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Social impact of the interdisciplinary physics applications presented

28 June 2022

Presented by: Martina Dal Molin

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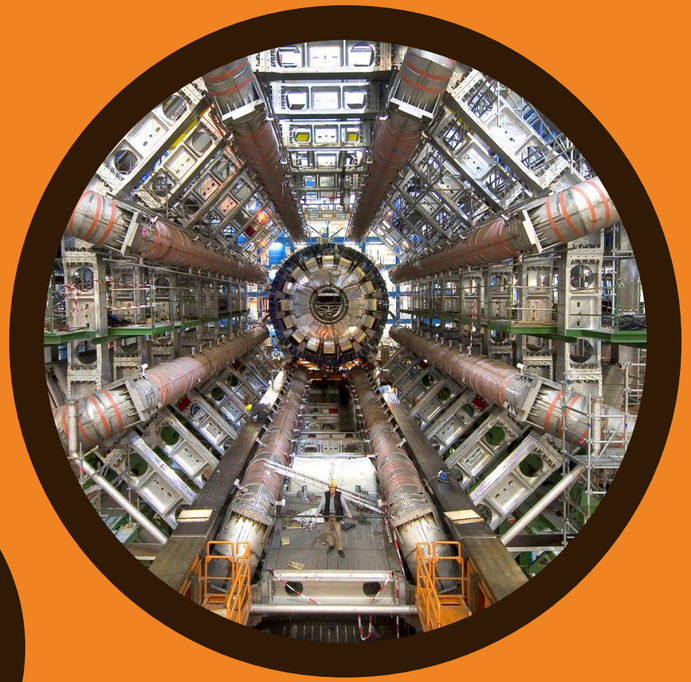
Agenda

- Me, myself and I
- The context
- Assessing the impact of Big Science
- The case of the INFN
- The Cultural Heritage sector
- The CBA of E-RIHS
- Conclusions
- References

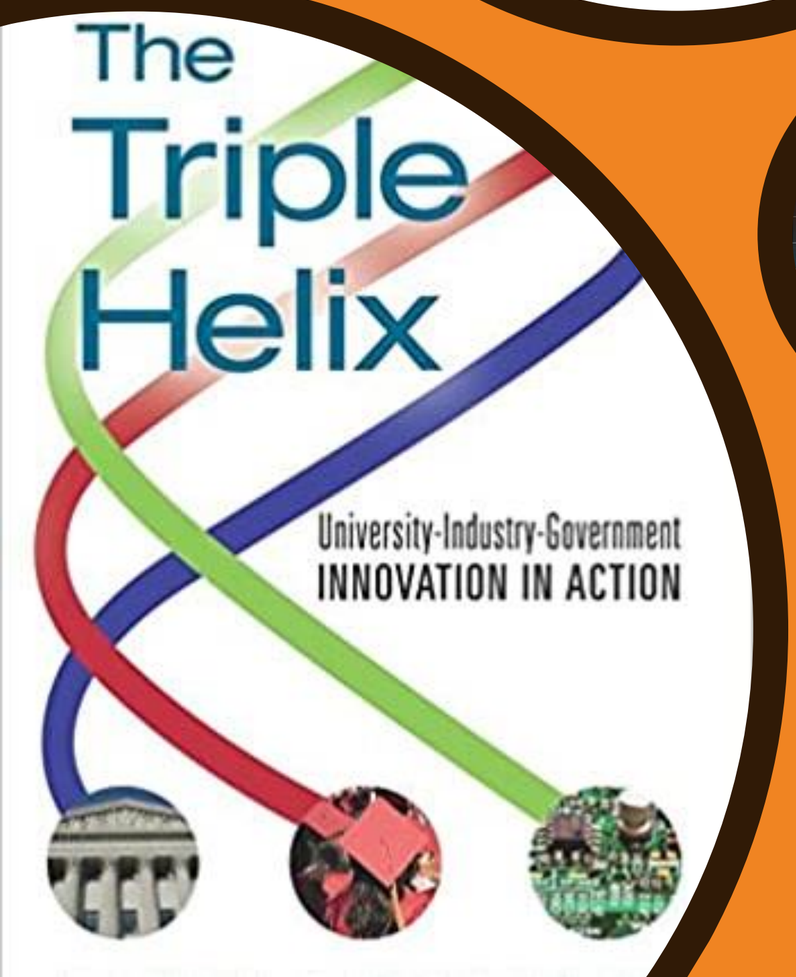
About me

- Degree in **Administration and Public Policy** (University of Milan)
- Ph.D. in **Institution, Administration and Public Policy** (University of Pavia)
- Previously Research Fellow at the Politecnico di Milano and at the Italian National Institute for Nuclear Physics (Istituto Italiano di Fisica Nucleare, INFN)
- Assistant Professor @GSSI Social Sciences Area (from June 2020) - **Policy Evaluation**
- Main research area: **evaluation of the research impact**


