**Fact finding / Literature review**

**2015-09-02**

**1. General studies / reviews on RI sustainability**

1.1 EIROforum discussion paper: Long-term sustainability of Research Infrastructures - 2015

A general discussion paper in which long-term sustainability of RIs is measured to 5 criteria:

1) Relevance of an RI to its scientific community and the ability to generate scientific excellence;

2) Sustainable governance model and legal framework;

3) Sustainable funding model;

4) Ability to attract scientific talent and build a critical mass of scientific expertise;

5) Socio-economic impact.

On the part of financing, major points of discussion include long term funder commitment for the operational budget, linking long-term funding with specific programmes and objectives, and investment and return.

On the part of scientific talent, mechanisms are discussed including employment conditions, transparent recruitment practices, openness to diversity, and adaptable PhD and post-doctoral curricula, as well as mobility and training.

Though sustainability of RI is mentioned as an important aspect in many publications (eg. Strategy Report on Research Infrastructures Roadmap 2010, Research Infrastructures in the European Research Area, OECD report of international distributed research infrastructure, Horizon 2020 WP 2016-2017), dedicated studies on sustainability of RI in general at present (such as the Eiroforum discussion paper) are rare. There are some studies on sustainability of RI in specific domains, though.

1.2 Strategies for Sustainability of Biological Infrastructure: Workshop report - 2010

The discussion is led by the Ecological Society of America (ESA). Its 2010 workshop produced a report with recommendations for the sustainability of biological infrastructures. Furthermore, EAS now runs a Sustaining Biological Infrastructure Initiative for training directors of biological infrastructure mainly in financial management and business models. It’s supported by NSF.

In the report, sustainability is defined as the capacity to preserve content and services, and increase their value to the user community over time.

Discussions focus mainly on ensuring funding and management of costs. Outcomes identify few key elements for a sustainable infrastructure: Standardization and Coordination; Understanding and Assessing Costs; Public Outreach, Communication, and Reaching New Users; Diverse Revenue Streams; Clear Value Proposition; Ongoing, Sustained Stakeholder Engagement.

ESA has not published further literature elaborating on the key elements yet.

1.3 Sustainability Considerations for Health Research and Analytic Data Infrastructures – 2014

The key discussion on sustainability is on how to sustain the research data infrastructure beyond the initial investment. The paper has 4 major findings:

1. The ongoing cost for supporting a RI is significant,

2. Cost can be recovered if value could be created for stakeholders, including researcher or for-profit companies,

3. Having multiple stakeholders increases the opportunity and complexity of sustaining an

Infrastructure,

4. Stakeholders may support an infrastructure to keep flexibility in an emerging area (the promising potential of a RI).

1.4 Sustainability of e-Infrastructures (for the Social Sciences) – 2007

Sustainability defined as business models that guarantee the provision of the necessary funding to sustain an e-Infrastructure. It sets 10 aims for sustainability:

1. Dependable services and long-term availability of infrastructure

2. Independence of infrastructure from single providers or funding sources

3. Long-term added value through an established base that new activities can build on

4. Realisation of the benefits of investments made

5. Ability to effectively plan investments and activities

6. A growing body of knowledge shared throughout the community

7. Technical evolution that does not lead to legacy issues

8. Embedding of e-Infrastructures in everyday research practice

9. Users’ needs are met and the costs of uptake are low enough

10. e-Science ‘sells’ and an increasing number of users are getting engaged.

It also listed some key issues for sustainability, including: implementation, professional support, technical skills, development, standardization, ect. Brief suggestions of response are provided.

1.5 A Framework for Discussing e-Research Infrastructure Sustainability – 2014

This study proposes characteristics that must be considered to sustain infrastructure elements, and highlights models that may be used to create and sustain e-Research infrastructure.

e-RI defined by Craig Stewart as consisting of “… computing systems, data storage systems, advanced instruments and data repositories, visualization environments, and people, all linked together by software and high performance networks to improve research productivity and enable breakthroughs not otherwise possible.”

