Asia Institute White Paper:

"Open-Source Reasoning and Open Mindedness as a Strategy for Responding to the Fukushima CrisIs"

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1. Introduction

This paper is an expansion of some of the central ideas that were articulated by Emanuel Pastreich and Layne Hartsell in an article published in Foreign Policy in Focus in September, 2013 concerning the response to the meltdown of three reactors at the Fukushima Daiichi Nuclear Power Plant. The article, titled "The Century-Long Challenge to Respond to Fukushima," called for an international collaborative response to the ecological, social and economic crisis left to the world after the disaster of March, 2011.

The article briefly outlined the potential role of wide scale collaboration across the globe between stakeholders and Institutions (public and private) across diverse disciplines to formulate and implement solutions to this on-going Fukushima nuclear disaster, radiation leakage from which has found its way into the food chain and even into products that sourced from Japan.

In addition to the treatment of the victims of radiation poisoning—which has led to the crippling of public health in the region—trust in many the formal institutions has declined due to their slow response to a problem that is still growing. Thus, posing a serious threat to public health in the Asia-Pacific region [1]. Moreover, the unprecedented secrecy surrounding the accident within the government and other institutions has resulted in many calls for greater transparency and participation of the Japanese and international intellectual community.

This white paper presents some of the original findings form a series of seminars involving experts working in varied fields related to nuclear technology, the environment, international relations and the potential of global networks. The white paper focuses on the potential for a Peer-to-Peer (P2P) collaborative method to employ so as to understand, mitigate and resolve the Fukushima crisIs through long-term projects. The P2P method of collaborative production entails free interaction between producers of knowledge, products or even services, and the process can include citizens and other stakeholders (namely members and employees from corporations, public or private research institutions, governments, non-profits and NGOs). Many of us are familiar with P2P based collaborations in open source reasoning and development (such as Wikispeed, Wikipedia and Linux). The full potential for P2P to address more complex issues of policy and technology has not been fully explored, especially in East Asia. This white paper introduces in greater detail the possible avenues for P2P collaboration between knowledge producers globally that would be relevant in the Fukushima case and presents insights concerning feasibility and possible shortcomings in the solutions they could deliver. Furthermore, a special emphasis is placed on governance, owing to the information intensive nature of such collaborations and their potential to serve as models for future global collaboration between formal institutions and a host of experts and activists.

2. Structure of the White Paper

In the beginning, the white paper was conceptualized as an experiment itself in open source reasoning in which experts from diverse disciplines such as political and social sciences, business management, sustainability, political economy and engineering would segment the Fukushima problem and brainstorm across the globe.

This open source reasoning demanded free interaction between peers coordinating the project and the experts who were interviewed and whose responses have been included in this white paper. In addition, although we initially presumed that the use of 'collective and collaborative intelligence' would result in the drafting of a white paper in a Wiki form of crowd wisdom, the immediate result was not a compelling self-organized white paper, but rather an exhaustive draft that offered diverse and useful insights but was poorly structured and articulated.

The initial problems in this critical white paper can be attributed to the inter-interdisciplinary nature of the white paper which spanned science, technology, policy making, social-media-based governance, ethics and peer production of various mitigation techniques. The interdisciplinary nature of the inquiry posed a daunting challenge for the contributing members: how to place their contributions within the most appropriate context for application. Although the roles were made clear at the beginning of the research project, by the time the preliminary draft was complete the variety of approaches went far beyond the imagined scope and several interactive projects had already been launched that drew our members in vital, but diverse, directions. The core members of the team have chosen those aspects of P2P in the draft that are most original and immediately relevant as the focus for this white paper.

Our audience mainly comprises of the government(s) (esp. policy makers and public services), in the NGO and Non-Profit sphere, for-profit corporations (large and small-medium scale), entrepreneurs, social activists, peer producers and concerned citizens.

For whom our goal is to illustrate that P2P has tremendous potential to positively transform the institutions by the formulation of suitable policies with development of technology for acquiring and analyzing massive quantities of information/knowledge and leveraging the two aforementioned facets for implementing robust and sustainable solutions. Furthermore, the potential very much includes many novel and transformational developments that are not well known at present.

The P2P collaborative approach can empower citizens and stakeholders to create a healthier and more sustainable civilization. Moreover, empowered citizens and stakeholders can also benefit from, and contribute to, the existing institutions that we know of as government and the private sector, thereby returning to them a concept of the commons that has been largely lost since the past few decades.

3. The Leap of Faith necessary to succeed in Open Source Development

Any massive institutional or cultural paradigm shift requires at some level a leap of faith. Just as IBM took leap of faith almost a decade ago, Facebook also ventured out to develop the innovative potential of open-source development on a global scale. At the first stage, this effort was an attempt to compete with companies such as Amazon Inc. who had built a comprehensive learning curve using proprietary global computing systems [2; 3].

One remarkable example is the Open Compute Project launched by Facebook which leverages crowd sourcing as a means of re-thinking its assumptions about servers, server racks, cabling, networking and a wide range of engineering problems. The end-result of the initiative was nothing less than outstanding as one of their servers which performs 4 billion operations per second now costs 24% less and has become 38%

more energy efficient as a result. This has resulted in $1.2 billion USD worth of savings in energy and other management-related costs. The experiment introduced new diversity in terms of vendors who can provide the servers in response to Facebook's evolving needs.

Some of the astounding innovations brought about by the Open Compute Project include the development of servers that utilize low-cost cellphone chips with great efficiency. [4] Likewise, Dell too has opted for providing low-cost networking equipment that is built using non-specialized semiconductors and runs on an open-source operating system contrary to those of its competitors Cisco, Juniper Networks and HP. The equipment developed by Dell Inc. is far cheaper and easier to build with a resulting lower cost for large data centers used by Google and Facebook and could ultimately make the internet more accessible worldwide.

Intel is one of the key participants in this effort and has announced the launch of a silicon-based optical system that would allow data and computing components within the rack of computer servers to communicate up at up to 100 gigabits per second (faster than conventional wire transfer methods) at half the power consumption.

Furthermore, although conventional design requires that memory and processing elements be placed in close proximity; a new design created through open source development permits flexibility in the placement within the rack so that it can be operated according to the users' requirements. Mainly because there is enormous waste at data centers because the serves are not upgraded for the simple reason that pertinent data processing hardware would also have to be changed.

There is also the computer motherboard known as the Grouphug which was developed in this Open Compute Project which allows different manufacturers' chips to be interchanged without changing other parts of the machine. This approach lowers the cost and complexity of operating small, or even large, data centers.

Meanwhile, Facebook has started scouting for participants from other industries such as aerospace and petroleum who are open to adopting radical design changes that offer the benefits of cheaper and more powerful computing.