RESEARCH
ASSESSMENT
EVALUATION
METHODS
TEACHERS
AERA
MEASUREMENT
INTERESTS
PROGRAM
TESTING
COMMUNITY
PROFESSOR
STATISTICAL




Analysis
RESEARCH

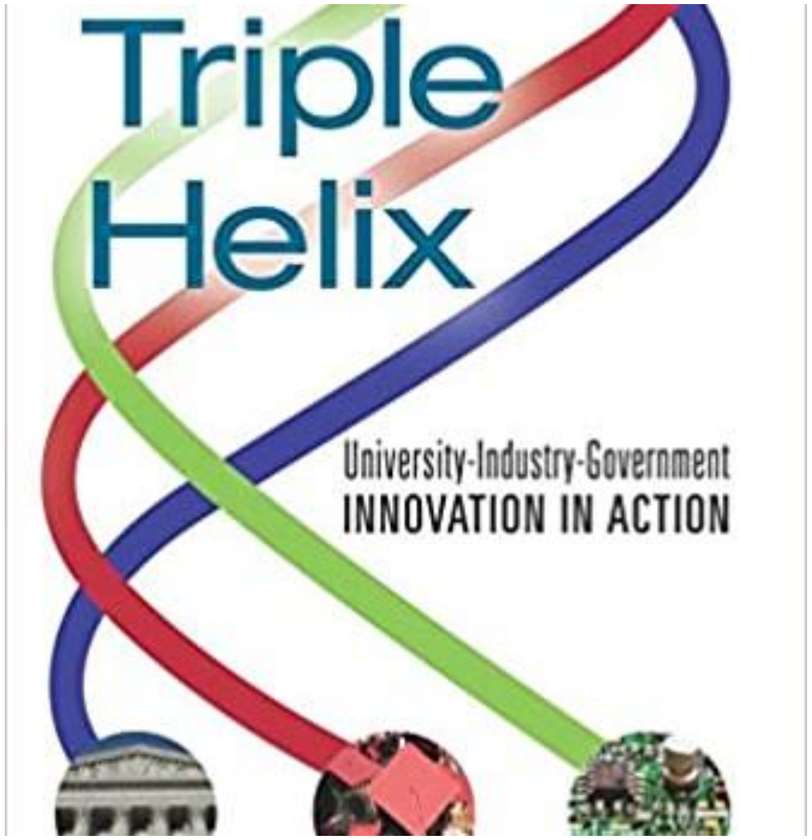

The
Triple
Helix
University-Industry-Government
INNOVATION IN ACTION

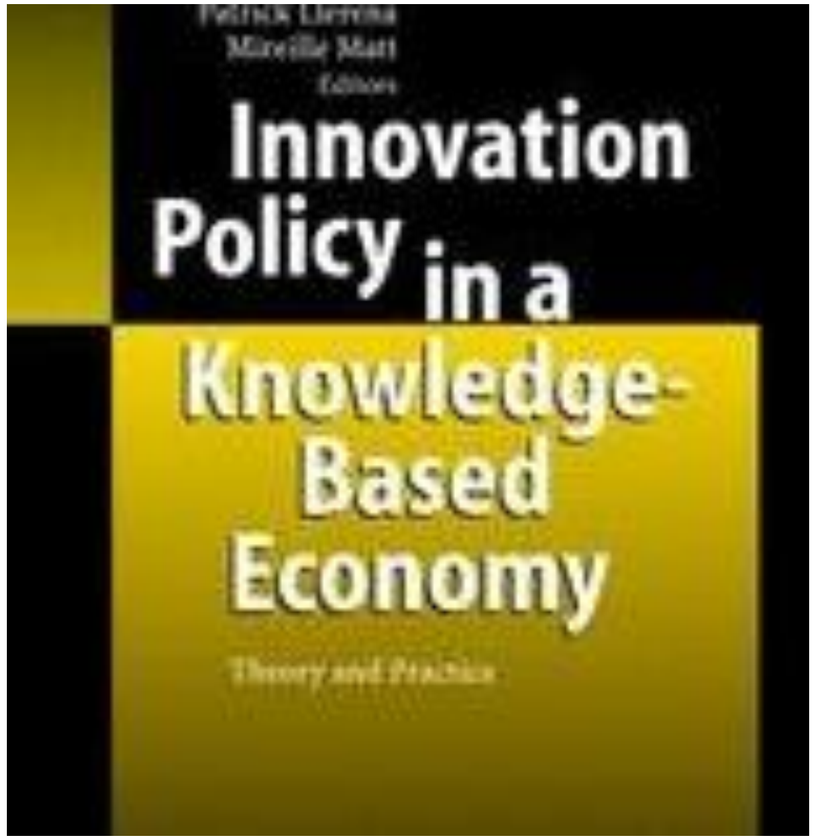
The context


ECONOMY
TECHNOLOGY
DEVELOPMENT
INFORMATION

The very beginning of the story…

Compagnucci and Spigarelli, 2020; Pinheiro et al., 2016; Bramwell and Wolfer, 2008; Jongbloed et al., 2008; Drucker and Goldstein, 2007; Charles, 2006





….more recently

(Degani et al., 2021; García Alvarez-Coque et al., 2021; Harrison and Turok, 2017).

