in January 2018 with a scoping phase to identify policy-relevant questions that could be addressed with big data and data science methods.

This was followed by an exploratory phase, where we carried out eight data pilots exploring various data sources and methods to address those questions. This included:

1. Mapping emerging technology ecosystems with an application to AI,
2. Nowcasting business R&D,
3. Monitoring technological change,
4. Developing advanced research indicators,
5. Measuring gender and ethnic diversity in the R&I workforce,
6. Building an evidence base for mission-oriented R&I policies,
7. Measuring technology diffusion through the adoption of standards,
8. Measuring the impact of research funding on knowledge flow.

This document includes further detail about each of the pilots.

Having concluded this phase of the project at the end of March, we are now moving into the scale-up phase where we will draw on the lessons from the exploratory phase to select four 'scale-ups' for additional data collection, processing, analysis, validation and visualisation in subsequent stages of the project. Ultimately, we will be producing new indicators, four interactive visualisations about them, and open data and code that can be used to reproduce our analysis.

We are currently developing these scale-up ideas. Some potential focus areas include emerging technologies, R&D funding, inclusive and mission-oriented R&I indicators and predictive analyses of R&I data. The workshop on the 30th will help inform the selection and design of the scale-ups with the biggest policy potential for the production of Relevant, Inclusive, Timely, Trusted and Open (RITO) indicators for R&I policy.

Goals

The main goal of the workshop is to obtain feedback from key policy stakeholders in the European Commission about the four scale-ups we will be focusing on for the rest of the project. This includes answering questions such as:

1. Broadly speaking, what policy agendas might the proposed scale-ups inform?
2. More specifically, what indicators should the scale-ups produce in order to inform policy?
3. Who would use these indicators, and what pathways to their adoption and sustainability exist?
4. Are there any other projects and stakeholder groups that the EURITO consortium needs to engage during the development and implementation of the scale-ups?

We will use the results of the workshop to select and design the scale-ups. We will further develop their methodology and present it for validation by a wider set of stakeholders (including individuals and organisations identified when answering question 3 above) at an event in Madrid at the end of June.

Agenda

We envisage a maximum duration of 2.5 hours, with the following items in the agenda:

1. Introduction to the project (15 minutes with 5 minutes Q&A)
2. Scale-up validation (130 mins with 30 minutes per scale-up and 10-minute10 minute coffee break)
    a. Introduction to the scale-up (15 minutes)
        i. Research questions
        ii. Data and methods
        iii. Outputs
    b. Discussion (15 minutes)
3. Conclusion and next steps (5 minutes)

EURITO Pilot Scale-Up Validation Workshop
30 April 2019, 09:30 -12:30
Brussels, Belgium

Minutes of Meeting

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Minutes

Item 1. Introductions

Introductions were made by:
Consortium Parties:

- Nesta: Juan Mateos-Garcia (JMG) as Project Coordinator; Chantale Tippett (CT), George Richardson, Joel Klinger and Soraya Rusmaully
- Cotec: Aleix Pons and Eva Senra
- Fraunhofer: Knut Blind (KB)
- DTU: Agzam Idrissov

Item 2. Overview of the Project and Objectives of the Meeting - *Juan Mateos-Garcia*

Link to Presentation

JMG provided an overview of the EURITO Project. He noted that since its inception in January 2018, the Consortium has identified eight policy-relevant questions and carried out a systematic exploration of available data sources and methods that can be used to develop indicators addressing them. These 'pilot' studies have been published and can be found at the following link. He added that, the goal was to identify high potential, technically feasible ideas that we can scale up, validate and visualise to support the development of RITO indicators.

JMG then outlined the objectives of the meeting: to present four streams analysis which have been derived from the eight 'pilot' analyses, with the greatest policy potential for the production of Relevant, Inclusive, Timely, Trusted and Open (RITO) indicators for R&I policy.

