Full Proposal Submission

Section 1: General Project Information

Project Title: **Open Source Hardware for Citizen Science in Indonesia, Nepal, and the Philippines: Mapping Networks, Understanding Outcomes and Testing Models**

Duration of Project: 24 months

Countries included in this project: Indonesia, Nepal, Philippines

Regions included in this project: Asia

Research Themes: 1 (Motivations), 2 (Infrastructures and Technologies), 3 (Communities of Practice), 4 (Potential Impacts)

Justification of Research Themes: This project targets all four research themes of the OCSDnet to study the opportunities and limits beyond the use of open hardware tools in open science and community science efforts in Indonesia, Nepal, and the Philippines. The focus on the open hardware design, building, and utilization in Indonesia connects the different themes to study how the collaborative work on laboratory infrastructure (theme 1 and 2) enabled the complex networks between universities and non profit organizations (theme 3) to solve various problems in primary, secondary and tertiary science education, public engagement in science through art and design events, but also water monitoring and remediation of volcanic lands (theme 4). The collaborative work on science infrastructure through OSHW is nestled and supported by both local university based student community programmes in science (theme 3 and 4) and the global maker and hacker movements, a multi-layered communities of practice, which also enable unique South to South open science networks. We are interested to understand the impact of these self-motivated local and global communities on the open science practices in the Southeast Asia by doing and in depth study in the primary research site in Indonesia (ethnography, interviews, network analysis) and testing a model of OSHW for science workshops in the nascent open science sites in Nepal and the Philippines.

Total Budget Cost (CAD): 79,910

Section 3: Proposed Study Information

Research Project Abstract

WORD LIMIT: 250.

The study will gather data for network analysis of Open-Source Hardware (OSHW) for science initiatives in Yogyakarta (Indonesia) since 2005 to evaluate them as a catalyst and model for open and community-based science efforts in Nepal and Philippines. OSHW for science efforts, which include practices of collaboratively designing, building and repurposing electronic components and tools, address the critical problem of the lack of customizable, repairable and affordable scientific laboratory equipment. Networks around OSHW enable science research and education while also connecting local initiatives with global agendas and interdisciplinary practices supported by the maker and hacker movements. We will analyze and evaluate the scope and effectiveness of OSHW for science practices in several aspects: local university research infrastructure, science education, interdisciplinary cooperation and community science engagement, impact on local rural and urban communities, and South to South research cooperation.

To engage community-based open design for science practices (designing, building, testing, and calibrating OSHW) defines a type of “subaltern” R&D, which catalyzes South to South research networks, and critically reflects upon science and community relations. The network analysis will help us visualize and understand various stakeholder interactions, outcomes and impacts of open and community science projects based on OSHW, and define “subaltern R&D” based on critical and open design for science. The workshops will improve understanding of applicability and scalability of this model for open science in the Global South, which prioritizes the material engagement with science over OSHW through active tool building rather than only access, data and communication.

Research Problem, Significant and Justification

WORD LIMIT: 1,000. Please provide a brief overview of relevant literature and highlight the knowledge gaps that this project will address. Indicate the size and scope of the problem, as well as how the problem relates to the purpose and goals of OCSDNet; broader national development priorities, and the research and capacity needs of the countries involved.

Advancement of open source technologies (Gillespie, 2006; Lerner, 2005) in the last

two decades, together with calls for sustainable and socially inclusive technologies, such as the Alternative Technology Movement (Smith, 2005) or the "Cradle to Cradle" manifesto (McDonough, 2002), led to the rise of the global hacker and maker movements. Activities include tool design for open science, which support building open hardware laboratory equipment and sharing protocols. Literature is virtually absent regarding the opportunities this movement offers to open science and R&D efforts in the Global South. Only a few studies exist, which connect these movements to DIYbio (Do-It-Yourself biology) efforts (Kera, 2012; Kera 2014) or open design communities in Asia (Kao, 2014; Lindtner, 2014). These community-based science and technology efforts span a variety of definitions regarding "open" and "collaborative" science (Gacek, 2004; Lerner 2005). These terms often relate to tools, community rules, norms and licenses, or participants described as "geeks, "hackers" and "makers," meaning citizens (scientists, but also designers, engineers, activists) (Holmgren, M. & Schnitzer, 2004) willing to engage, share, learn, and teach in "open" environments. In our study we will concentrate on one aspect of these "open" and "collaborative" activities, which offers unique opportunities for Asia, which is the open design and open-source hardware efforts in building laboratory equipment.