A changed role for Higher Education Institutions (HEIs)

from knowledge warehouse to knowledge catalyst and knowledge hub

knowledge transfer and human capital creation are considered crucial drivers for regional social and economic development

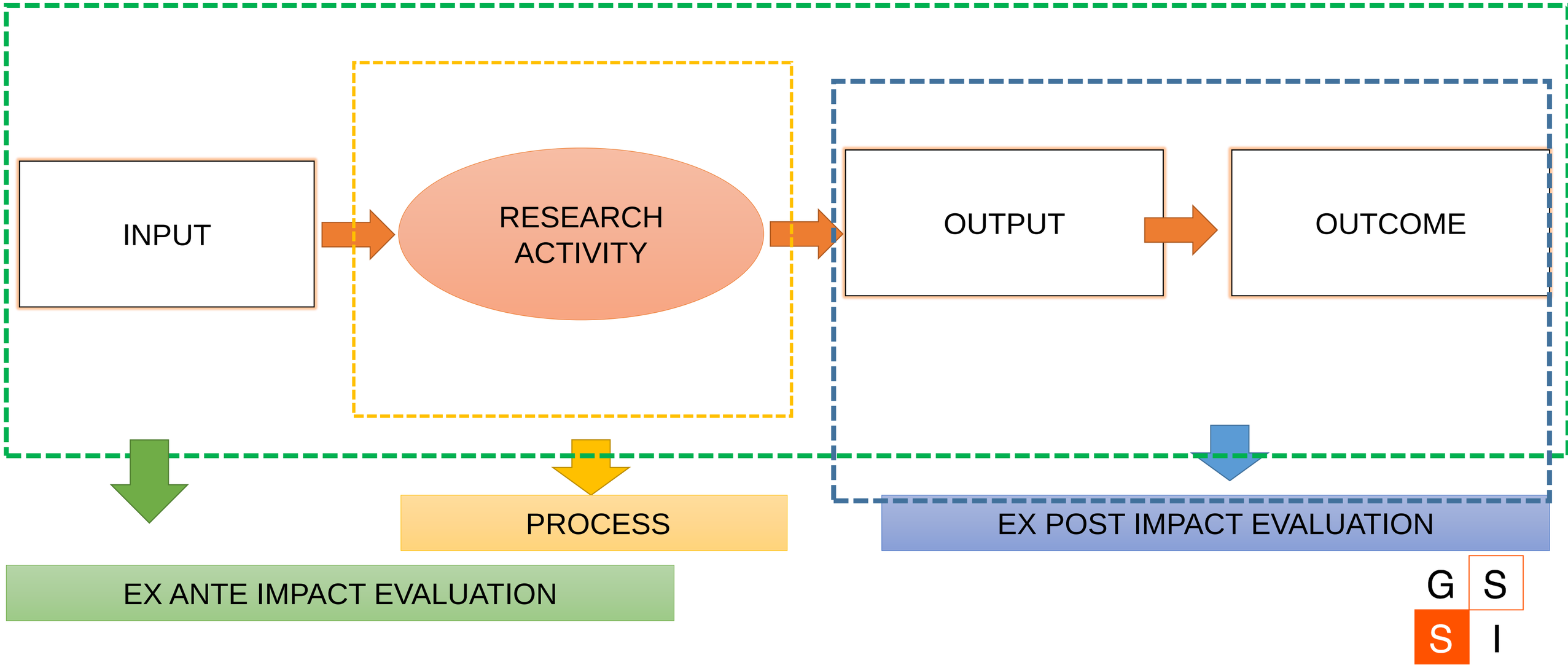
Degani et al., 2021; García Alvarez-Coque et al., 2021; Harrison and Turok, 2017

How HEIs (and research) support socio-economic development?

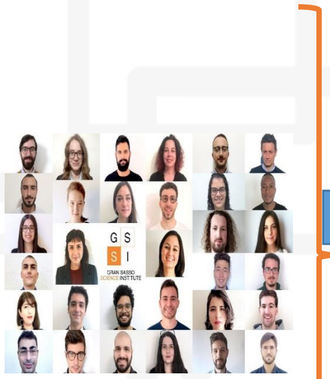
- human capital creation
- learning impact (e.g. knowledge and technology transfer)
- Innovation impact (technological innovation)
- capital investment
- regional leadership
- production of knowledge infrastructure
- Economic impact (increased demands for goods and services)

Rossi and Goglio (2018)

Assessing research impact: a framework



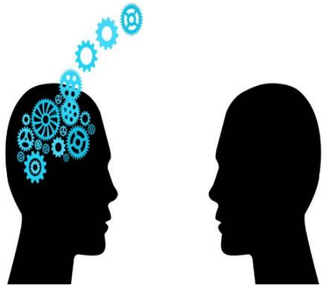
Research impact generation and assessment