He added that the goal of the workshop was to obtain feedback from key policy stakeholders about the four scale-ups and suggested that the following question be used as a guiding framework:

- What policy agendas might the proposed scale-ups inform?
- What indicators should the scale-ups produce in order to inform policy?
- Who would use these indicators, and what pathways to their adoption and sustainability exist?

- Are there any other projects and stakeholder groups that the EURITO consortium needs to engage during the development and implementation of the scale-ups?

Each Theme Leader provided an overview of their theme and sought feedback from the group.

Theme 1: Emerging Technology Mapping

This scale-up aims to build on the pilots of emerging technology ecosystems and technological change, generating indicators about levels of research and innovation activity in emerging technologies in the EU, and about structural change in those technologies. It could also include a dimension of mission mapping capturing where these technologies are being used to tackle mission challenges or Sustainable Development Goals (SDGs). Here, the mapping of international standards to the SDGs by the International Standardization Organization ISO could also be integrated.

Discussion/Feedback

- The group sought further clarification on the types of technologies that would be captured and how this selection/prioritization would be conducted. JMG highlighted that one option would be to create an instrument/tool that is flexible, allowing users to present data that is relevant to their specific needs, i.e. where there might be a particular interest in AI, policymakers will use the tool in a similar way to a search engine, in order to generate a set of outputs relevant to the requirements of their policy activities and decisions. Ultimately, the selection of technologies would be driven by the user.
- Furthermore, he noted that unlike the European Innovation Scoreboard, the data gathered here is far more granular which will allow for exploratory analyses i.e. to determine to what extent the technologies being developed focus on one sector or another.
- The question of geographical granularity and, whether national level data is sufficient was heavily discussed. And, there appeared to be strong demand for indicators and information that represents activity at a regional level, in particular NUTS-2.
- Some members of the group discussed whether an attribution analysis where one can retrospectively identify the point at which a specific technology has emerged as well as monitoring its trajectory towards success/failure etc might be feasible. JMG noted that while this would be an interesting analysis to undertake, it would be rather challenging within the constraints of the EURITO project. Analyses undertaken in other scale-ups, such as the analysis of research funding, might help with this.
- There was also some discussion of using the data collected into order to provide more robust evidence of emerging technologies at the sectoral level. Further, it was suggested that it would also be useful to demonstrate the value of these emergent technologies by linking them with the economic structures of each of the respective countries.
- Ana Correira noted that the addition of 'University Skills' data would be useful in order to understand the distribution of AI talent within the EU.

- What is the role of R&I to derive these emergent technologies?

Theme 2: New Research Funding Analytics.

This scale-up would build on the pilots on Knowledge Flow and Advanced Funding Analytics to develop novel indicators of research diversity, novelty and impactfulness including the link between research and standardization.

Discussion/Feedback/Clarification

- It was noted that there are several other groups which are also incorporating OpenAIRE data into their projects, and it was suggested that the team consider the impact of the how data is being used and re-used by others.
- Members of the group sought further information on the dimension of time would be incorporated into the analyses. AG shared some early ideas of what this could look like i.e. use of network analyses to show how a publication may have led to a patent, etc.
- Members of the group asked what the predictive power of Cordis and FP7 and H2020 data could be in retrospectively understanding the impact of these streams of funding. GR noted that there was some scope for this work, but as yet no formal analyses has been conducted.
- Ana Correira recommended that colleagues in Unit A5 at REA would be useful discussants to engage with for this stream of work.

Theme 3: Inclusion in Inputs and Outputs:

This scale up would build on the inclusive innovation pilot and consider socio-demographic diversity in innovation activities based on the data sources above, as well as inclusion in outcomes in terms of research and innovation activity relevance for SDGs. It would work as a 'layer' of enrichment for the data used in other pilots rather than a thematic pilot on its own right.