In contrast to the approach taken for funding Silicon Valley through long-term contracts with US Military and other financially powerful institutions (esp. Government and large scale bank financing), the Open Compute Project brought in around 150 companies including Intel, AMD, Bloomberg and Microsoft into an alliance driven by innovation itself, as opposed to large government contracts.

Open Compute has been a success for large corporations who have the ability to deploy material and financial resources within a short span of time to address changing trends in their respective markets. Clearly an economy of scale plays a dominant role in those cases. Economies of scale are the ability to produce large quantities of the same, or similar, products at very low costs.

But is such an approach limited in its effectiveness only to large corporations? We at the Asia Institute envision that a similar open-source development paradigm that involves private corporations, research institutes, NGOs, local and central governments, and other public institutions based commons who can establish more effective peer-production (P2P) communities in order to leverage those knowledge resources with other forms of financial and material resources for deploying more specific solutions to either ongoing or anticipated circumstances.

The response to Fukushima is a perfect example of a massively complex long-term problem for which coordinated peer-production communities can effectively respond to, more so, perhaps than institutions which even though have the authority and the resources but sadly are ineffective in launching a more comprehensive response. The solutions for mitigating the ongoing Fukushima crisis need to be specific and hence cannot simply be imported from elsewhere in a “copy-cut-paste manner” like we all do in word processing software packages. They must be manufactured from scratch or will require extensive modification of existing products/services. But more importantly, those solutions will require global brainstorming.

There is the potential to develop meaningful economies of scope that can provide diverse solutions in terms of goods/services while at the same time offering those solutions at lower costs, especially for decontamination, expedited healthcare services, disaster management and rehabilitation aid. The important innovation is that these economies of scope (and scale) are not to be considered as the exclusive domain of large corporations or governments.

In addition, the higher costs of development for certain solutions can also be compensated for by transferring part of the additional costs to existing product lines and making modifications that improve customer satisfaction so as to justify a slightly higher price, in case the companies cannot take a cut in profit due to the ongoing economic recession. Such creative approaches to financing can also be a topic for P2P discussions among members of the community. In sum, the entirety of the problem, from long-term planning, to finance, to technological innovation, implementation and social reform can and should be open to a vital and dynamic on-going discussion between experts and non-experts from around the world.

The participants in such open-source development must endeavor to devise licensing arrangements for revenue sharing in case of commercialization of the solutions developed for other applications. For instance, the robotics designed for use in high radiation environments in the process of the Fukushima crisis could then be modified to operate in nuclear energy plants, or other mining activities which are hazardous to human health. We, at The Asia Institute also recommend the need for pertinent structures in the form of policies, consultation or advisory bodies and regulatory institutions to be in place with reference to global collaboration that go beyond the destructive influence of current Intellectual property Rights (IPR) policies.

In the months ahead, the Asia Institute will clarify which of these recommendations requires further evaluation in light of the needs and concerns of all potential participants, whether a cooperative, a government ministry or a large corporation.

4. The Potential of Peer-to-Peer Collaboration to Contribute to the Mitigation of a Complex Crisis

4. 1 The Relevance of Peer-to-Peer Collaboration to the Fukushima Crisis

This white paper describes how P2P production can have a positive an immediate impact on the manner in which a global response to a global challenge can be formulated and implemented. P2P is defined as the production of products/services, solutions and knowledge through the free interaction of producers (either as individuals or as communities of both the paid and the volunteer, the expert and the amateur. In such a system producers will have access to a distributed infrastructure of communication and production for the production of physical and chemical products that address the needs of the local community, the community of users or humanity as a whole, as opposed to an imagined market [5]. Such new emerging technologies as 3D printing, because they fundamentally alter the nature of production and manufacturing, and open the door to a distributed design and manufacturing system without a dependence on expensive machine tools, can play a major role in this social transformation.

Such distributed infrastructure could take the form of access to an online community that can readily share designs and the schematics for hardware systems that can be used in concurrence with fab labs and programmable 3D printers for production. In terms of software development, the Linux open source initiative is well known and hence networked computers are necessary for developing open source software.

As the solutions required to address the Fukushima crisis are by nature “needs” rather than “market opportunities” they lend themselves well to such an approach. The pressing needs are: (a) radiation decontamination, (b) facilitating evacuation and responding to emotional trauma, (c) communicating with the community about the regions impacted by radiation in a transparent manner, (d) the rehabilitation and treatment of victims, (e) building healthcare facilities, (f) rebuilding local infrastructure and (g) enabling the gradual adoption of renewable energy as a long-term solution.

Although these issues can be handled in a multitude of ways, this white paper would discuss the applicability of P2P based collaboration for addressing these “needs” in the following sections. By presenting original concepts as to how these critical needs could be addressed through P2P production, rather than simply listing existing examples of P2P collaborations that could potentially address ‘only’ parts of the Fukushima crisis and hence, we desire to open the debate up more widely. We need to think about the entire problem in a P2P manner and address “needs” in a holistically.

Inevitably, the concept of “market opportunity” is predominant when we conceive of demand in terms of the purchasing power of the individual, or of the nation. Certainly the participation of the Japanese Government is certainly desirable in terms of the funding for massive decontamination and rehabilitation programs and for pursuing the long term goal of transforming the nation and putting it on a path towards long term sustainability. However, despite the inadequacies of such endeavors as exemplified by many social activists and concerned citizens across the world (especially the Japanese people). We need to acknowledge that such large scale programs can eventually undermine the future of Japanese economic growth mainly in terms of deficit and performance of its currency worldwide.

Furthermore, there is no reason to assume, however, that the decision makers within the government or in industry will ‘always’ have a greater degree of expertise or wisdom than the group assembled in a P2P community. Already, P2P projects such as NAIIC "The Simplest Explanation of the National Diet of Japan Fukushima Nuclear Accident Independent Commission Report" in Japan have done an excellent job of both producing solid research and creating a strong community for future collaboration. Large-scale government and corporate projects that lack the constant feed-back and self-correction of the P2P community are potentially extremely wasteful, and potentially counter-productive, and could undermine future economic growth because of deficits and misallocation of resources.

Furthermore, P2P solutions for the response to a crisis like Fukushima are not only technologically feasible, but also cost intensive. P2P production and open innovation are more than intriguing ideas, they can be the crucial components of a new open-reasoning/open-source development approach that will develop and implement robust solutions to complex challenges at much lower costs. The P2P approach is a welcome anecdote to the collusion between expensive consulting firms, technological specialist and profit-driven corporations for the control of national and international planning and development.