Sustainability is used to mean that the element will continue to be supported as changes occur to other infrastructure elements, the user communities and their abilities and needs, and the underlying principles upon which the element was built. And it is measured as:

1. Can the infrastructure continue to provide functionality?

2. Is it friendly to new users? And is it adaptable to old users?

3. Does it incorporate and implement new science and theory as they develop?

Operation models include: Open source, licensing, paid support, for profit, foundation and government.

1.6 A Framework for Biobank Sustainability – 2014

This study proposes that biobank sustainability should be considered within a framework of three dimensions – financial, operational, and social.

It studies the difference of biobank sustainability from other RIs, including diversity in organization and purpose, and lack of a general set of value metrics.

A general recommendation is to operation through networks of biobanks to share components. Specific recommendations are given concerning the 3 dimensions:

Finance: Develop market strategy, meet stakeholder needs and create value, create brand recognition,

Operation: increase input efficiency, optimize internal management, increase output,

Social: acceptability, public engagement, good practice.

1.7 Approach to Sustainable e-Infrastructures: The Case of the Latin American Grid – 2009

This paper studies the approach and the strategy being developed to ensure the long-term continuity of the EELA-2 (E-science grid facility for Europe and Latin America) beyond its term in March 2010.

The study lists 4 major aspects for sustainability of EELA-2:

1. defining the best model for its future organisation,

2. studying its implementation from its current state,

3. deducing the manpower effort to operate and maintain it on the long term

4. anticipating a transition phase in the second year of the Project.

1.8 Sustainability of Research Infrastructures: Some lessons learned from TextGrid and CLARIN-D – 2014

A brief paper listing major points of sustainability issues as derived from TextGrid and CLARIN-D, such as:

1. In general, the long-term life cycle of research infrastructures will not be funded.

2. Based on experience, labor costs usually account for 85% of overall costs of research

infrastructures.

3. Overall life cycle costs are allocated among key infrastructures (10%), long-term archiving

(30%), support of tools and services (30%), user liaison, support and training (20%), and

administrative management (10%).

**2. Studies on finance aspect of RI Sustainability**

Key words are searched in the following aspects:

- Finance / business model

- Funding policies

- Cost management

- Risk management

2.1 Models for financial sustainability of biological databases and resources - 2009

A common challenge for most data resources and biological repositories today is finding financial support for maintenance and development to best serve the scientific community. The paper discusses financial sustainability issues and potential business models that could be adopted by biological resources.

It examined the major business models: full-cost recovery, partial-cost recovery and institutional funding, in which the last one is found to provide a secure environment for the infrastructures to develop and implement a secure data management plan and potentially ensure the long-term accessibility. A proposed model of academic-commercial partnership may appear to have potential should vendor corporations become involved.

2.2 A Sustainable approach to large ICT Science based infrastructures; the case for Radio Astronomy – 2015

*Some studies focus on sustainability in terms of energy, green development and carbon footprint reduction, which could be considered as a form of cost management.*

The study proposes the use of Green ICT (eg. Cloud computing) and Green energy (power efficiency, new energy) to reduce energy consumption and carbon footprint, with the examples of radio astronomy RIs including LOFAR and SKA.

2.3 Best Practices for the use of e-Infrastructures by large-scale research infrastructures – 2015

Recommendation is that the e-Infrastructure needs and data aspects have to be fully taken into account from the beginning of the research infrastructure study phase, which will in turn increase efficiency and data sustainability.

2.4 Biobankonomics: Developing a Sustainable Business Model Approach for the Formation of a Human Tissue Biobank – 2011

The study approaches biobank sustainability through the study of the market need for the particular type of biobank and the efficiently managing the biobank’s “value chain”. It also introduces a Total Life Cycle Cost of Ownership (TLCO) model, which may be developed to estimate all costs arising from owning, operating, and maintaining a large centralized biobank.

Besides government and project financing, it offers considerations for building a cost-recovery model, which including measures to recover cost, such as building scale, inventory turnover, case mix desirability, ect.

2.5 A funding and governing model for achieving sustainable growth of computing e-infrastructures – 2010

The study identifies the major shortcomings of computing e-infrastructure are 1, the insufficient involvement of the private sector in the development of computing e-infrastructures, 2, the restricted user access to e-infrastructure resources, and 3, the lack of sustainable funding. It proposes a business-oriented operation model of the computing e-infrastructure, and a token-based mechanism is suggested to overcome the barrier of access restrictions for researchers and enterprises across different e-infrastructures.