- The group sought further clarification on the process of gender labelling. CT confirmed that in the current analyses the gender labelling has been based on first names and surnames with the algorithms able to make predictions about the likelihood that a name is male or female
- There was much discussion concerning the way in which gender classification would be validated. CT confirmed that although the current analyses has not been rigorously validated, during the scale-up phase we would consider the use of native language speakers to validate edge cases. JK added that there may also be scope to incorporate an uncertainty threshold throughout the entirety of the analysis. Thus, the idea would not to discard data but, acknowledge that there may be uncertainty within the data.
- The group queried whether factors other than gender and diversity such as socioeconomic status would be considered in this scale-up. CT confirmed that the data being used does not allow for this - but, JMG noted that factors such a geographical variation and the impact of urban/rural on R&I would be considered elsewhere.

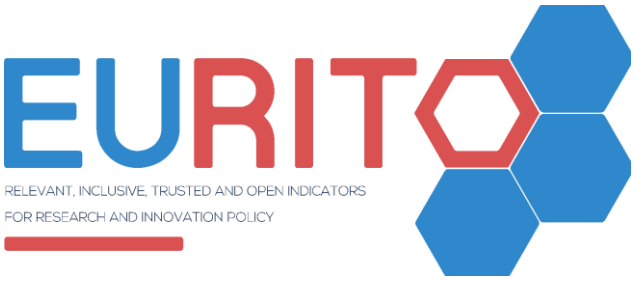
Theme 4: Predictive Analysis:

This scale-up would use all the data produced in the project to perform predictive analyses of relevant innovation variables. An interesting aspect of this scale-up is that it would initiate the triangulation between our indicators based on novel data and methods and traditional data sources, like publications, patents and standards, that will be the focus of the validation work package.

Discussion/Feedback/Clarification

- The group provided very positive feedback, noting that for many policymakers predictive indicators are often very valuable - but, highlighted in order to be beneficial such metrics must be sufficiently robust.
- The group discussed how to convey uncertainty about out of sample predictions without discouraging policymakers from using novel indicators
- A member of the group sought clarification as to whether 'lagged variables' are taken into consideration - she asked how it would be possible to address differences between countries with smaller economies where these kinds of metrics are very difficult to predict compared to larger, more stable economies where a single linear regression may provide more accurate results, more easily.

Appendix 2:



EU Relevant, Inclusive, Timely, Trusted, and Open Research Innovation Indicators

EURITO Scale-Up Validation Workshop agenda

20 June 2019, Madrid, Spain

Fundación Cotec para la Innovación, Velázquez 24, 2nd Floor, Right Door ·28001 Madrid

Time	Session
10:30 – 11:00	**Registration** and Arrivals
11:00 – 11:10	**Welcome and Introductory Remarks**
11:10 – 11:30	**Introduction to the EURITO Project**: Overview of the Project Objectives
11:30 – 12:30	An Overview of the EURITO Scale-Up Themes: • ***Theme 1: Emerging Technology Mapping***: This stream of work seeks to generate indicators about levels of research and innovation activity in emerging technologies in the EU, as well as structural change in those technologies. We also aim to include a dimension of mission mapping where we capture where these technologies are being used to tackle mission challenges or the Sustainable Development Goals (SDGs). • ***Theme 2: New Research Funding Analytics***: Here, we will build upon novel indicators to understand how research funding contributes to the scientific excellence, research novelty and the development R&I collaboration networks in EU. • ***Theme 3: Mission and Inclusive Innovation:***: This stream aims to produce indicators of socio-demographic diversity in different countries, technology sectors and cities to consider and measure gender and ethnic diversity in innovation activities. • ***Theme 4: A Predictive Analysis***: Here, we aim to use all the data produced in the project to perform predictive analyses of relevant innovation variables.
12:30 – 13:00	**'Data for Good' Project Presentation** *SAS, leading company in analytics and predictive visualization, in collaboration with the Madrid City Council will provide an overview of their "Data for Good" project which encourages using data in meaningful ways to solve humanitarian issues around poverty, health, human rights, education and the environment.*
13:00 -14:00	*Lunch*
14:00 -15:30	**Interactive Workshop**: Validating the Scale-Ups *Participants will have an opportunity to get an in-depth insight into each of the scale-up themes.*
15:30 – 15:45	*Coffee Break*