The new P2P solutions that may emerge from the efforts to respond to Fukushima could be models for the future of commercial and social entrepreneurship conducted at a minimal cost with a maximum focus on the precise needs on the ground. Such a paradigm shift could boost the local economy and improve income distribution with fostering the diffusion of knowledge and the establishment of an innovation culture.

4. 2 The Elements of the Peer-to-Peer Collaboration Framework

There are numerous public-private partnerships in telecommunications, space exploration, electronics and healthcare that have received broad acceptance. The general approach has immediate implications in infrastructure development, nation building and disaster response and management—all issues that have a broad impact on society and are therefore immediately political in their implications.

However, the formation of robust partnerships can demand substantial financial resources and man hours that discourage serious engagement even in the face of a manifested necessity.

Therefore, in order to expedite the development and implementation of low cost, highly specific and effective technologies for disaster mitigation such as customized robotics and mobile decontamination vehicles, we recommend the formation of a public-private-commons peer production approach.

A public-private-commons peer production program encompasses private corporations; research institutions (public or private), NGOs, and a broad swath of stakeholders from individuals with special skills, social activists & volunteers, knowledge workers and local residents. Those stakeholders can be a complex balance of individuals with in-depth knowledge in technical and non-technical fields, or individuals with expressive abilities (as writers or artists) or organizers and administrators. The participants can be either volunteers or paid employees, and they can determine the nature of their relations through spontaneous interaction and organization (with or without a governing body). The suitable collaborative framework should evolve out of the process of co-production wherein at least one hierarchical organization is involved.

The participants of this public-private-commons peer production program would utilize the knowledge commons which have been formed exclusively by a consortium of private companies (and their partners) and initiate a stable collaboration with the peer producers and stakeholders who operate by utilizing the common pools of knowledge which are meant for the whole of humanity in general. On the other hand, Mr. Michel Bauwens, founder of Peer-to-Peer Alternatives, notes that such common pools of knowledge meant for the whole of humanity in general are sadly dominated by private corporations and start-ups. He suggests that rather a peer production license should be used that permits the commercialization of knowledge taken from these pools through a program of reciprocity towards the same commons meant for the whole of humanity in general [6].This vision suggests a practical agreement for collaborative partnerships that can be readily implemented.

The participants can define suitable licensing and reciprocity agreements for future use of the knowhow generated by way of an intermediary which could be a non-profit or non-governmental organization, or even a representative body for the stakeholders.

The aforementioned recommendation is inspired by the collaborative knowledge commons established by pharmaceutical companies such as the Toxicogenomic Cross-Validation Consortium (TCC) in which the participating companies share their internally developed laboratory methods so as to gain insight into the safety of their experimental treatment methods under development. The TCC is regulated by a non-profit known as Critical Path whose founding member is the Food and Drug Administration of the United States. Critical Path executes the functions of collecting membership fees, coordinating the research projects and structuring suitable licensing agreements [7].

Similarly, IBM provides suitable remuneration for its employees and other non-employees who contribute to the Linux pool and who supports the non-profit Linux Foundation through contributions[8].Accordingly, the participants of the public-private-commons peer production program can decide upon suitable modes of remuneration for these knowledge workers; some of these compensatory mechanisms would be discussed in later sections.

The fundamentals of open innovation and open source development are closely related to peer to peer (P2P) production. All involve collaboration across organizations, intellectual communities and peer groups that stretch beyond geographical boundaries. Even small contributions by specialized or amateur scientists, technicians and engineers can substantially advance the project and do so at a low cost. There are many experts, including retired people, who would gladly volunteer their knowledge and expertise if given such an opportunity to help. The savings brought about by the actions of volunteers can be substantial. Such collaborative activities can reduce unnecessary administrative costs in terms of contracts; although the participating producers must show a commitment to each other and to the project for the long term. Such open innovation and crowd sourcing of knowledge can eventually de-link the costs of development from the sales price of a product, as has been done in the development of drugs for neglected diseases [9].

Open innovation and open source development produces drugs at lower prices by recognizing that drugs are simply chemical or biological entities. Therefore, a suitable open innovation and open source collaborative framework based on public-private-commons can be a universal platform for developing specialized chemicals for decontamination, or other applications for mitigation of the crisis. In contrast to a modular system comprised of sub-systems, components and sub-assemblies like an automobile or a cell phone; a drug molecule or a specialized chemical mixture may not possess granularity, or even modularity, as defined in the Peer-to-Peer production methodology [2]. This open innovation methodology for P2P production of chemical mixtures potentially obviates the perceived barriers of modularity and granularity.

The focus in this white paper is on lower developmental costs and shorter development cycles. Pragmatic and technically-oriented solutions for the mitigation of the Fukushima crisis probably would take the form hardware systems, such as customized mobile decontamination vehicles, specialized robotics for operation in highly radioactive environments and for radiation decontamination and developing specialized decontamination chemicals such as DeconGel and Radiation Decontamination Solutions LLC. Furthermore, in some cases we can anticipate the use of advanced chemicals, electro-chemical and mechanical methods and biological entities such as plants and microorganisms for soil decontamination as well for radiation decontamination related activities [10].

The aforementioned peer production and open source development approach can be utilized to developed contamination systems, protective equipment and suits for workers engaged in radiation clean-up activities [10].These systems make use of special materials such as polymer composites (in items such as gloves and protective suits) and components that are required to operate in radiation intensive environments. The constant open dialog makes it possible both to pursue new innovations in manufacturing otherwise overlooked and also customize the particular product or service according to the specific needs.

4.3 Adopting an Open Source Development and P2P methods

We recognize the possibilities of various forms of public-private-commons peer production for developing and deploying a wide range of solutions to address the "needs" mentioned in Section 4.1. We, further anticipate that the interaction between collaborative efforts will be complementary and will minimize expenses in terms of materials, energy, labor and finance.

A) On-site Decontamination Activities

Retired personnel with a background in the nuclear power industry and experts in radiation safety protocols and decontamination can form global cooperatives (instead of for-profit consulting companies) to provide training and certification for workers to engage in radiation clean-up at the Fukushima site. Private contractors have consistently offered unrealistic bids to secure contracts with the result that they offer very low and unsustainable wages. In some cases, such low-budget work has resulted in minimal concern with worker's health and non-adherence to safety standards [11]. We envisage that such ground level radiation clean-up activities could be part of a concurrent project for the public-private-commons peer production collaborative framework.