RESEARCH ACTIVITIES

t 0

t1



t2

SCIENTIFIC IMPACT:

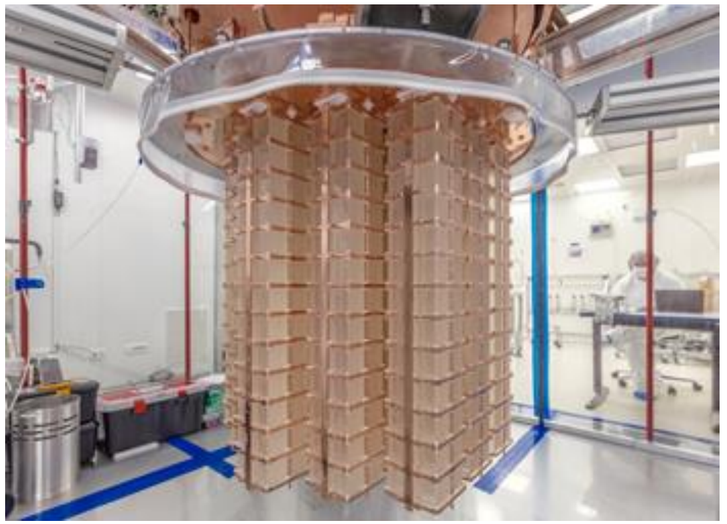
- N. of papers published
- N. of citations
- H-Index
- …..

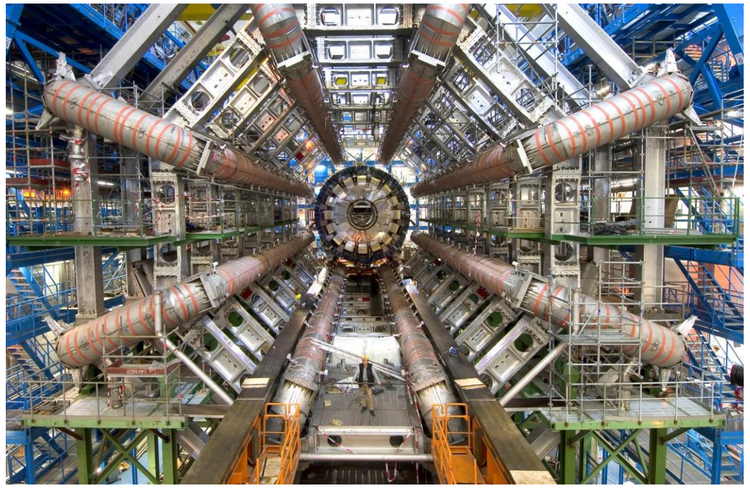
INNOVATION IMPACT:

- N. of patents
- N. of spin-off
- N. of start-ups
- …..

Assessing the impact of Big Science (1/3)

- Big Science as a «peculiar» research context
- Large and capital intensive Research Infrastructures (RIs) (i.e. facilities, resources and services used by the research communities to conduct research)
- Technology is pushed to the frontier and beyond
- Procurement process, transfer of new knowledge
- Value of scientific discovery
- Dissemination
- Long-time horizon to assess the impact
- Intangible impact(s)





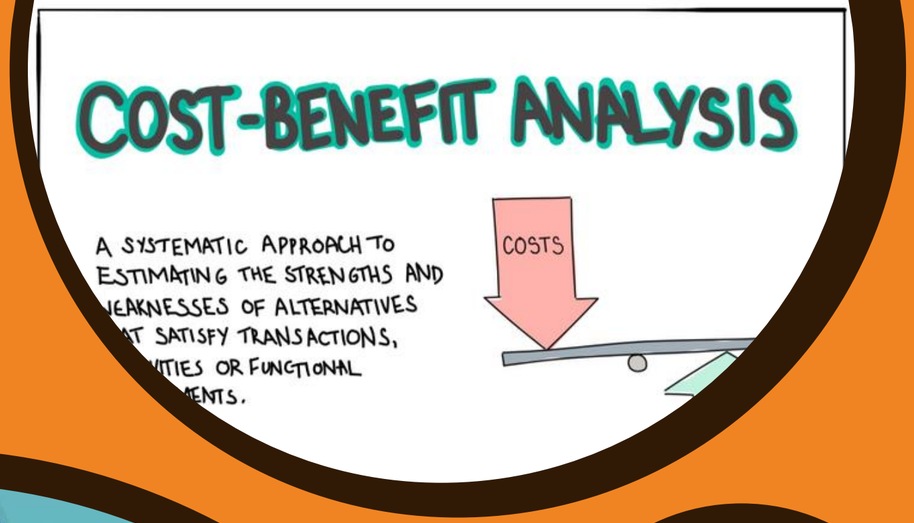
Li-Yin et al., 2022; Rådberg and Löfsten, 2022; Bastianin et al., 2022; Castelnovo and Dal Molin, 2022; Florio, 2021; Dal Molin and Previtali, 2019

Assessing the impact of Big Science (2/3)