15:45 – 16:00	**Final Questions**
16:00 – 16:15	**Closing Remarks**

Rapporteur Report

Introductory Remarks

The meeting was opened by Project Director, Juan Mateos- Garcia of Nesta UK with an overview of the EURITO Project. Since its inception in January 2018, the Consortium has identified eight policy-relevant questions and carried out a systematic exploration of available data sources and methods that can be used to develop indicators addressing them. The complete rationale, methodology and emerging findings for each of these exploratory pilots can be found in D2.2 Pilot Research Results.

The goal of this workshop was to review four high potential, technically feasible ideas that the team wishes to scale up, validate and visualise to support the development of relevant, inclusive, trusted and open indicators to support Research and Innovation (R&I) policy.

As such the objectives of the meeting were: *to present four streams analysis which have been derived from the eight 'pilot' analyses,* to shed light on their requirements, characteristics, data sources, methodology and potential application in policy.

Each Theme Lead provided an overview of their work, outlining how and why these streams of work have been selected for the next stage of the EURITO project.

Overview of the Proposed Scale Up Themes

Theme 1. Emerging Technology Mapping

This stream of work aims to generate indicators about levels of research and innovation activity in emerging technologies in the EU, as well as structural change in those technologies. EURITO also aims to include a dimension of mission mapping to capture where these technologies are being used to tackle mission challenges or the Sustainable Development Goals (SDGs).

Theme 2. New Funding Analytics

This stream of work will build upon novel indicators to understand how research funding contributes to the scientific excellence, research novelty and the development R&I collaboration networks in EU.

Theme 3. Inclusive and Mission-Oriented R&I

This stream aims to produce indicators of socio-demographic diversity in different countries, technology sectors and cities to consider and measure gender and ethnic

diversity in innovation activities. It is also aimed to include novel indicators that can be used in designing, implementing and evaluating mission-driven R&I policies

Theme 4. Predictive Analysis

This stream of work will use all the data produced in the project to perform predictive analyses, providing more timely or more granular estimates of relevant innovation variables, for example R&D expenditure. Quantification of, and effective communication of uncertainty is a core tenet of this scale-up.

Following the presentations to provide an overview of the Scale-Up Themes, workshop attendees were invited to engage in small round-table discussions to obtain structured feedback. The following questions were used as a guiding framework to encourage debate:

- What policy agendas might the proposed scale-ups inform?
- What indicators should the scale-ups produce in order to inform policy?
- Who would use these indicators, and what pathways to their adoption and sustainability exist?
- Are there any other projects and stakeholder groups that the EURITO consortium needs to engage during the development and implementation of the scale-ups?

Below we highlight the key questions and recommendations that arose through these discussions:

1. MAPPING EMERGING TECHNOLOGIES

Participants held an intense debate about how to relay the results of the indicators to the decision makers. GIven that one of the central aims of the EURITO project is to develop indicators that are relevant, consistent and reproducible - it was noted that this may affect the keywords considered for each topic.

Additional items that were raised included:

- Some participants recommended that it may be necessary to consider what kinds of participants should be asked to assist in the validation of these analyses in order to correct biased systems
- The necessity of exploration of new data sources such as trademarks, and other non-conventional sources beyond what is currently available and what has been used previously.
- Questions were raised regarding the geographical resolution of indicators. Will indicators represent national, local, regional levels of activity? And, how can we ensure that those indicators which are adopted for at regional level can be comparable to even lower levels of granularity. It was noter that the greater the resolution the more likely the adoption of new indicators will.

- There were some concerns raised in relation to data matching between different sources (usually data models are not compatible) with commercial applications.
- Some participants raised key concerns regarding the representativity of seed terms and, how we can ensure that we do not miss 'hidden' emerging trends.