B) Disaster Management and the Coordination of Relief Efforts

P2P is a structure appropriate to both the global and the local response to the Fukushima crisis. Innovative cooperatives comprised of local civilians can be built to respond to the disaster that allows individuals from diverse capabilities to combine their expertise so as to respond to the unfolding and disaster(s). Moreover, disaster management knowledge can be provided to other more vulnerable regions within the same nation or across large geographical distances with the help of simple internet based communication tools that deliver training programs to the local civilians [12].The experiences of Fukushima can serve as the institutional history for the world.

The public-private-commons peer production collaborative framework can build on the legacy of the Ushahidi peer communication project that has been implemented in Africa wherein multiple participants share data and information so as to enable a faster response to a crisis. Likewise, the commons- based collaborative method can establish open-source based equipment that form larger communication networks known as "meshes" wherein a functionality similar to that of the internet, permitting people to share information[13]. One successful example is the Commotion Router which employs open source software that allows communities to build their own mesh networks.

Mesh networks could have played a critical role in the response to the devastation unleashed by Typhoon Haiyan a few months ago. Many relief efforts could not communicate with their colleagues on humanitarian efforts because they were dependent on reliable communication networks. Because 90% of the people had access to mobile phones, the implementation of an emergency "mesh" network could have eliminated such connectivity problems and many more lives would have been saved. Unlike, the conventional internet which depends on a few centralized access points (normally known as Internet Service Providers), mesh networks are broadly distributed and stable, offering far-reaching benefits. For instance, the U.S. State Department has invested around $2.8 million to support a group of American hackers, social activists and community geeks who have developed a local "mesh" network that enables dissidents and reformers to communicate with each other freely and securely than through the open internet. Thus, proving its potential for building communities and governance.

In an email-based interview, Taka Honda, head of World Network for Saving Children from Radiation, stated that only 30% of the population at Fukushima has access to internet and as a result, majority of the population is unable to get information about the harmful effects of the radiation. He also mentioned that people who have access to social media platforms such as Facebook and Twitter have used those mediums to express their concerns and have even built a few initiatives for materializing them. However, he pointed out that without a massive effort supported by people across Japan, and even across the globe, to take concrete steps to help Fukushima recover from the crisis, there is not much hope for complete rehabilitation. He suggested that in his experience, the Japanese Government has still underestimated the impacts of the Fukushima nuclear disaster and its future repercussions. Without the input of a broad rather of experts and citizens, the government has failed to make a large investment in supporting renewable energy and rather continued to move forward with the nuclear energy option. At the moment, Honda is collecting funds to build a dormitory for refugees hoping to form a larger community to support such efforts in the future.

More comprehensive mitigation measures for such a disaster, requires government agencies, open source collaborative groups and civilians to interpret massive amounts of complex computer generated data. How such ‘big data’ collected from a variety of sources can be combined with information from individuals on the ground to provide a more complete picture of the immediate situation and its long term impact.

We at The Asia Institute envision that not only the gathering of information, but also the interpretation of that information and data can be broadly distributed between the participating peers. The Fukushima problem could become a discourse that draws in not just experts, but common citizens in the millions, or tens of millions, across the world. If concerned citizens in all countries were to pore through the data and offer their suggestions online, there could be a new level of transparency in the decision-making process and a plethora of new insights.

In our comprehension, the detailed information about radiation emissions and the state of the reactors can be made publicly available in enough detail to satisfy the curiosity of a trained nuclear engineer. As a result, the response to any future nuclear related disaster would then be built on a consensus of experts and an even larger community of concerned citizens.

The illustrate the capability of peer-to-peer based communication, a project to classify stars throughout the university has demonstrated that if tasks are carefully broken up, it is possible for laypeople to play a critical role in solving technical problems. The Galaxy Zoo project is open to the public and anyone who is interested can qualify to go online and classify different kinds of stars situated in distant galaxies and enter the information into a database. It's all part of a massive effort to expand our knowledge of the universe, and it has been immensely successful. Galaxy Zoo demonstrates that there are aspects of scientific analysis that does not require a Ph.D. In the case of Fukushima, if an ordinary person examines satellite photographs online every day for a specific region, he or she can become more adept than a professor in identifying unusual flows of water carrying radioactive materials. There is a massive amount of information that requires analysis related to Fukushima, and at present most of it goes virtually unanalyzed.

An effective response to Fukushima needs to accommodate both general and specific perspectives. It will initially require a careful and sophisticated setting of priorities. We can then set up convergence groups that, aided by advanced computation and careful efforts at multidisciplinary integration, could respond to crisis and challenges with great effectiveness. Convergence groups can also serve as a bridge between the expert and the layperson, encouraging a critical continuing education about science and society.

On the other hand to enable more comprehensive mitigation measures for a wide ranging disaster, the stakeholders including government agencies, open source collaborative groups and civilians need to articulate (and not just interpret) massive amounts of complex computer generated data. As this ‘big data’ which is mined from advanced sensors and social media streams for visualization and GIS mapping for responding to disasters in a more effective manner. It is essential that analysts of such ‘big data’ are able extract and utilize the right bits of data to implement the most suitable mitigation measures. Because the most current information of the situation with knowledge of past experiences in similar circumstances may not be entirely accurate and effective anymore. We need to acknowledge that if solutions for mitigation require the comprehension of complexities in social, political, environmental, economic and technical factors so would the repercussions of the disaster which is unfolding in a region(s) [14].

In one such case in point for Superstorm Sandy, FEMA, USA created a team comprising of many different public and private agencies of which a non-profit known as Geeks Without Bounds, a non-profit humanitarian accelerator collaborated with Splunk4Good for social media analyses. The hashtags on Twitter feeds with Instagram photos were studied to determine pertinent keywords (power, fuel, food and water) and evacuation related circumstances. The analyses were used for determining most suitable locations for delivering supplies and the assessing the public sentiment towards disaster response. Some experts recommend the combination of expert insight with crowd sourcing some of the ‘big data’ analysis to gain the “wisdom of crowds” in terms of accessing both collective as well as collaborative intelligence.

Although much work has been conducted on collaborative methods; nevertheless the use of large scale international and an emergent form collaborative environment is still inadequate to counter systemic crisis such as Fukushima. Even with the clear evidence of global communications that occurred in various countries during the Arab Spring. Unfortunately, those communications did not focus on problem solving, consensus building and shared models of cooperation for grass roots development.

Daniel Rasmus, an Industry Analyst and Strategist mentioned the role of real-time data monitoring and sensor integration to determine the pathway of the disaster. Although the aims of the Fukushima Crisis Group are to encourage open science, when situations like Fukushima arise so as to facilitate the participation of all the pertinent stakeholders. It is the position of this white paper that participants of the public-private-commons production can openly share information, collaborate on interpretation of the data, its implications and potential actions to be derived from it. Being able to understand a situation in itself is not enough without being effectively translated into action in cooperation with national, regional and municipal leaders and citizens.