Impact dimensions	Description
Scientific impact	Scientific impact of Big Science is related to the **production of new knowledge** and the **generation of new data** that support further scientific development
Learning impact	Learning impact of Big Science is related to the fact that when researchers face new technological and complex problems to design and construct new technologies and methodologies in collaboration with companies and a process of **transfer of knowledge and technology** take place. As a result, thanks to this process, companies may acquire **new knowledge**, may learn **new technical solution** and may acquire **problem solving capabilities**
Innovation impact	Innovation impact is related **to innovation introduced (e.g. new products, new technologies)** after the collaboration with Big Science center and it is concerned with product and process innovation.
Economic impact	Economic impact is related to the **improved economic performance** of supplier companies and it may be direct or indirect
Market impact	Market impact is related to the effect on market due to the fact of being a supplier of a Big Science center. It includes **reputational effect, acquisition of new clients and the penetration in new market**

Assessing the impact of Big Science (3/3)

Impact dimensions	Description
Organizational impact	Organizational impact is related to changes in the **organizational structure and strategic** vision of the supplier company
Educational impact	Educational impact is related to both benefits in term of learning and knowledge acquisition, as well **career development and career opportunities**
Networking and clustering impact	Networking and clustering impact refers to the **creation of new partnerships** with other companies and other research centers
Cultural impact	Cultural impact is related to the **improvement of cultural level of society, by disseminating new scientific discoveries to the widely society and by the organization of cultural events to the public**
Social impact	Social impact is related to the creation of **job positions** and the **increase of employment rate**



Case studies

CASES: INFN and E-RIHS

Istituto Nazionale di Fisica Nucleare

- Ex- post evaluation
- Surveys
- Interviews
- BN Analysis

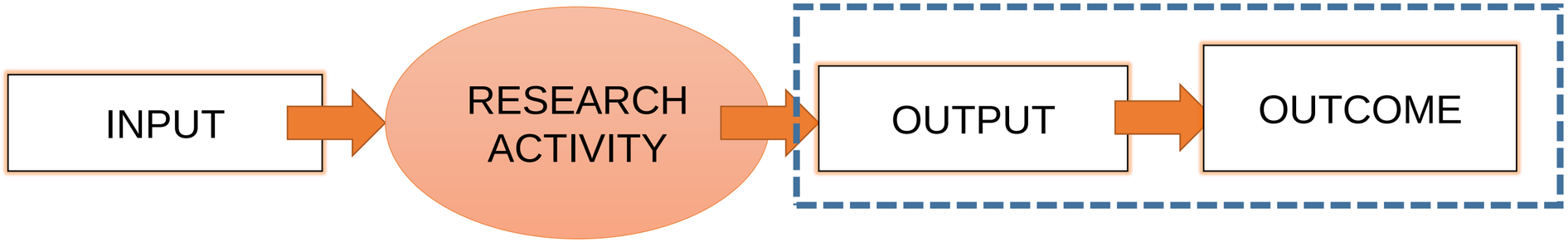
Castelnovo and Dal Molin, 2021; Dal Molin and Previtali, 2019

E-RIHS
EUROPEAN RESEARCH INFRASTRUCTURE FOR HERITAGE SCIENCE

- Ex- ante evaluation
- Cost Benefit Analysis (CBA)

With Dr Silvia Vignetti and Dr. Francesco Giffoni from Center for Industrial Studies (CSIL)

The impact of INFN procurement of suppliers



Research Design

- Questionnaire sent to companies that collaborate or collaborated with INFN through public procurement (n. 168 valid questionnaires, 54%)
- Direct interviews (n. 10 supplier companies)
- Structure of the survey:
  - ✓ Part 1: general information (dimension, annuale sales volume, type of procurement, frequency of contacts with INFN researchers)
  - ✓ Part 2: identification of the impact realized after and thanks to the procurement relations (economic impact, learning and innovation, relationship with the market, alliances and networking, social impact)

Dimension	Asked Questions	% of positive answer	% of positive answer excluding missing data	% of missing data (for each question)
Economic impact	**Increased sales volume related to new products or services**	**31,2%**	**62,8%**	**32,0%**
Learning and innovation	Patents	3,0%	4,2%	28,6%
	New products or services	11,03%	26,0%	56,5%
	Acquisition of new technical competencies	**40,5%**	**49,6%**	**18,5%**
	Acquisition of new managerial competencies	12,5%	16,7%	25,0%
	Improvement of market knowledge	**23,8%**	**30,8%**	**22,6%**
Relationship with the market	**Improvement in company's image and reputation**	**49,4%**	**58,0%**	**14,9%**
	Acquisition of new clients	**25,6%**	**31,9%**	**19,6%**
	Entry in new market	**21,4%**	**26,7%**	**19,6%**
	Increasing in market shares	**17,9%**	**22,2%**	**19,6%**
	Reduction of the time to market	6,0%	7,8%	23,2%