Laboratory equipment is often unavailable in the Global South due to high acquisition costs. This unavailability is perpetuated by divides in knowledge production centered in the North, which denies the South recognition and validity. This divide is manifested in international aid through the idea of technology transfer, which was embraced in neoliberal policy in the "development decades" following World War II (Perez, 1988; Kumar Mehta, 2001). This has created inequality and dependency on the West for scientific knowledge and research (Posadas, 1999). We want to highlight practices and interactions between research and communities pioneered in the Global south, which paradoxically offer a model for the "west" to adopt, and question the predominant obsession with science effectiveness reduced to patents and publication in closed journals.

Attention must be drawn to DIY and maker approaches, which insist on the possibility of building laboratory equipment with open source hardware tools and, in the process, democratize technology infrastructure. Furthermore, we claim that by building laboratory equipment, communities are empowered to define their own scientific and development challenges and goals in their local context outside the technology transfer rhetoric. The specific hardware that these communities have

begun to create and iterate include, but are not limited to, microscopes, polymerase chain reaction thermocyclers, laminar flow cabinets, and centrifuges.

Addressing all four themes of the OCSD Network, we will focus on two open citizen science organizations (HONF & Lifepatch) and their relations to local communities in Yogyakarta, Indonesia. We will connect empirical research to historical cultural context while mapping open science stakeholders in terms of their institutions, actors, objects (tools), and events (workshops) around communities and initiatives regarding building open source laboratory equipment and sharing open science protocols, which will play a significant role in defining the aspirations of open science. We will explore the implications for intra-urban and rural-urban development through critical making, open design, and the expansion of agency among actors within these networks through building tools and executing science protocols (regarding fermentation, textile dyes, and other research). Understanding the aspirations, limits, and opportunities behind OSHW for science, and discussing challenges related to testing, calibrating and developing grassroots certification authority on OSHW will provide a foundation for discovering examples of endogenous development efforts. This mapping will help to define a model to be tested in OSHW movements in Kathmandu and Manila. A central question of our research into OSHW open science efforts is whether and to what degree building laboratory equipment and organizing various initiatives and institutions around OSHW empowers local research communities to define their own science aspirations and criteria of assessing impact. We see evidence that OSHW efforts involving broad swaths of local communities, which can serve as data helping to define new assessment criteria for science production and development outcomes, and help compare between established open science and citizen science efforts in Yogyakarta with emergent sites in Kathmandu and Manila to understand local contexts, opportunities and limits for both science and development assessments. The examples in Indonesia, such as the existing student community services program at the Universitas Gadjah Mada in Yogyakarta, suggest that the DIY approach to science supports these existing models of open and community science.

With this study we want to challenge the deficit model of science communication and the idea of technology transfer, which are rooted in unreflected colonial views of the Global South as a recipient of science knowledge leading to development (Perez, 1988; Byerlee and Fischer, 2002; Forero-Pineda, 2006). We see these views as a

form of “epistemic violence” (Spivak, 1988), which defines technologies and science as something that is always transferred and applied in the developing countries by the help of various donors, corporate responsibility programmes or other innovators from the “west.” In contrast to the deficit model, the activities in Yogyakarta, Kathmandu, and Manila support the concept of cognitive justice, which recognizes plurality of knowledge creation and demands the physical presence of knowledge creators in the local context, rather than application of remotely-derived technical expertise (Visvanathan, 2006). We are interested in how these efforts around building open laboratory equipment in Yogyakarta support and recognize the agency of actors at the local level. They enable community-based and open science, which involves a variety of actors within unique open science networks. (Holmgren, M., & Schnitzer, 2004). In this sense, we are rephrasing Spivak’s question from the title of her famous essay "Can the Subaltern Speak?" (1988) and trying to define the goal of open science in the postcolonial context. While agreeing with Spivak that the “subaltern” maybe can not research and innovate (speak), we still see evidence that they dare to question what research and innovation mean in the present economic and political crises and in the postcolonial context.