Moreover, the long-term response to Fukushima will be as much about educating ordinary people about science as it will be about gathering together highly paid experts. It is useless for experts to come up with novel solutions if they cannot implement them. But implementation can only come about if the population as a whole has a deeper understanding of the issues. Large-scale networked science efforts are not merely a means of taking advantage of multiple skill sets, they are also an essential means of building a consensus in the community and around the world about the proper path forward.

C) Biological methods for Radioactive Decontamination and Independence in Food Production

MASIPAG[1](Farmer-Scientist Partnership for Development, Inc.) of the Philippines uses GNU tools (developed as part of a mass collaboration open source operating systems similar to Unix) which are provided to programmers and farmers so as create the means to save, trade and collectively develop their seeds so as to produce better strains. In this open source development partnership, a commons-based peer-production network has been established to facilitate the sharing of plant genetic information and other pertinent biotechnological tools [15].

Likewise, the specter of GMOs (genetically modified organisms) that have haunted the public because of their development in secrecy by multi-national corporations can be replaced by a more reasoned development of synthetic biology whereby life forms such as bacteria, fungi and plants are programmed to produce a desired biological entity through transparent and appropriate open-source development of genomics &proteomics and other fields of computational biology [16; 7].

We recommend the development of a commons-based peer production network along the lines of MASIPAG that would enable the sharing of –omics (genomics/proteomics) related information on plant, fungi, bacteria and other living organisms that can be genetically modified or

[1]Magsasaka at Siyentipiko Para SaPag-unladngAgrikultura.

hybridized to assist in radiation decontamination in soil and water in the Fukushima region—and eventually around the world in similar problem sites. There is a wide body of research concerning the development of semi-industrial scale bioleaching in tanks using thio-bacteria and capillary to treat radioactive contaminated soil action [17].

Prof. Tomihisa Ohta of Kanazawa University had developed a compound of natural minerals and chemicals that is capable of treating 1,000 tons of water containing in radioactive material within one hour, in comparison to Areva's water treatment system that can treat only 50 tons per hour. Areva is a renowned French public multinational industrial conglomerate in nuclear energy. The technology was developed in partnership with the pollution clean-up Kumaken Kougyou Inc. Another approach adopted in the region around the Fukushima plant is the planting of sunflowers to decontaminate the soil [18].

Nevertheless, we envisage that these bio-based endeavors, whether undertaken by peer production efforts or through conventional structured partnerships, will be time consuming and will require a longer learning curve—except if the knowledge curve has already been built previously for other applications and requires only minimal modifications.

D) Crowd sourcing of Equipment and Financial Resources

In the past, a few computer geeks have obtained Geiger counters by crowd funding campaigns so that dedicated volunteers and activists could place them on top of their automobiles so as to detect zones of high radiation and inform the people via their smart phones, social media or private messaging [19]. Likewise, similar funding mechanisms can be utilized so as to obtain some of products for decontamination that are easily available and do not require additional development.

The Lead Researcher of this Fukushima White Paper, Mr. Layne Hartsell was interviewed by Geeks Gone Global via a Google Hangout chat. During the interview, Mr. Hartsell discussed about the recently developed Smart Phone App which enables users to share information on social media about the radiation levels in their food and other daily use items by acquiring the readings from an off-the shelf Geiger counter. In 2011, a Japanese company, Sanwa launched a 14 centimeter long, portable and light Geiger counter for around USD$203 which can be connected to a iPhone to detect harmful beta and gamma rays.

We must be careful as to what the nature of crowd funding will be. Even if funding is from concerned citizens, and even if government funding is appropriately targeted, whether from Japan or from the international community, there will remain considerable similarities with foreign aid and international loan initiatives practiced by the World Bank and other international financial organizations. It is essential to avoid the problems of such funding, particularly the inadequacies and self-serving approaches to large-scale aid that have been employed in the developing world by wealthy nations, as described in William Easterly's 2006 book *The White Man's Burden*.

Easterly pointed out that to attain a high level of success, project teams much adopt a "searchers" approach. The first step is to understand the complex entanglement of a wide range of political, cultural, economic, technological and environmental factors so as to be able to implement piece-meal problem solving strategies slowly and appropriately. Any public-private-commons peer production endeavor in Fukushima must involve a careful assessment of the social, political and economic factors involved.

One lesson the participants of P2P production and the readers of the white paper can learn is that the profit motive of the private sector has created a strong cultural outlook towards the three facets of incentives, accountability and customer feedback. And sadly the focus on profit in our society has profoundly impacted the concept of incentives, accountability and customer feedback Furthermore, these 3 facets should be translated into its appropriate counterparts for mitigating the Fukushima crisis namely, incentives (in terms of national and humanitarian interest with reasonable remuneration), accountability towards the stakeholders and feedback from the stakeholders to alter the course of the outcomes from the public-private-commons peer production [20].

E) Open Source Development of Robotics and Vehicles for Decontamination

In terms of developing robotics using peer to peer production modes, currently there are many open source robotics projects e.g.: FarmBot Genesis (e.g.: FarmBot Genesis) and the well-known open source automobile development company, known as Wikispeed are good models for effective development. This implies that open source collaboration has become matured enough to develop and build robust and relatively complex systems that comprise of many sub-systems, components and sub-assemblies that encompass diverse interdisciplinary areas of science and engineering.

Likewise, private corporations owning to their profit motive have attained a substantial degree of advanced knowledge in the domain of robotics, chemistry (and chemical engineering) and various other applied sciences. Moreover, they are also well versed with regulatory approval procedures for their products/services and some of them could even have special licenses to develop complex systems/devices for operating in a highly radioactive environment.

In later sections, conceptual collaborative framework would be discussed as a recommendation for developing and deploying robotic systems for decontamination. This recommendation would form a remarkable example to enlighten readers and potential participants on the possibility of forming suitable collaborative frameworks.

In order to exemplify that people with expertise and determination who do not desire to wait for the slow and sometimes ineffective responses from their Governments and private corporations can collaborate by virtue of free interaction and launch robust solutions to mitigate Fukushima like disasters even if the solutions are technologically and cost intensive in nature. Accordingly, one of the finest examples of opting for a self initiated collaborative endeavor can be found in the work of Mr. Junichi Iwamura who prior to the Fukushima disaster was a professor of business management at Kinki University in Osaka. After which he quit his former position and built a robust machine which comprises of a 4 part process for soil decontamination to isolate Caesium-137 particles which leaked out from the plant. The project has been running on a volunteer basis and TEPCO and the Japanese Government have been considered as potential clients. [21]

5. Building a Robotic System for Radiation Decontamination: One Paradigm for Open Source Development

5.1 Modularity and Granularity in the building of a Robotic System

This section describes a plausible approach for realizing public-private-commons peer production approach (as mentioned in Section 4.2) to develop a robotic system for decontamination activities.