Dimension	Asked Questions	% of positive answer	% of positive answer excluding missing data	% of missing data (for each question)
Alliances and network	**New partnerships**	**23,8%**	**31,0%**	**23,2%**
	Co-patenting	0,6%	0,8%	26,2%
	Co-authored publications	1,8%	2,4%	25,6%
	Out-licenses	1,2%	1,6%	25,6%
	In-licenses	1,2%	1,6%	25,6%
Social impact	New hiring in relation with INFN activities and specifically:			
	Temporary worker	**11,9%**	**16,1%**	**26,2%**
	Scholarship	3,6%	5,1%	30,4%
	Ph.D. students	2,4%	3,4%	30,4%
	Apprenticeship	3,0%	4,3%	30,4%
	Stage	3,6%	5,1%	30,4%
	New types of activities	**11,9%**	**17,2%**	**31,0%**
	Start-up	6,0%	8,5%	30,4%
	Spin-off	6,5%	9,9%	33,9%
	International collaboration	**10,1%**	**15,7%**	**35,7%**

Results (2/3)

“We **modified our existing products**, since the requests of INFN researchers have some peculiarities we want to fulfill. Once we have customized products, we also **sell them to other clients**. In a nutshell**, INFN pushed us to increase our range of products**”

“During the meetings with researchers, they explain to us the expected technical requirements of the technology to be delivered and this favored, from us, the **acquisition of technical knowledge**”

“Collaborating with INFN **improved our competencies of the productive processes of highly specialized technologies**. Without this collaboration, it would have been very difficult to improve such productive processes”

“Being a supplier of INFN has **improved our reputation for external and new clients**, but it is relevant also from an internal point of view. The fact that we serve INFN has a “**motivational” effect on employees**, that is to say that we are **more confident in the quality of our products** and in our competencies”

“At the beginning we didn’t work for public research centres and **we didn’t know anything about the market of research**. But, after having developed new products for INFN it was easier **to enter that market** and to satisfy the needs of other researchers by selling the products previously developed to meet the INFN technical requirements”

Results (3/3)

Dimension	Selected indirect effects	% of positive answer	% of positive answer excluding missing data	% of missing data (for each question)
Acquisition of technical knowledge	Incremental sales volume	45, 6%	75, 6%	39, 7%
	New products or services	20, 6%	50, 0%	58, 8%
	Acquisition of new clients	41, 2%	50, 0%	17, 6%
	Entry in new market	35, 3%	42, 9%	17, 6%
	Improvement in market share	27, 9%	33, 9%	17, 6%
	New collaborations-partnerships	47, 1%	54, 2%	13, 2%
Improvement in company image and reputation	Incremental sales volume	41, 0%	70, 8%	42, 2%
	Acquisition of new clients	39, 8%	45, 8%	13, 3%
	Entry in new market	33, 7%	39, 4%	14, 5%
	Improvement in market share	28, 9%	35, 3%	18, 1%
	New collaborations-partnerships	37, 3%	48, 4%	22, 9%

The Heritage Science field

- According to ICCROM(*) (2015), heritage science (HS) is becoming an «umbrella term», unifying **different interrelated applied science fields**
- HS as a melting pot of **scientists** (from different disciplines), **policy makers** and **practitioners** (public and private) interacting each other
- HS as an applied field aimed at producing practical **benefits** for better understaning, analysizing and managing cultural heritage
- A wide variety of **skills, data, instruments** and **technologies** are therefore needed

(*) International Centre for the Study of Preservation and Restoration of Cultural Property

E-RIHS (1/2)

- The European Research Infrastructure for Heritage Science (E-RIHS) is a distributed RI designed to support research on heritage interpretation, preservation, documentation and management
- It entered ESFRI Roadmap(*) on 2016; it is under its preparatory phase and it is expected to become and ERIC (**) in 2023. After a ramp-up phase (2023-2025) it is expected to operate at full regime in 2026
- Main aims:
  - ✓Facilitate access to a wide range of technologies, facilities, infrastructures and data
  - ✓Create and shape a shared identity for the HS and the related scientific community
  - ✓Facilitate and improve the availability and access of high quality services to the HS community

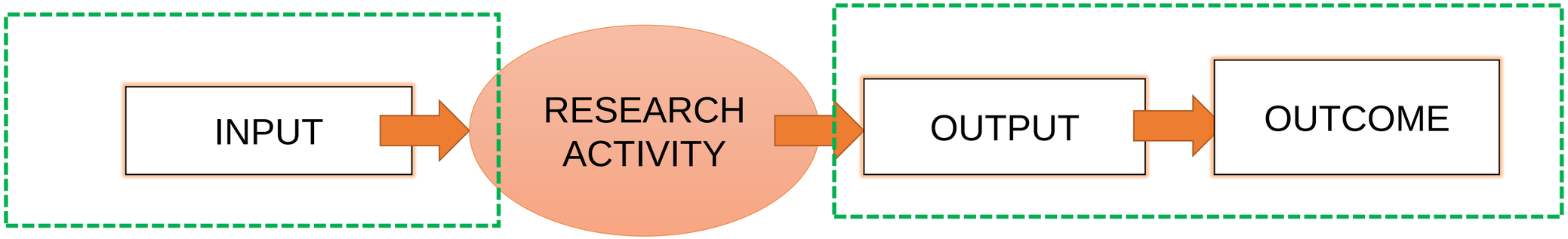
(*) https://www.esfri.eu/esfri-roadmap

(**) https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures/eric_en

E-RIHS (2/2)