2.6 Discussion Paper of the Strategic Framework for Research Infrastructure Investment - 2010

This is a discussion paper for the Australian government. It is recommended in the discussion paper that commitment to continuity of funding should be a central consideration for the provider of the funding. Beyond running costs, expenses such as upgrades, routine maintenance, replacement of components and natural growth should also been considered.

The key 2 messages are:

1. Research infrastructure funding programs should be ongoing and predictable.

2. Infrastructure that continues to be a priority should be able to access funding for ongoing operations.

2.7 The business models for ICT Research Infrastructures – 2012

Sustainability of an e-Infrastructure can be defined as the potential to maintain that e-Infrastructure for a long period of time. Sustainability in this study includes aspects of funding, costs, evolution and miscellaneous facts.

2.8 Financing UK biobanks: rationale for a National Biobanking Research Infrastructure – 2013

This is an in-depth study on financing of biobanks, with case studies and cross-case comparisons.

Though sustainability is not a dedicated topic, the study has given key recommendations for the long-term maintenance of biobanks:

1. Funding should be provided for projects and project proposals to ensure biobanking is driven by research needs;

2. core biobank activities and facilities should be supported by central public funds to overcome discontinuity of funding problems and enable investment in best practice.

3. the marginal costs associated with accessing samples could be paid for by the user.

2.9 A Norwegian Research Infrastructure Resource Model – 2014

This study aims to use a research infrastructure resource methodology to declare the costs and pricing the use of research infrastructure. By taking into consideration the full investments and operation costs of RIs, it aims to ensure RI operation and maintenance with proper pricing.

2.10 Comments of the Helmholtz Association of German Research Centres regarding the cost of large RIs – 2013

Suggestions on operation costs of RI:

1, A complete list of all cost items which can be important in operating a RI is close to impossible to generate, and a prioritisation of the cost will always depend on the different types of RI and is thus not possible.

2, The soundest and most precise way of considering these costs would in our view be to allow full cost accounting as an option for research organisations operating RI.

Among the costs, listed examples are:

Personal cost, material cost, depreciation, internal services (energy cost), cost allocation (heating, securities)

2.11 Cost control and management issues of global research infrastructures – 2010

The study identifies key cost and management issues in different stages of RIs from concept screening, feasibility study to operations, and has given recommendations for each different stage, altogether 12. Concerning costs, they are:

1. At the start of a research infrastructure (RI) initiative, the political stakeholders must agree upon a shared understanding of the foreseen scope, schedule and cost, addressing inherent uncertainties and any external constraints, and describing what must be done if deviations occur during the following phases.

2. Independent scientific and technical evaluation and external professional auditing of financial and management performance must be carried out and acted upon.

3. To harmonise expectations and reduce risk, a standardised, stepwise, and phased approach to the preparation and approval of an RI project is necessary.

4. Up-to-date, bottom-up planning, control and reporting systems based on work breakdown structures and financial management tools covering technical, financial and schedule issues, are mandatory.

5. Best-practice systems for project control and risk management have to be fully embedded in the project management, covering technical, financial and schedule issues.

6. Costs must be clearly defined and spending must be realistically planned, including in-kind contributions. Costs should be estimated with appropriate precision according to the different approval stages, and contingencies must be provided. The costs must be controlled by always current bottom-up best-practice systems.

2.12 Ramiri handbook chapter 2 and 4, Finance and Management – 2013

The finance part gives an overview of finance issues, including major costs and funding sources.

Management part touches sustainability briefly, noting that it may be necessary to produce proposals ranging from the support to more appropriate environmental technologies, to support for the training of staff, etc.

2.13 Delusion and Deception in Large Infrastructure Projects – 2009

The study addresses over-cost and delay in execution of large infrastructure projects. Two measures are recommended: focus on best practise and use reference class forecasting.

– could possibly serve as a reference to RIs.