2. NEW RESEARCH FUNDING ANALYTICS

Some participants recommended that it may be useful to review the extensive and growing literature on alternative metrics for publications - and, comparing the results obtained for the EU with what is known for the US (e.g. CORDIS/PubMed data vs National Health Institute).

Participants mentioned eCorda database. This database links EU projects with the publications that have been generated out of them, offering a fuller set of data compared to CORDIS, which we are currently using.

With regards to the Normalised Citation Index indicator, one suggestion was to distinguish between conference papers vs journal papers. In addition to this, some participants sought further explanation regarding the purpose of certain methodologies, such as the normalization of publications or the k-factor.

Geographic granularity was also highlighted as an important element to consider. It was agreed that users should be able to 'drill down' to regional levels in order to detect actionable insights.

Many participants also agreed that an interactive visualisation for this stream of work would not benefit from too much complexity. It was agreed that a tool should be able to be used to 'tell a story' of the way in which an innovation may evolve over time.

3. MISSION-ORIENTED AND INCLUSIVE RESEARCH AND INNOVATION

Many of the participants, reflected on the concept and definition of the term "mission", specifying that possible differences could emerge in terms of process (e.g. citizen-led or top-down). The participants questioned the social approach of the determination of missions and the effect on the society beyond innovation indicators.

It was noted that "mission" concept, as the concept established and developed in Germany, was not spread in other countries. It could mean a challenge on how to align those missions for EU level and how to deploy the mission across organisations.

As well, it is necessary to consider and reflect about the trade-offs/complementarities/etc. that will result from the missions to address from the perspectives of the European Commission and the individual countries.

The missions we are currently trying to address are far more complex (socially, economically). It is unclear how well the coordination/experimentation aspects of multiple missions will be as effective, and also whether the missions are ambitious enough to really promote the type of innovation required to make a serious difference to the issues at hand. How robust will missions be to changing political goals,

governments, etc.? Some will certainly require a timeframe beyond what any given government administration is able to achieve during its tenure. Are the missions correctly formulated or are they already too narrowly defined? For example, the moon mission didn't say 'go to the moon with a rocket' whereas we are now saying that 'we will treat chronic diseases with AI'.

Several questions regarding the process for selection of keywords for the mission topics (e.g. AI, chronic diseases) was mentioned too. At what point does human intervention make sense? How might language/vocabulary differ across different datasets?

It was agreed that there is a need to capture citizens impressions on the actual results and impacts of innovations, to ensure a society-centered policy making, stressing the need to adopt new approaches (social) for the evaluation framework of innovation policies.

The participants also pointed out that research (academic results) are absolutely different from innovation (citizen impact results). Due to the fact that missions set the goals but not the path, it could be difficult due to the uncertainty about what would be the path (new approaches, innovations) to reach the goals of the mission.

Specifically about the inclusion, it is even more difficult to find out the relevant data sources for innovation and its relation with the inclusion terms. Methodological questions were discussed about how to identify the relevant data (not just inferring i.e sex and ethnicity from names) and how to make it operational at different levels. Due to the specificity of inclusion, it has to be taken into account some procedures to be tolerant to failure (partial) in the results without compromising all the gathered data.

Many concerns were raised concerning the ethics of using an algorithm to assign ethnicity or gender with lack of informed consent.

There were some questions around the extent to which we can truly understand the societal impact of R&I using data sources such as research funding, patents, etc.

4. PREDICTIVE ANALYSIS

For some participants this pilot looked like the most promising because it looks both doable and well linked to the actual data. For some others, part of the EURITO mission is precisely to think a bit "out of the box" - from this perspective, this pilot might not be "open" enough to capture disruptions. Therefor, it seemed to be two different camps on the policy relevance/use of this scale-up:

1. This scale-up seems the most 'ready to go': It is using indicators that are already used to make policy decisions and making them more useful by increasing timeliness
2. The scale-up limits itself when sticking to existing R&I indicators as these can't answer many policy relevant questions. What is needed are e.g. BERD on a micro level (i.e. company level or least city level).

