Sustainable Research Infrastructures? What Are They?

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Are you a researcher? If you are, research infrastructures are probably essential to your career – whether you realise it or not. Basically, research infrastructures are the services, facilities and resources used during research. Research infrastructures can be both physical and digital. This can include, for example: major pieces of equipment or collections of equipment; libraries, both physical and virtual; collections of scientific data; and computing systems and networks. While such infrastructures are primarily used for research, they can also have a wider purpose, such as in education or public service.

The Variety of Research Infrastructures

You probably use several different research infrastructures, every day that you work. It is easy to take these facilities and services for granted.

Some research infrastructures are large and high-profile. One example is the European Organisation for Nuclear Research – perhaps better-known as CERN, the world's largest particle physics facility. Another is the Infrafrontier Research Infrastructure, which aims to boost genome research into human disease. National supercomputers, like ARCHER in the UK, also form part of a community's research infrastructure.

Other infrastructures are smaller or less visible, but no less vital. Some of these you might use every day. Biological databases like GenBank, publication databases such as PubMed, or even citation databases like Web of Science all form part of knowledge-based research infrastructure. Physical collections, such as in library or museum archives, are also important.

Some less well-known examples of research infrastructure might surprise you! Facilities such as research ships, satellites and collections of living organisms are more examples of research infrastructure.

Pros and Cons of Research Infrastructures

Research infrastructures are essential to the research community. Without these facilities and services, scientific progress would be far more difficult. However, research infrastructures are not without problems.

Some infrastructures work very well. One example is ORCID – the system which gives every researcher a unique ID, with which they can tag all their output. ORCID is praised by researchers as an example of an infrastructure that works well, benefiting both individual researchers and the scientific community.

Sometimes, though, there are problems with the development and use of infrastructures. At a recent workshop, researchers discussed some of these issues. One problem is that publicly-funded infrastructures may sometimes need to compete with one another, for example for funding or users. This could mean fragmented services, leading to duplication of effort: a waste of time and money.

In addition, some infrastructures struggle to attract long-term funding. While there is often interest in setting up new infrastructure – developing new software, for example – less value is placed on long-term maintenance of the service.

Joining together resources created in different countries, or by different teams, can be a challenge. For example, researchers in different countries may use different systems to store their data or publish their output. If infrastructures are incompatible, it can be difficult for researchers to access what they need.

Finally, from the point of view of a researcher, infrastructure is often designed without the end user in mind. This means that the people who create the infrastructure – governments, funders or libraries, for example – fail to consult the people who will

actually be using the service. The result is that researchers discover that infrastructure does not meet their needs.

Why is Research Infrastructure Evolving?

Going forward, research infrastructure will become even more important. More international collaboration is taking place than ever before. It is vital that the structures are in place to allow these collaborations to reach their full potential.

These days, most new infrastructures are digital. One particular area of growth is in Open Science: the push for the results of scientific research to be freely accessible to all. For this to become a reality, we need new systems and databases.

In recent years, many new digital databases have been built to provide a gateway to Open Access research (i.e. research articles that are free to view). These include DOAJ and PMC. This is also an example of where better collaboration could aid the research community. Many of these databases overlap, while none cover all open access journals.

In some cases, research infrastructures also allow researchers around the world to share data far more quickly than in the past. Sometimes, the infrastructure itself is operated by paid staff or volunteers who are based in different parts of the world. The design needs to reflect this fact.

How Can We Create Sustainable Research Infrastructure?

For research infrastructures to survive, they must be sustainable. This does not only mean financially sustainable. Infrastructures must also attract the support of the scientific community. After all, it is the people who use an infrastructure who will ensure its survival.

From a researcher's perspective, infrastructures should meet a number of criteria to be sustainable:

• **They must be open:** in how they are funded, how they work, what their aims are and who can access them.
• **They must collaborate.** This means avoiding competition and duplication of effort.
• **They must be diverse.** As researchers from countries such as China and India take on a more prominent role, infrastructures should adapt to recognise this fact. Infrastructures should be designed with an international user base in mind.
• **They must be adaptable.** Sustainable infrastructures should take into consideration the needs of researchers working across different disciplines.
• They must **make use of the best technology available** at the time.
• They should **support the principles of Open Science**.

So, what can researchers do to help develop sustainable research infrastructure? The main thing to do is to contribute to discussions about this topic. This could be informally, through online forums. It could also be through participating in consultations on new infrastructure, or joining workshops or discussion groups.

In addition, when choosing which infrastructures to use for a project, researchers can think carefully about two things: which infrastructure meets their needs, and which is most sustainable. The more users sustainable infrastructures have, the more likely they are to survive.

Which research infrastructures do you use in your work? What improvements could be made to them? Let us know your thoughts and suggestions in the comments below.

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