Research Questions and Objectives

WORD LIMIT: 500. Outline your project’s central research question(s), sub-questions, and objectives. There must be congruency between the questions, objectives, research design and methods. You should highlight how the study’s questions and objectives will contribute to the research themes of the OCSDNet.

This pilot study will map and reflect the existing and emerging open science and citizen science networks in Indonesia, Nepal and Philippines, and then subsequently support them through three workshops in order to achieve the following research objectives:

Objective 1: Determine the role, if any, of low cost, DIY, open source tools and hardware in supporting alternative networks of knowledge creation and endogenous development through open and collaborative science.

Does open-source hardware and the practices and events surrounding it facilitate interactions between community and science in Indonesia, Nepal, and the Philippines?

Can any forms of endogenous development be witnessed?

How could these interactions and iterations through the global hacker and maker movement legitimize and support the “vernacular and grassroots” science and knowledge?

What type of open science infrastructure do these tools enable? How they define “openness”?

How open-source hardware supports South to South (and North) research collaborations and networks?

Objective 2: Comprehensively map and evaluate the existing documentation, utilization and dissemination of open source tools (especially open science hardware and open science protocols) in the alternative research communities in Indonesia, Nepal, and the Philippines.

How have open and collaborative science initiatives in Yogyakarta, grown and sustained themselves over the last 10 years?

What are their future aspirations and how they relate to lessons learnt?

Do open science practices, materials and tools support science education on various levels?

Do open science practices, materials and tools support community-based projects in places without infrastructure?

Objective 3: Contextualize the present open science and citizen science efforts in the existing university models of community engagement and science assessment and discuss the various models of science, crafts, art and design engagements in Indonesia.

Do existing models of community-based science (student community services in

Indonesia and similar projects and examples elsewhere) create conditions for appropriation of open science and collaborative science in Yogyakarta, Indonesia?

What kind of cultural phenomena and institutions related to makers, crafts and science activities support open science and collaborative science?

What are local, regional, and global legitimization and validation processes of open and collaborative science?

Are there policies supporting such activities?

What are the challenges local organizations and individuals face when doing science using open and collaborative methods?

Objective 4: Create effective workshops focused on open design for science efforts, which empower participants to identify development challenges and needs in their own contexts, including the testing and calibration of open source tools for science to meet those challenges.

How do workshops enable the open and collaborative science communities to spread and develop further?

What institutions, initiatives, tools, and practices do they mobilize?

Does the documentation and use of open data tools (GitHub, Wiki, Thingiverse) help in the processes of accessing, designing, and utilizing hardware?

Can the iterative process of open-source hardware design and knowledge creation in thes workshops, through using and contributing to open-source resources available online, serve as a form of knowledge legitimization?

How does building open-source laboratory hardware connect cultural, scientific, and educational purposes related to open and citizen science efforts?

Stakeholders

WORD LIMIT: 250. Identify and briefly describe your project's stakeholders. How will your project respond to their needs and interests?

Our primary stakeholders are the universities together with the hacker, maker, and artist communities in Yogyakarta, Indonesia, which formed not only connections with communities in Indonesia, but also with Kathmandu, Nepal, and Manila, Philippines. Specifically, this includes Universitas Gadjah Mada, Universitas Sanata Dharma, Universitas Kristen Duta Wacana (Yogyakarta), The House of Natural Fiber, HONFablab, Lifepatch, Sewon Food Lab, XXLab (all from Yogyakarta), WAFT lab (Surabaya), Karkhana (Kathmandu); and the AwesomeLab (Manila). There are a variety of existing formal and informal connections and collaborations between these organizations.

This project will support the efforts of these organizations to do open and collaborative community science by providing the means to expand their work in building scientific hardware using an open design method that addresses the specific needs of their communities by allowing self-identification of community development needs and the subsequent space to create the requisite hardware. The research team will conduct participant observation without directing the hardware selection or other efforts, the members of the team will be represented as any participant in the events.

The secondary stakeholders comprise the cooperating primary and secondary schools in Indonesia, Nepal and Philippines, government organizations supporting the work of these organizations, international funding agencies and cultural institutions cooperating with these local actors, the global network of hackerspaces and makerspaces, and also scholars researching these networks from anthropology, science, technology, and society studies, science communication, and development studies. Stakeholders supporting the research include the following academic institutions: Chulalongkorn University, Bangkok; Universitas Gadjah Mada, Yogyakarta; National University of Singapore, Singapore.