In general, the idea of the pilot is considered well headed: take mainly existing (macro) data; avoid data from firms (due to the complications that would entail working with them); assume some "structure" (associations in terms of economic exchanges across countries or sectors); with the goal of reducing the time lag of key indicators, e.g. BERD.

The project staff emphasizes the idea that it is equally important to come up with numbers with a shorter lag than to be able to explain the relationship between the agents and sectors in the analysis as well as the reasons why numbers change over time (a type of explanation which cannot be extracted with the existing database). The staff also makes a sound case for the complementarity between the four pilots: the idea is that insights from the other three scale-ups can be used to refine the predictions of this one. Even so, there seemed to be general agreement that the factors driving a prediction are often more important than the prediction itself.

Some participants point at the convenience of enriching the framework by including data on services in addition to trade when selecting data sources when incorporating country heterogeneities in the model —using the concept of the product/knowledge space—.

Other scale-ups fill the need to provide R&I indicators on a more granular scale. We explored the possibility of providing the most policy relevant (based on previous stakeholder engagements) existing R&I indicator — Business Expenditure on R&D (BERD) — on a company-level in the pilot phase of the 'Nowcasting R&D' pilot; however, we found that this was not feasible because the data sources to do this do not exist to do this in a sufficiently accurate and unbiased manner. Furthermore, even ignoring biases, this would require the licensing of expensive proprietary data and would require significant R&D resources to implement in an automated manner in order to meet the timeliness requirement (and not automating would require significant labour costs).

One participant remarked that this needs to be as simple as possible and suggested that for example something like a network visualisation would be a terrible idea.

Visualisations

In addition to having the opportunity to get an in-depth insight into each of the scale-up themes - the EURITO Team sought to gain some insights from the group regarding visualisations and graphical representations of these data sets,

Participants were presented with an array of 55 visualisation chart types and engaged on what kinds of charts they preferred and understood. The chart types covered broad data categories including continuous data, categorical data, networks and geographical information.

Participants identified the scale up that was most relevant to them to think about what variables they would like to visualise and to choose charts that they felt strongly about, either because they liked and understood them or disliked and did not understand them well.

There was some consensus about keeping the simplicity along the graphs and design than more complex ones, although including several dimensions. Participants ranked the visualizations types in terms of being more and less understandable.

Complexity

Two schools of thought emerged when discussing how to present complex, linked or high dimensional data. The majority of participants preferred to have many simple charts to explain these data, rather than rely on a single more detailed chart. It was felt that complex charts are often hard to understand and more easily misinterpreted (intentionally or unintentionally). An alternative suggestion from several people was to simultaneously complement complex charts with simple ones to show descriptive statistics and trends more clearly. It was also suggested that complex charts simply serve to raise more questions, which is fine if further charts are provided to answer them. To a lesser degree, participants suggested that complex charts were fine, as long as they were accompanied by significant explanation, prompts and helper dialogues, while others thought that all charts needed to be self explanatory.

Chart Choice

For general quantitative data, the vast majority of participants had clear preferences for the types of charts, tending towards clear visualisations that leave little ambiguity around the data. More broadly, participants found it difficult to imagine which charts would be useful unless there was a specific question being posed.

A comment that was repeated multiple times was that the chart types available on a visualisation platform depend on who the audiences are. Strong emphasis was placed on the idea that while analysts might be used to statistical charts such as a boxplot, something much clearer was often needed when communicating findings to senior decision makers, policy workers and ministers. Additionally, in order to produce more complex visualisations, they will have to face a steep learning curve to use the underlying programming language.

Interaction

Some people felt very limited by the tools that they currently had available for data visualisation. Several participants indicated their desire to be able to easily build a narrative from the charts in order to present or serve in a traditional report. This included being able to pick out and highlight the detail within trends.