Moreover, this approach can be suitably modified to build other effective technologies and solutions to address a broad range of circumstances.

A robotic system would be comprised of multiple components that contain mechanical parts fabricated from plastics, metals, non-metals and composites, electronic components and chemicals for the hydraulics system, power courses and coatings for radiation protection.

A robotic system is usually modular in nature so that the system can be further subdivided into components, parts and sub-assemblies. Any peer production activity demands a comprehension of the extent of "granularity" by its participants because it determines the degree to which a design configuration can be sub-divided into smaller manageable pieces so as to enable people who possess varying levels of motivation and expertise, or are located at different geographical regions with distributed (but connected) resources for design, evaluation (i.e. verification and validation) and fabrication.

A robotic system that can operate in a radiation intensive environment may require specialized expertise only available after a considerable investment of time and resources (mainly design, production and testing). Therefore, the degree of both modularity and granularity required in the

Fukushima case may be unique for a peer production activity and include members from corporations (or public institutions such as the National Labs in the US) who can bring specific expertise to the table as part of a peer production that utilizes the knowledge commons meant for public use [5].

We recommend the readers to refer to the two figures and the special note mentioned within this section while reading the text.

5.2 Role of the Knowledge Commons in Joint Product Development endeavors

The Fukushima crisis calls out for a knowledge commons that includes private corporations (and their partners in public and private institutions) built on the model offered by the Toxicogenomic Cross Validation Consortium among pharmaceutical companies [7]. It is a reality of interdisciplinary research that it requires enormous investment by corporations (with or without collaboration with public/private institutions) in fields such as aerospace, medical devices, telecommunication, chemical engineering, macro-scale and sub-atomic physics. Advancements in one branch of applied science can have critical impact on another branch. For instance, research in polymer chemistry has accelerated the development of the telecommunication sector because polymers are crucial components in the cables that criss-cross with millions of kilometers the world. Similarly, the success of advanced semiconductors was dependent on the progress in quantum scale chemistry and physics [22].

Therefore, a knowledge commons can significantly increase the advancements in the applied sciences because they are shared amongst its participants. Research outcomes published by one participant in a certain field can benefit another participant even if the producer may not directly benefit from it that process, and vice-versa. This approach minimizes the wasteful activity of ‘re-inventing the wheel’ by one participant when another contemporary has already published their research outcomes in the knowledge commons. Furthermore, this knowledge commons can deliver mutual benefit to each other can foster suitable partnerships between the participants as well. Such an approach is much closer to the actual process of innovation than the ineffective and stodgy process of submitting to peer-reviewed journals that is often quite far from what on the citizens need at the ground level.

Industry analysts recognize that clinical safety considerations for a new drug molecule under development are generally applicable and thus the formation of a knowledge commons can be mutually beneficial and reduce the time and money required to deploy a new technology as a product or a service [7]. The private sector can utilize the peer and commons-based production methods to develop more effective solutions at lower costs and deliver it so as to meet the purchasing capacity of its desired market.

Such a pragmatic and conceptual collaborative framework can “fire the imagination” and lead our partners around the world to brainstorm with each other as they form peer-to-peer production collaboratives.

Such recommendations have already gathered some credibility through Facebook’s Open Compute so that corporations, regulatory agencies and government institutions have some experience with peer-to-peer partnerships. For instance, the National Renewable Energy Laboratory was the key institution for the coordination of the 21st Century Power Partnership which aims to accelerate the deployment of large-scale energy efficiency of renewable energy sources by way of peer-to-peer learning and collaboration. That partnership includes regulators, grid operators, policies and programs which advance the application of smart grid solutions and clean energy technologies [23].

Some empowering aspects of Peer-to-Peer production can be complemented by the discipline and management-based leadership of conventional institutions creating unique ecosystems that are both hierarchical and flat in nature [24].

5.3 A Collaborative Framework for the Public-Private-Commons Production

The collaborative structure for the development of low cost and highly effective robotic system for radiation decontamination is as follows:

Robots have been deployed for work in the areas of high radioactive contamination at Fukushima, but have met with limited success [25; 26].

Traditionally most robot research in Japan has been focused on care for the elderly and not the response to dangerous environmental problems. But Japan has a tremendous tradition of product development known as the Quality Function Deployment which was invented in Japan in 1966 and facilitates the translation of the stakeholders' considerations to meet well-defined requirements in engineering terms. The approach can finalize the technical specifications for the components/parts/sub-assemblies and establish the production set-up though testing and establishment of validation protocols.

The stakeholders require a robotic system that is resistant to radiation and is robust enough to operate in disaster zones. The engineering requirements would determine the range of operation with respect to temperature, radiation levels, durability and reliability (for suitable time duration). The technical teams would have to determine the technical specifications of the parts/components that can endure the radiation and disaster ridden environment (whether within the plant near the reactor or in the vicinity).Testing procedures for quality control and the production process must be established before the parts are fabricated and assembled to assure validation prior to deployment.

We anticipate that the private corporations or publicly funded research labs possess comprehensive knowledge and the ability to mobilize various resources to develop and deploy the ‘specialized components’ required for the desired robotic system. These ‘specialized components’ could deliver the radiation resistance required to operate in disaster environments owing to their durability and the sophisticated control systems. Within open source development initiatives for robotics the existing learning curves can help to modify substantially the sub-systems and components for the desired robot. These aforementioned institutions would be the participants of their private knowledge commons and consortiums.

Meanwhile, knowledge producers in the form of stakeholders and peer producers would utilize their commons pools of knowledge meant for public use for the benefit of humanity at large for developing more generalized components of the desired robotic system at far lower costs with much lesser time. Because, as learnt from the open source development initiatives for robotics the existing learning curves can be used for marginally or even substantially modifying the sub-systems and components for the desired robot.

We expect that the participants of the public-private-commons collaborative would provide free access to each others’ knowledge commons so as to make possible the concurrent development of the sub-systems and components for the desired robot. We further anticipate a certain degree of conflicts of interest for which intermediaries such as non-profit or non-governmental organizations, or even representative bodies for stakeholders, would facilitate conflict resolution and help define the reciprocity agreements.