Research Design & Methods

WORD LIMIT: 1,000. In this section, applicants should clearly indicate and justify the proposed study design. You should discuss how you intend to collect the data that you will need to achieve the study's

objectives and answer the project's research questions. You should clearly outline how each data collection activity will contribute to the study objectives.

We plan to gather empirical evidence on this marginal, but impactful network of open science organizations in Indonesia, Nepal and the Philippines, which practice science in open and collaborative ways by building their laboratory equipment needed for protocols, experiments, and performances connecting research with aesthetic explorations of critical design, education and community development. The empirical data about these practices, activities and institutions will be discussed in the context of local culture, especially in Yogyakarta, Indonesia, our main research site, which is praised for its vibrant citizen and community science.

We will collect data on the institutional, social and material bases and support (events, organizations, individuals, but also the OSHW electronic components and design, repurposing of tools, digital fabrication methods) from the websites and available media to combine them with ethnographic data, surveys and interviews on current projects. We plan to connect these data on the local context and define the unique aspirations of the open and citizen science movements in Southeast Asia, which created unique interactions between citizen science organizations, universities, and the public.

This project will combine grounded theory method with network analysis in order to capture the unique qualities of the networks and interactions found in the research site and its associated connections. A variety of methodologies will be employed to gather data from the online sources, actors and institutions involved and events and workshops.

Objectives 1 and 2 and their associated research questions aim to map the role of low cost, DIY tools in creating open and collaborative science networks (especially in Yogyakarta). To gather this data we will need timelines of hardware creation, events, and people and organizations involved from both online and offline sources through a review of documentation and literature. We will use a combination of structured and unstructured key actor interviews, laboratory ethnography and participant observation to understand the type of interdisciplinary practices around open hardware for science and its impact on education, research and creative practice.

A very important aspect of Objective 2 is the gathering of data regarding milestones and aspirations for citizen science organizations in Yogyakarta, which will be collected through surveys and structured key actor interviews. The interviews will

focus on gathering the motivations, roles, and length and scope of involvement, types of activities, and tools developed in the network for open science and collaborative science activities. Participants (both day to day, and workshops) will be surveys regarding their view of open and collaborative science in their region, what they observe as the critical problems and opportunities, and how they perceive the interactions between actors. Surveys will be limited to non-leadership positions in these organizations (participants in workshops, events), while structured interviews will be conducted with leaders of various citizen science organizations, and will be primarily used for gathering demographic and interaction data.

For Objective 3, data regarding the cultural and historical contexts and the conditions for open and citizen science will be gathered through literature review of materials in Bahasa, and interviews with administrators running student community services at two universities (UGM and Sanata Dharma) and selected students involved in projects involving science rather than engineering.
The above data will form the foundation for Objective 3, as they expand these efforts towards the university and community as major areas of interaction. We plan on using a variety of tools from the Digital Methods Initiative (https://www.digitalmethods.net/Digitalmethods/WebHome) to collect data from related internet resources.

For Objective 4, this data will help prepare the design of the workshop model, which will reflect the cultural context and social dynamics through open data and critical making activities. The workshops will also be designed to foster South to South research cooperation through community building, designing, fabricating, and testing existing open science hardware solutions. We will also prototype new tools designed to meet community-identified challenges. In the interactive portion of the workshop, we will use a combination of participatory action research methods, participant experience data, and analyze the data gathered over GitHub, Instructables and Thingiverse. These data will enable us to understand the perceptions of community problems, documentation capability, and also the feelings and aspirations of the participants. Data will be gathered regarding actors' usage of resources available online and their interactions with it and subsequent responses and iterations to the available resource body.

The data gathered in the project will help the research team and primary

stakeholders to begin to reflect on and understand the dynamics and relations between the material (open source tools), social (types of organizations), and institutional (cultural, economic, etc). All data gathered will be available in real-time and online in the GitHub repository and as outlined into the communication and outreach plan below.

Analysis & Synthesis

WORD LIMIT: 1,000. Describe how you intend to organize, examine and model data to arrive at conclusions and insights.