- 4 interrelated platforms:
  - ARCHLAB – (archives) gives access to specialised knowledge and organized scientific information in datasets largely unpublished from archives of European museums, galleries and research institutions
  - FIXLAB – (fixed facilities) gives access to large-scale and medium-scale facilities (particle accelerators and synchrotrons, neutron sources; non-transportable analytical instruments)
  - MOLAB – (mobile facilities) offers access to mobile instrumentation for complex multi-technique
  - DHLAB – (virtual facilities) gives access to scientific data concerning tangible heritage
- Services provided:
  - Transnational Access (TNA) to physical facilities through three intregrated platform (one or more access point)
  - digital access to cultural heritage data
  - education and training through the E-RIHS Academy (e.g. summer schools, conferences, training camps)
  - Outreach activities
- Governance structure:
  - A central hub located in Florence, representing the unique access point to E-RIHS services and infrastructur[illegible] provides specific services, e.g. training courses, events, conferences, ….
  - A network of distributed national hubs, representing the E-RIHS Member States (e.g. France, Spain,

E-RIHS ex ante impact assessment



Research Design

- Ex ante Impact Assessment (IA) by discussing the expected direct and indirect benefits
- Methodology combines:
  - Cost Benefit Analysis (CBA) to quantify and forecast (in €) the impacts through specific economic concepts (e.g. willingness to pay, marginal cost of production, avoided cost) to potential users
  - Qualitative interviews to discuss the wider long-term impacts
- Source of evidence includes:
  - Desk research and literature review
  - Primary data, collected via survey to: 1) E-RIHS target users; 2) service providers; 3)national coordinators (192 valid questionnaires)
  - 20 face to face interviews with E-RIHS stakeholders and experts

CBA in a nutshell

- Economic Analysis aimed at «comparing» costs and benefits of a project or a RI
- It aims at quantifying, in monetary terms, both costs and benefits
- CBA Test:
  - Net Present Value (NPV) > 0, benefits > costs
  - Return rate of the project or the RI
  - Ratio B/C
- Costs:
  - Investment costs
  - Operating costs (fixed and variable costs)

Estimation is based on :
- E-RIHS Financial Statement
- direct interviews
- Cost of previous projects

- Benefits:
  - Direct (i.e. use-benefits)
  - Indirect (i.e. non-use benefits)

Estimation is based on:
- demand analysis (800 users from 2026) and survey to users (to assess the willingness to pay)
- direct interviews lead to the identification of indirect impact

E-RISH CBA: the cost side

- INVESTMENT COSTS (2017-2025)
  - Cost of previous project connected with E-RISH (IPERION CH and IPERION HS)
  - Cost of E-RIHS preparatory phase
- OPERATING COSTS (2026-2057)
  - Fixed costs (e.g.):
    - central-hub (personnel and travel expenses)
    - digital infrastructure management and curation
  - Variable costs (e.g.):
    - Users travel and subsistence
    - Training, events, communication

E-RISH CBA: the direct benefit side (2026-2057)

TYPE OF IMPACT	DESCRIPTION	ESTIMATION (willingness to pay)
Impact on science production	through the coordinated access to multiple facilities and data, E-RIHS is expected to enhance the research performance in term of efficiency and quality	• Value of access, due to the coordinated platforms • Value of publications and citations • Value of scientific information (available through the E-RISH website)
Impact on human capital development	E-RISH Academy will deliver lecture and training events to scientists and practitioners from different disciplines, boosting cross-fertilization in heritage science.	• Value of training events delivered
Dissemination and outreach	E-RISH activities will promote the heritage science and its activities in understanding and preserving the cultural heritage beyond the scientific community	• Value of benefits generated through the web portal visitors • Value generated by using E-RIHS social networks

E-RISH CBA: the indirect benefit side

- **IMPACT on CULTURAL POLICIES:**

➢as a global actor in the heritage science, E-RIHS ambition is to contribute to build a cultural identity at the national, european and international level