5.4 Role of Concurrent Development and Cost Effective Strategies in Product Life Cycle

Concurrent development refers to the design engineering process during which project managers, engineers, technicians and scientists spend considerable time conducting a thorough evaluation of a product's design configuration to establish the appropriate production process in terms of cost, distribution requirements, reliability during use and ease of recycling and refurbishment for future use [27]

Assessing feasibility of the design configuration requires preliminary testing and the validation after prototyping and fabricating of a few initial units prior to deployment. The entire series of activities which include continuous interactions and feedback loops is known as concurrent engineering [28].

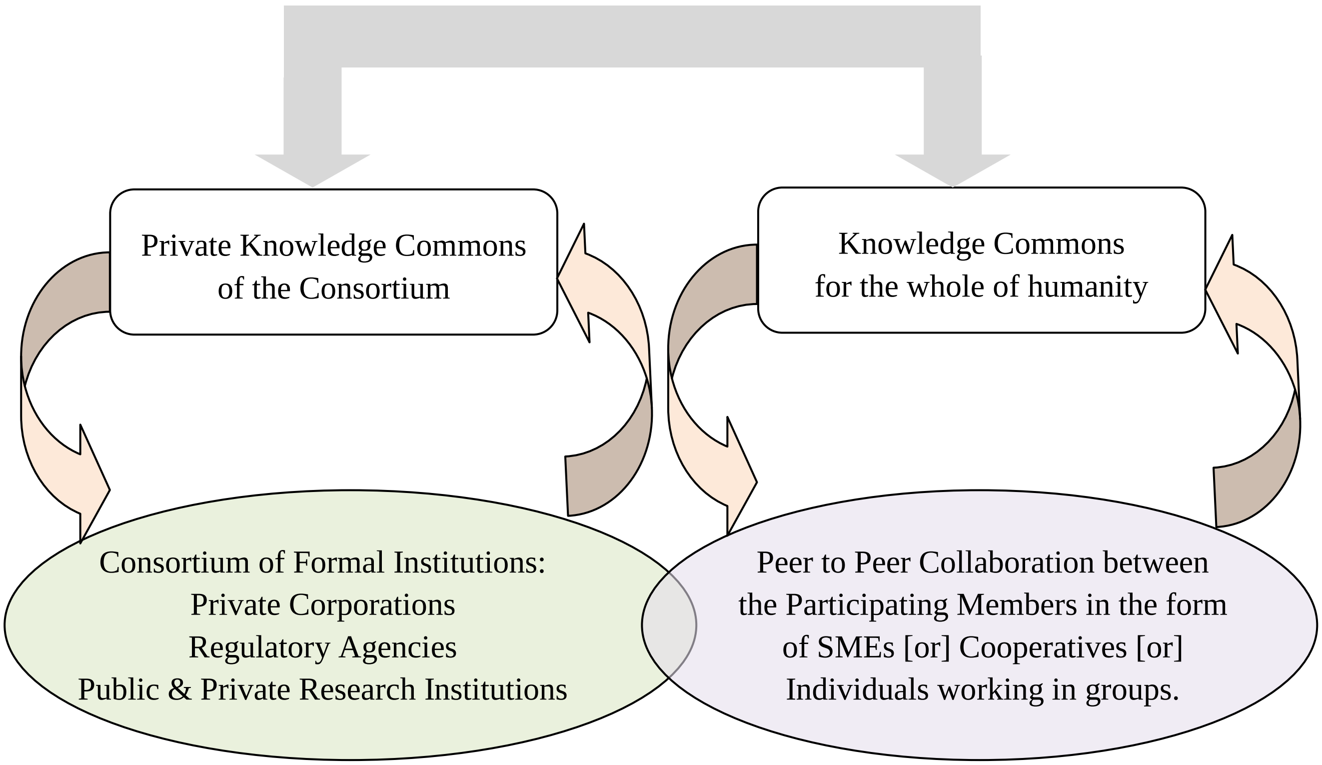
Such work methodologies are a part of systems engineering and provide insights into the development of robust systems such as aircrafts, mobile phones, software and electronic hardware. In Systems Engineering, project management also plays an important role in defining the goals and tasks in order to build the desired system (Source: International Council on Systems Engineering).

The design engineering process involves comprehensive analyses of the components and sub-systems intended for use in a robotic system by building their corresponding computational models and predicting their performance under various operating conditions. This process saves time and material in the fabrication process, allowing for the production of only a few prototypes that closely resemble the final component/sub-system.

However, the design engineering process for computational modeling and simulation requires tremendous financial resources to purchase and maintain the computing infrastructure to store data and process it. Unfortunately, maintaining such massive infrastructure means much unused capacity when project plans change. We can find invaluable solutions to such problems in the software programs developed by Folding@home and SETI@Home that give access to distributed computing by donors who volunteer computing time by downloading a software program onto their computers. Likewise, proprietary or even open-source cloud computing programs (such as Apache CloudStack) can reduce alleviate computing costs through such sharing arrangements. The Open Compute initiative of Facebook also provides some hints as to how such problems can be addressed.

The concurrent engineering process includes two critical stages: verification and validation. The verification stage entails the testing protocols to determine whether the components and sub-systems are functioning as per the defined technical specifications. For a component that is designed to operate at 100^0C for 100 hours, the Verification stage would clarify the functionality of the component when it reaches that stated operating condition.

The validation stage is more essential as it determines whether the component or sub-system, or even the whole robot, satisfies the needs of all the stakeholders such as social activists, peer producers, citizens, producers, distributors, suppliers and so on so forth. For example, the on-site decontamination cooperatives mentioned in earlier sections can test the operational capabilities and ease of maintenance of the robotic system at the Fukushima site and report back the results to the public-private-commons collaborative.



Participating Members:
1. Scientists
2. Engineers and Technicians
3. Management Expertise
a) Systems Engineering
b) Project Management
c) Regulatory Affairs

Resources:
1. Finance & Material
2. Instruments & Machinery (Production/Research)

Example:
Toxicogenomic Cross-Validation Consortium (TCC) [7]
21st Century Power Partnership [23]

Participating Members:
1. Grass roots stakeholders with special skills
2. Social activists
3. Knowledge workers (Paid or Volunteer):
4. Employees from formal institutions
5. Concerned citizens
6. People with in-depth knowledge (technical / non-technical fields)

Resources:
1. Cultural Capital of cooperation and social development
2. Collecting and sorting waste for recycling into raw materials
3. Fablabs and 3D Printers

Figure 1: Participants of the Public-Private-Commons Peer Production Collaborative (as per Section 4.2 and 5)