The methods of data collection above will yield a breadth and depth of data from our primary stakeholders for our grounded theory methodology. The main analysis for this project is the comprehensive network mapping of the various organizations in Yogyakarta, while using hardware and events as central nodes in the network analysis. Regarding the survey data and the interviews, we will code that data to define the key concepts in open and collaborative science efforts in Yogyakarta, including: expectations, goals, definitions, views, etc. This will then be mapped in a network using the snowball method (Hanneman and Riddle, 2005) focusing on the hardware as central nodes in the network analysis, which will connect institutions, people, tools, activities, and events in order to understand what is happening on the ground, especially outcomes and results of festivals, artwork creation, open source hardware fabrication, and how they relate to the expectations and reflections identified regarding milestones and aspirations.

For our visualization and analysis, we will use open source exploratory data analysis software, Gephi (https://gephi.github.io/). The network model will be analyzed in several regards, beyond the interview and ethnographic discourse analysis, in order to code different levels of interaction between nodes and and modes. In mapping interactions with hardware and people, we will use multi-category nominal measures of relations in order to capture the types of relationships people see themselves as having with each hardware interaction. The same scale of measurement will be applied to interactions between people and institutions, but with different categories of relationships.

The grounded theory methodology and the the network analysis will concentrate on

actors involved, how the network developed and grew, and how it reflects and legitimizes open science and citizen science over the last 10 years. The historical analysis of the student community services and the local cultural origins of making, hacking and open science, will describe the context and conditions, which enable the open science to emerge and develop. In the participatory and open design phase, we plan to employ the insight we gather in the network analysis on how open and community science operates in Indonesia to support the emergent communities in Nepal and Philippines and test our hypothesis on the importance on DIY, low cost equipment as a form of empowerment to do science in open and collaborative ways to encourage greater occurrence of endogenous development in the participating communities. We will also identify the limits and opportunities behind this form of open science efforts. We will use surveys, interviews, ethnography, and participatory action research tools to capture what is happening during and after the workshops, and will be used for further analysis of the network dynamics.

Depending on the progress of this project, and that of the OCSDNet projects in Francophone Africa and Haiti, and Argentina, there may be interesting opportunities to compare and contrast data sets, stories, and lessons learned between both research and action engagement oriented activities from all three projects. Between the three projects in Latin America, Asia, and Africa and the Caribbean, there are all elements of citizen science efforts within the larger scope of the global hacker and maker movements. This would be a good opportunity for the OCSDNet to also act on the principles of its creation in sharing and iteration of ideas in line with the movements that we are looking to both research and participate.

We will be able to answer how practices and phenomena related to these three ontological domains enable open and citizen science in the Global south, the dynamics of the networks they create and how we can scale the model and discuss its sustainability.

Outcomes & Outputs

WORD LIMIT: 700. Describe the major project outputs and intended outcomes. Your project outputs should creatively reflect the principles of open and collaborative science.

This project will have 6 distinct outputs each with specific outcomes. Each of these outputs, while specific in their delivery will also be re-processed into different

channels of communication to the wider public. For further details see the Knowledge Translation and Dissemination section.

Output 1: An open-source journal paper, blog post series, a section of the project's GitHub repository, social media engagement, and contributions to Wiki pages regarding the role of open, DIY, low-cost laboratory equipment in formal and informal open and collaborative science networks and their implications for development in Yogyakarta, Indonesia developed from and through the open process of writing a master's thesis in collaboration with primary stakeholders.

Outcomes:

a. Primary stakeholders will foster and enlarge the South to South (and North) Networks and enable new research communities to appear in Nepal, Philippines and Indonesia.
b. Primary stakeholders will better understand the importance of open and collaborative infrastructure and documentation related to sharing protocols and open design of laboratory equipment practices in creating stronger R&D networks.

Output 2: Open-source journal paper, and complementary blog posts, and a section in the project GitHub repository documenting a study about publicly engaged science, alternative researcher feedback indicators, and community-driven science focusing on the Community Service Section at the Institute for Research and Community Service at Universitas Gadjah Mada.