- **IMPACT on ACCESS to CULTURE and on CULTURAL TOURISM:**

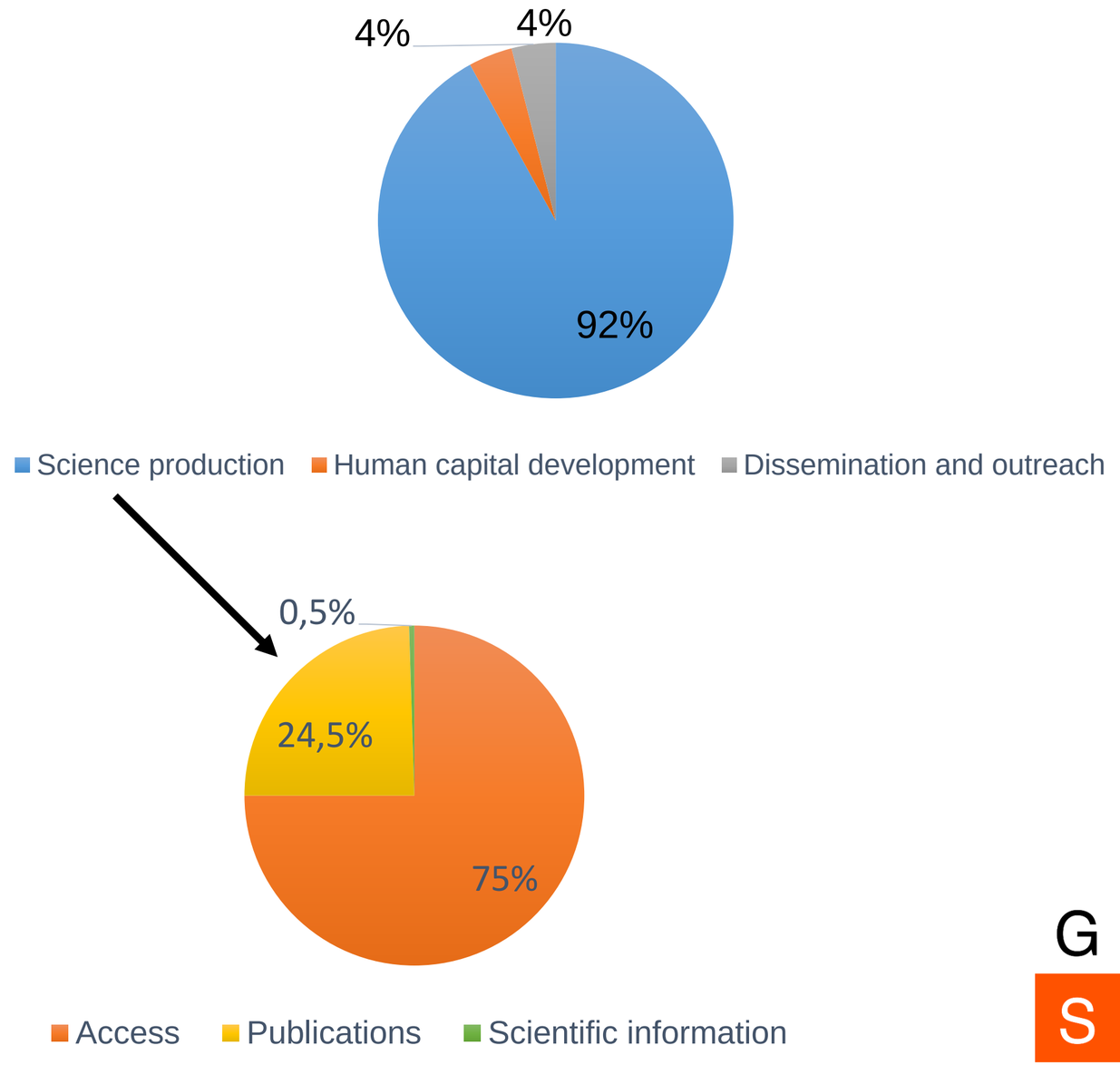
➢Outreach activities for the general public can enhance citizens' awareness on the heritage science role by disseminating non-technical knowledge and understanding of cultural assets

E-RISH CBA: total costs

COST ITEM	DISCOUNTED VALUE (EUR 2017)
Tot. Investment costs	***20,675,839 €***
Tot. Fixed costs	24,299,470 €
Tot. Variable costs	9,105,351 €
In-kind contribution	6,116,571 €
Tot. Operating costs	***39, 521, 392***
TOT. COSTS	**60,197,231 €**

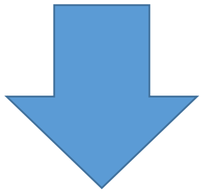
E-RISH CBA: total direct benefits

BENEFIT ITEM	DISCOUNTED VALUE (EUR 2017)
Science production	**65,873,325 €**
Access	49,225,764 €
Publications	16,301,935 €
Scientific information	315,625 €
Human Capital development	**2,736,874 €**
Value of training	2,736,874 €
Dissemination and outreach	**2,940,936 €**
E-RIHS ERIC web portal	2,682,913 €
Social networks	258,024 €
TOT. BENEFIT	**71,551,135 €**



E-RISH CBA: Final results

E-RIHS B/C ratio = 1.20



Benefits > Costs

To conclude

Big Science (and its application) as a peculiar, but powerful, context to generate socio-economic impact:

- Suppliers:
  - Economic return, learning, innovation
- Researchers:
  - publications and human capital development
- Society:
  - Value of discovery, value of dissemination

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- Research Infrastructures (Ris)

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Grazie a tutti!
Thank you everyone!

Martina Dal Molin

martina.dalmolin@gssi.com

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