Overcoming the Barriers of Cyberinfrastructure Development and Implementation

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Introduction

Cyberinfrastructure (CI) within virtual organizations is an innovation that will benefit many social systems. According to Kee et al. (2016), CI can combine elements of many definitions, but can be summarized as, "a complex system, involving a diverse network of interdependent technologies, remote instruments, big datasets, dispersed experts, diverse institutions, etc." (p. 5). CI as a whole has increased the quality, seamlessness and accuracy of collaboration throughout e-science projects.

Literature Review

The development process of CI tools consists of many factors such as people, collaboration, and technology. Additionally, the developers comprised of computational technologists create tools with the goal of addressing the needs of the user community. The development stage is essential in CI projects and at times can be overlooked when the focus is on implementation or adoption of the tool.

At the developmental stage, developers of virtual organizations face multiple barriers due to various conditions. First, they are pressured to immediately develop and launch the CI tool as soon as possible. However, the NSF funding for these projects mostly fund science and not the technology posing many problems (Kee & Browning, 2010). The disconnect between funding science and limited on technology is still evident today. Developers balance creating the tool, meeting users' needs, and driving science within a CI project with a specific funded period. Following the development stage, the implementation stage is when users begin to employ the tool to carry out their research. On the other hand, developers in this stage also fix minor issues and develop new iterations of the tool. The implementation stage is critical for the tool to be in use and adopted by users. Yet the implementation stage also face several challenges to sustain the utilization of the tool. However, there is limited research on overcoming the barriers of cyberinfrastructure development and implementation. This current study seeks to understand the barriers and, most importantly, the solutions. Thus we ask the questions: RQ1: *What are the major barriers of cyberinfrastructure (a) development and (b) implementation?* RQ 2*: What are the strategies to overcome these barriers?*

References

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Methodology

This study employed the Grounded Theory approach (Corbin & Strauss, 1990) and analyzed 60 interviews conducted with members in the e-science community, such as directors, domain scientists, and principal investigators. Participants were from a diverse range of institutions across the United States. Following a semi-structured protocol, interviews were conducted by telephone. The co-authors performed multiple iterations of data analysis and literature integration, yielding preliminary findings presented in this poster.

Findings

Barriers

Specific barriers that emerged from the analysis emphasize, gaps between users (domain scientists) and developers (computational technologists) as well as funding in development. The barriers of implementation consist of usability of the tool and support.

Development

- GAPS: As a researcher, appreciating the difference in working with this developer and user group is that we each had our own objectives and goals…and how to make everyone happy is something that I can see is a real barrier in some of these collaborations, that can lead to ill feelings if only one side needs are getting met. (Computational Technologist, UT, 22 April 2014)
- FUNDING: Because NSF funds research and innovation, not production stuff, and that makes sense. So it is a huge challenge to figure out what to do for an organization like ours that provides free access to scientists [and users] around the world…. So funding brings us people, but the lack of funding threatens us, because it requires a certain amount of money to sustain. (Computational Technologist, CA, 16 July 2014).

Implementation

- USABILITY: The biggest challenge I've seen is users want flexibility, and once you promote too much flexibility it comes to confusion, so how do you draw the lines. It's a very tough problem, a usability problem, and like different users have different perspectives of what they expect the tool to be doing for them. (Computational Technologist, IN, 18 November 2013)
- SUPPORT: Support is an interesting issue. Often, software developers don't provide the level of support the users may need for the software they developed. (Computational Technologist, IL, 17 July 2014)

Strategies

To overcome the development barriers include seeking assistance in grant writing for funding and engaging the community to bridge the gap. The proposed solutions for implementation barriers are providing tutorials and expertise to combat the barriers of usability and limited support.

Development

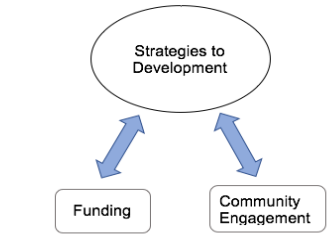
- FUNDING: Having a group of people who are very, very good at seeking support and seeking funding makes things a lot easier as well. I mean funding is very very competitive and the review committees are often given a very very challenging amount of work to do in a short period of time. If you can get help from people whose business it is to understand grant writing, get their help to present your ideas very, very clearly, that gives you an advantage against people who really are primarily scientists and are just trying to do their best but don't have a lot of experience with grant writing. (Scientist Developer, IL, 15 October 2014)

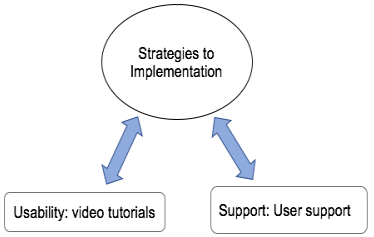
- GAPS: So I would say our standard process is we engage the community pretty heavily. We try to ascertain what the key, most important features would be to add. And that's driven by a handful of user basis that we already have that are already using our stuff, as well as new potential collaborators. (Scientist Developer, TX, 7 July 2014)

Implementation

- USABILITY: Then the second thing is if you can get them to click the launch button and the tool comes up… so the usability of it is like critical at that point. Because once you've convinced someone to click the launch button and the tool comes up, if they can't figure out the next step, then they'll just walk away. So at that point the video tutorials help in that respect because they might explain to someone, 'Oh, this is what I do first and this is what I do next'. We try to make the tools super easy to use, super obvious what you can do, and we try to build in the visualization. (Scientist Developer, IN, 4 December 2014)

- SUPPORT: So another thing could be having a user-support hat or expertise or experience is good, because, whenever you develop something I assume you'll have users using it, you will have to provide support. Sometimes scientists develop something and they are not used to having the user support side of it at all (Computational Technologist, CA , 17 July 2014)





Conclusion

The existing barriers of development and implementation are evident through the findings. However, the findings also reveal the solutions to challenge these barriers. The solutions for development barriers focus on finding personnel to help solve funding issues. In addition, using expert personnel such as social scientists is pertinent for bridging the gap between the users and developers. Further implications include addressing the barriers of development in CI proposals by keeping in mind the people who can bridge the gaps and provide support. Also, key personnel include those trained in a social science background who can assist in the testing and usability of the tool. It may be strategic for CI projects to collaborate with a social scientist who can be a co-PI. Specifically, problems often emerge due to afterthoughts that could have been prevented at proposal writing. Therefore, it is essential to consider key personnel during proposal writing to prevent these barriers. The solutions for development and implementation point to the value of people bridging the gaps, offering assistance in the grant writing process, providing usability testing, and giving expert support for CI projects.

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