Outcomes:

a. Increased recognition from policy actors in the Global South on the importance of the student community service model of public engagement in science by institutions of higher education.
b. Stronger understanding by university leadership of the impact that the SCS-CEL program has for societal good in Indonesia and greater motivation to improve the program and communicate it as a model for other universities

Output 3: Two open-source journal papers, blog posts, a section of the project

GitHub repository, social media engagement, and contribution to Wiki pages regarding open design, critical making, and rethinking the discourses on sustainable development in Yogyakarta, Indonesia produced through an open process PhD dissertation research in collaboration with primary stakeholders.

Outcomes:

a. Students feel empowered to create new transdisciplinary organizations (non profits, social enterprises, start-ups) and explore careers in open and citizen science related fields after theytheir graduate.

Output 4: Training of two Indonesian research personnel in science and technology studies methods for gathering data for the project in an open and collaborative manner, including the use of open-source software, and in social media engagement for digitally underrepresented partner organizations.

Output 5: Pilot a low-cost mobile telephone-based reporting and evaluation mechanism established and integrated into the curriculum for the student community service program at Universitas Gadjah Mada.

Outcomes (4 and 5) :

a. Principles of open science and collaboration are instilled in researchers, participants, collaborators of the project, and subsequently change the attitudes and perspectives of the people (advisors, peers) that they work with in their respective programs.

Output 6: Three workshops conducted and evaluated regarding building open hardware laboratory equipment for cultural, scientific, and educational purposes related to open and citizen science efforts.

Outcomes:

a. Participants' capacities for and efforts in research hardware creation, community building, and open documentation will be catalyzed resulting in greater activity between Global South communities.

We believe that these outcomes can contribute to the following long term impacts.

1. Positive education policy changes utilizing open and collaborative science for development, which are not based on the deficit model, but rather embraces a participatory model of science and knowledge creation and R&D activities.
2. The adoption of alternative indicators and ranking systems by universities worldwide, which are more focused on community involvement and social impact, inspired by models in the Global South.

Knowledge Translation & Dissemination

WORD LIMIT: 700. Describe how you will disseminate your outputs. To ensure that the results of your study are applied to address development challenges, explain how you intend to package, disseminate and promote the application of your findings amongst relevant stakeholder groups.

We plan to use a variety of media forms to disseminate our six major outputs so that they enable people to access and use the knowledge generated by this project in a useful and productive manner. The foundation for our knowledge dissemination plan is distributed across five distribution styles. These include the following: (1) GitHub Repository (2) Published Works and Wiki Pages (3) Instructables and Thingiverse (4) Blogs (5) Social Media (6) Interactive Media. These distribution styles will utilize the OCSDNet Virtual Hub as much as possible.

Our GitHub Repository will be used for transparent management of the project while also serving as a central database for all activities during the project and afterward. The Published Works and Wiki Pages will be used to document research activities, findings, and media for a wide variety of reading-oriented media, including, but not limited to, open journals, popular science and development websites (ie SciDev.net), and Open Wiki articles in order to reach an audience beyond academia. Our Instructables and Thingiverse accounts will allow us to upload protocols and schematics in an accessible format for the digital public. Blogs will allow researchers and participants to share their thoughts, feelings, and stories in a way that engages the public in conversation and dialogue. Social Media (with focus on Twitter, Facebook, Vine, Instagram, IndieGoGo) will allow our team to extend our communication capability for all other distribution methods, and it will allow us to engage the public in a way that allows for conversations and collaboration to occur with greater efficiency, transparency, and engagement energy. Social media

engagement will be encouraged by all researchers and participants, and guided and promoted by the project's research coordinator. Finally, Interactive Media includes the workshops, the hardware outputs of the workshops, and the videos and photographs that will require the public to interact with our project outputs in ways that go beyond reading.

For the purposes of knowledge translation and dissemination, our primary and secondary stakeholders can be divided into the following categories (in reference to Yogyakarta as "local"): (A) Local Hacker and Maker Organizations and Associated Community (B) Local Academic Institutions and Associated Community (C) Local Public (D) Study-related Connected Hacker and Maker Communities (Kathmandu, Manila) (E) Global Hacker and Maker Community (F) Global Academic Community and (G) Global Public.

We expect that different categories of stakeholder will be more effectively engaged by different styles of distribution. These expectations are as follow.