2.14 Funding policies from Australia, Israel, South Africa, US

Operating and upgrade are eligible for apply for funding for RIs.

**3. Studies on human resources aspect of RI Sustainability**

Though human resources are mentioned in some of the general studies in RI sustainability, dedicated studies on human resource aspect of RI sustainability are hard to find.

3.1 Ramiri handbook chapter 3: Human Resources in a Research Infrastructure – 2013

Provides an overview of human resources in a RI, without particular emphasis on sustainability.

Dedicated slides on human resources in single-sited and distributed RIs, focusing on HR management.

3.2 Skills and Human Resources for e-Infrastructures within Horizon 2020 – 2012

Studies on skills and human resources development needed for e-infrastructures, focusing on the skills aspect.

3.3 Research Infrastructures Staff Exchange (RISE): a new scheme for staff mobility within European Research Infrastructures – 2011

The proposal intends to promote staff mobility between European RIs.

**4. Reports from the RIs**

Searches are done on RI websites, and key words are searched in the following aspects:

- Business plan

- Annual / Financial report

- Human policies / contracts

However, many RIs do not provide annual reports, while many reports do not include financial or human resources data (eg. the PRACE, most of the annual reports of RIs in China).

4.1.1 BBMRI Business Plan – 2012

BBMRI-ERIC is a biobank projet.

In its business plan, BBMRI conducted a survey of the costs and funding of European biobanks. The analysis of 84 biobanks showed that the average cost of running a biobank is of 530 K€ per year excluding the cost of research projects. 41% of this cost reflects salaries related to human resources.

The European Commission has granted 5 Mio € funding (2008-2011) to the Preparatory Phase of BBMRI to conceptualise and secure funding for the construction.

For BBMRI, costs for construction and operation at start-up phase are expected from member states and hosting countries. From 2016, it expects income from research grants.

4.1.2 BBMRI ANNUAL REPORT – 2014

BBMRI published 1 annual report after its business plan in 2012.

In the part of financing, membership contribution was lower than due to an unpaid membership contribution by Greece.

Costs are lower than expected due to delayed staff hiring and no common services.

4.2 Business planning perspective and fi nancial models of participation for the research icebreaker AURORA BOREALIS – 2012

Running cost is included in the business planning stage.

It also includes a business model that connects member contribution with access, in order to encourage investment.

The project has not been implemented, though.

4.3 SHARE Annual Reports – 2012-2014

SHARE reports have a dedicated part on funding.

Funding of Share is complex because there are many funders on the international and even on the national level, with different periods of commitments and time frames for funding sources.

As noted in the 2014 report, the situation has significantly worsened since 2013, making both financial and operational planning very difficult.

4.4 XFEL Annual Reports – 2010-2014

XFEL reports do not have detailed parts on funding.

It has a stable income of contribution as seen from the reports. An annual budget is given in the reports.

Human resource is also mentioned.

Key points including recruitment, training, and settling new employees. In 2014, participation in EURAXESS – Researchers in Motion programme is also mentioned.

4.5 Shanghai Supercomputer Centre Annual Reports – 2010-2014

SCC’s major income comes from user applications supported by different projects, mostly national projects supported by the government. Projects from the industry remain less than 10%.

No specific details on human resources.

**5. General findings:**

* RI sustainability is gaining more importance, though studies of sustainability of RI in general are rare.
* Some studies are made of sustainability of RIs in specific science domains.
* There are more studies on sustainability on distribute RIs and e-RIs than single sited RIs. And different RIs (eg. distribute vs single-site, domestic vs international) have different challenges and emphases on sustainability.
* Despite different definitions of sustainability and diversities of RIs in different domains, financial sustainability remains a focus across the studies.
* Present studies focus more on the operational phase of RIs, or the phase after the initial investment, instead of the whole life circle of RIs (eg. the termination phase is seldom studied).
* Besides ensuring financial incomes, cost management and creating value for stakeholders are also considered important for RI sustainability.
* Human resources are mentioned as an important factor for sustainability, though dedicated studies are rare.
* Most studies are discussions with the aim to set the framework. Further in-depth studies with best practices, policy recommendations and toolkits are yet to be found.