Stakeholder Group	Expected Distribution Style Engagement
Local Hacker and Maker Organizations	GitHub Repository, Instructables and Thingiverse, Blogs, Social Media, Interactive Media
Local Academic Institutions	Published Works and Wiki Pages, Instructables and Thingiverse, Interactive Media
Local Public	Social Media, Interactive Media
Study-related Connected Hacker and Maker Communities	GitHub Repository, Published Works and Wiki Pages, Instructables and Thingiverse, Blogs, Social Media, Interactive Media
Global Hacker and Maker Community	GitHub Repository, Published Works and Wiki Pages, Instructables and Thingiverse, Social Media, Interactive

	Media
Global Academic Community	GitHub Repository, Published Works and Wiki Pages, Instructables and Thingiverse, Social Media
Global Public	Published Works and Wiki Pages, Blogs, Social Media

Outputs 1, 2, and 3 will be processed into the following distribution styles: GitHub Repository, Published Works and Wiki Pages, Instructables and Thingiverse, Blogs, and Social Media.

Output 4 will be processed into the following distribution styles: Published Works and Wiki Pages, Blogs, and Social Media.

Output 5 will be processed into the following distribution styles: GitHub Repository, Published Works and Wiki Pages, Instructables and Thingiverse, Blogs, Social Media, and Interactive Media.

Output 6 will be processed into the following distribution styles: GitHub Repository, Instructables and Thingiverse, Blogs, Social Media, and Interactive Media.

We expect that our Knowledge Translation and Dissemination will be a fluid effort that adapts to the expectations and needs of our stakeholder groups, and we will adapt to meet those expectations and needs. The outputs will enable various stakeholders to access and utilize the protocols, schematics, knowledge, and inspiration for identifying their own community development needs. They will contribute to the larger body of knowledge communicated and iterated through the internet and workshops within the hacker and maker movement.

Network Connections & Interactions

WORD LIMIT: 500. Illustrate how you will contribute to the overall OCSDNet framework and themes. Draw on other initiatives and approaches discussed at the OCSDNet workshop, if applicable.

This project connects to all research themes of the OCSDNet. This research

contributes to T1 because it looks at the origins and evolution of organizations and their interactions with individuals and institutions in Yogyakarta, Kathmandu, and Manila. It will map the interactions that encouraged and discouraged actors and catalyzed actions. This research will illuminate the positives and negatives of the process to create this thriving community of open and collaborative science revolving around open source hardware.The research will look at historical context and conditions of Yogyakarta that allowed those specific communities to flourish and expand over the last decade.

T2 is directly related to this project's study of infrastructure creation from the community itself. This project will follow the infrastructure as it was created and how those objects interacted with people inside and outside of Yogyakarta. The workshops portion of this project extends the Yogyakarta example to other organizations that are just beginning to experiment with open source hardware fabrication for use in their own communities. The use and access of these open schematics and protocol documentation are key to the development of these Global South networks within the larger landscape of the hacker and maker movement.

T3 aligns with this research as it connects to the network analysis and its layer of experiences, aspirations, and emotions on top of the connections between events, hardware, individuals, and institutions. The examples of Yogyakarta, Kathmandu, and Manila expand the traditional view of science in radical ways by including designers, students, the public, engineers, and artists. In understanding these different actors, the project expects to discover how the individual expectations and contributions to the hacker and maker community shape and mold the local, regional, and global networks of hackers and makers. The project will also facilitate direct networking between actors in these three communities through workshops.

T4 speaks to the core of what these networks are, communities created through self-motivation and enabling of community development at the urban-urban, urban-rural levels. Open design and the processes of critical making in the research sites of this project have enabled communities to organize that are concerned about and motivated to improve their communities. The processes of open and collaborative science, and exploration through the development of open source hardware have already made amazing impacts on the the organization of people, their actions, and the connections that they have made in order to do good in their homes, and this

research project will look at these impacts through T1,2, and 3.

This project identifies several projects that it shares synergies with, including the proposals by Arul, because there are always new ways to learn how people share knowledge, especially when there are potentially difficult people; Catherine and Florence, because of the concepts of cognitive justice; Aline, because of the focus on education and the two-way street that allows for learning and knowledge creation; and Mariano, because of the focus on communities that have formed through self-motivation and in response to the challenges of their communities.

Bibliography (APA style)

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education*, *27*(9), 1099–1121. doi:10.1080/09500690500069483

Byerlee, D., & Fischer, K. (2002). Accessing modern science: policy and institutional options for agricultural biotechnology in developing countries. *World Development*, *30*(6), 931–948.

Cohn, J. P. (2008). Citizen science: Can volunteers do real research? *BioScience*, *58*(3), 192–197.

Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environmental Monitoring and Assessment*, *176*(1-4), 273–291. doi:10.1007/s10661-010-1582-5

Cooper, C. B. (2012). Links and Distinctions Among Citizenship, Science, and Citizen Science. A Reponse to“ The Future of Citizen Science.” *Democracy and Education*, *20*(2), 13.

Cooper, C. B., Dickinson, J., Phillips, T., & Bonney, R. (2007). Citizen science as a tool for conservation in residential ecosystems. *Ecology and Society*, *12*(2), 11.

Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen Science as an Ecological Research Tool: Challenges and Benefits. *Annual Review of Ecology, Evolution, and Systematics*, *41*(1), 149–172.

doi:10.1146/annurev-ecolsys-102209-144636

Forero-Pineda, C. (2006). The impact of stronger intellectual property rights on science and technology in developing countries. *Research Policy*, *35*(6), 808–824. doi:10.1016/j.respol.2006.04.003

Gacek, C., & Arief, B. (2004). The many meanings of open source. *Software, IEEE*, *21*(1), 34-40.

Gillespie, T. (2006). Designed to 'effectively frustrate': copyright, technology and the agency of users. *New Media & Society*, *8*(4), 651-669.

Guédon, J. C. (2008). Open Access and the divide between "mainstream" and "peripheral" science.

Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods*. University of California Riverside. Retrieved from http://www.researchgate.net/publication/235737492_Introduction_to_social_network_methods/file/3deec52261e1577e6c.pdf

Holmgren, M., & Schnitzer, S. A. (2004). Science on the Rise in Developing Countries. *PLoS Biology*, *2*(1), e1. doi:10.1371/journal.pbio.0020001

Kera, D. (2012). Hackerspaces and DIYbio in Asia: connecting science and community with open data, kits and protocols. *Journal of Peer Production*, *2*. Retrieved from http://peerproduction.net/issues/issue-2/peer-reviewed-papers/diybio-in-asia/?format=pdf

Kera, D. (2014). Innovation regimes based on collaborative and global tinkering: Synthetic biology and nanotechnology in the hackerspaces. *Technology in Society*, *37*, 28–37. doi:10.1016/j.techsoc.2013.07.004

Lansing, J. S., & Kremer, J. N. (1993). Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape. *American Anthropologist*, *95*(1), 97–114.

Loyola, R. D., Diniz-Filho, J. A. F., & Bini, L. M. (2012). Obsession with quantity: a view from the south. *Trends in Ecology & Evolution*, *27*(11), 585. doi:10.1016/j.tree.2012.07.016

McDonough, W., & Braungart, M. (2002). Remaking the way we make things: Cradle to cradle. *New York: North Point Press. ISBN*, *1224942886*, 104.

Miller, C. A. (2007). Democratization, international knowledge institutions, and global governance. *Governance*, *20*(2), 325–357.

Mueller, M. P., Tippins, D., & others. (2012). The future of citizen science. *Democracy and Education*, *20*(1), 2.

Perez, C., & Soete, L. (1988). Catching up in technology: entry barriers and windows of opportunity. *Technical Change and Economic Theory*, 458–479.

Pollock, R. M., & Whitelaw, G. S. (2005). Community-Based Monitoring in Support of Local Sustainability. *Local Environment*, *10*(3), 211–228. doi:10.1080/13549839.2005.9684248

Rata, E. (2011, May 5). *A Critical Inquiry into Indigenous Knowledge Claims*. Department of Education, University of Cambridge.

Robottom, I., & Sauvé, L. (2003). Reflecting on participatory research in environmental education: Some issues for methodology. *Canadian Journal of Environmental Education (CJEE)*, *8*(1), pp-111.

Spivak, G. C. (1998). Can the Subaltern Speak? In *Marxism and the Interpretation of Culture* (pp. 271–313).

Visvanathan, S. (2006). Alternative Science. *Theory, Culture & Society*, *23*(2-3), 164–169. doi:10.1177/026327640602300226