— Flow of Knowledge

— Flow of Information

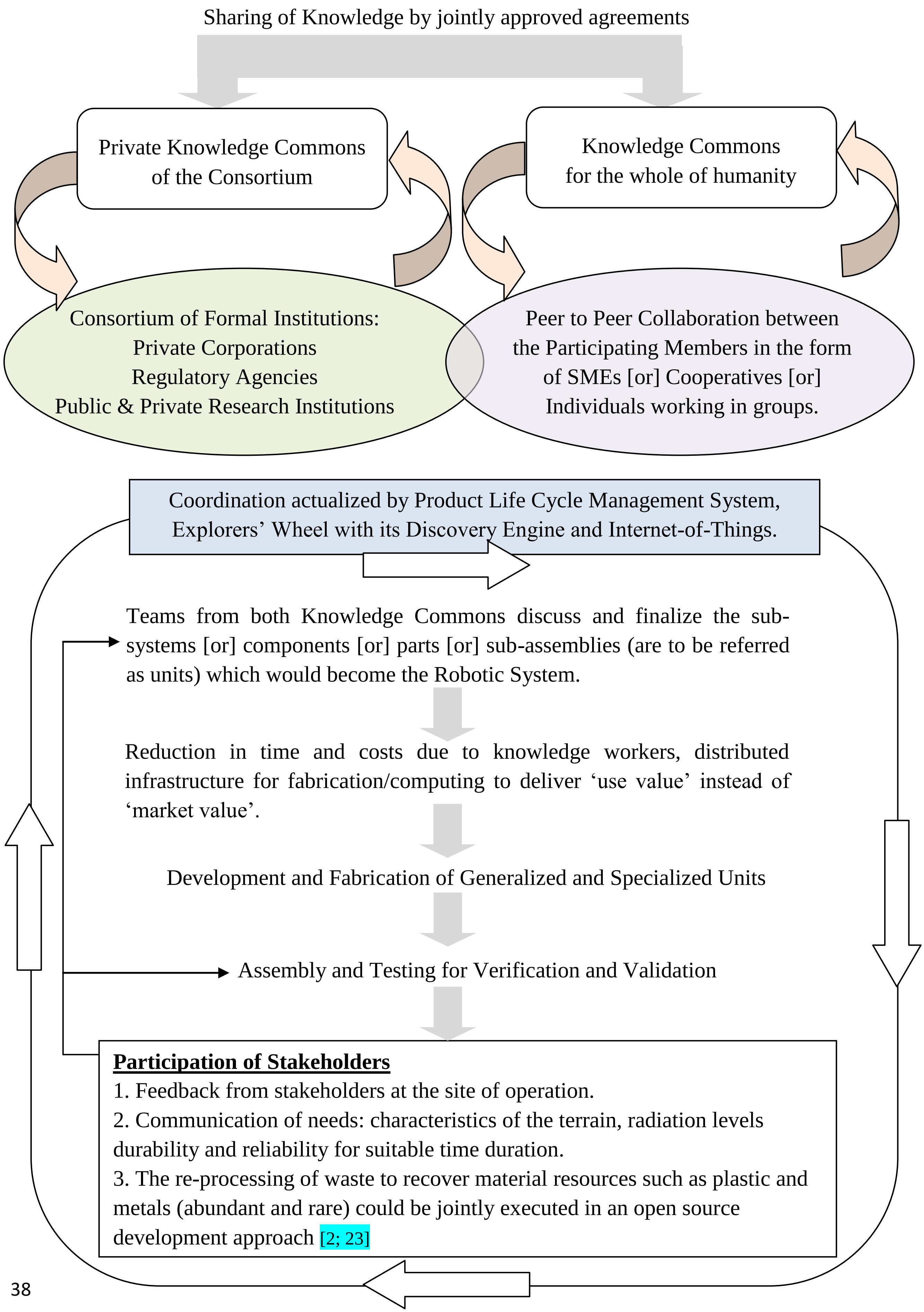


Figure 2: Framework of the Public-Private-Commons Peer Production Collaborative (as per Section 4.2 and 5)

Special Note for Figure 1 and Figure 2

Explorers' Wheel and its "Discovery Engine": Maintaining the knowledge and building Collaborative Intelligence of the knowledge workers (discussed in Section 6) [39; 40].

Utilization of social media platforms, big data tools, crowd sourcing and search technologies.

A preliminary version of "Internet of Things" with logistical and energy internet to coordinate supply chain-distribution of raw materials, manufacturing facilities, units and the Robotic system.

Robust Information Technology based communication systems that enable knowledge based engineering and management of the entire life cycle.

Testing and Validation protocols for Quality Control (techniques to 'check' that every single unit meets the desired outcomes) and Quality Assurance (the various business and technical processes to ensure that each unit produced meets the desired outcomes). The Quality Control techniques "only checks" whether each unit conforms to the appropriate standards while Quality Assurance comprises of an array of processes "to ensure" even before the checking starts that the standards are met.

Verification confirms whether the units adhere to the appropriate specifications and regulatory standards.

Validation determines whether the units and the whole robot satisfies the all the regulatory standards and the stakeholders' needs, including social activists, peer producers, citizens, producers, distributors, raw material suppliers and so on so forth.

5.5 Role of Collaborative Intelligence in the Product Life Cycle

Unlike the "collaborative intelligence" that is generated on open source platforms such as Wikipedia which provide convenience of use to the volunteers and collaborators in terms of time and location; however, the response to Fukushima requires an explicit form of organization to establish collaborative structures that deliver flexibility with strength so as to prevent the duplication of unnecessary tasks and avoid an unaccountable management structure.

Product development for engineering systems such as robotics, mobile phones and medical devices require knowledge and technology intensive tasks (if not cost intensive) which demand on-the-job accountability. This process entails a special focus on adherence to quality, labor and safety standards that employ either hierarchical or flat management structures to govern crucial activities such as prototyping, testing and computational modeling[29].

It is possible for public-private-commons peer production to wholly, or partially, adopt the model of open innovation familiar to non-profits and private corporations [9]. Moreover, the collaborative intelligence that is anticipated to be generated out of public-private-commons peer production can be incorporated into the knowledge system for the knowledge commons.

The focus of the private sector on profit helps to define the most effective management structures for complex product development processes and the private sector has even opted for a complex adaptive systems method of collaboration in which members of the organization engage in their own unique form of self-organization without too much centralized control [30]. As a result private firms are able to articulate an adaptive process capable of re-orienting itself to changes in the circumstances faced by the organization, whether internal or external.

Consequently, we openly advocate a dominant role for a peer production approach to expediting low cost, highly effective, technologies for mitigating the Fukushima crisis. We also suggest a serious consideration of dominant modes of production either via private enterprise or state production (i.e. namely state owned enterprises and the active participation of public funded institutions or programs).

The open source nature of the development of robotic systems can allow the participants to share the schematics, blue prints and production related details via the internet to permit fabrication in fablabs—perhaps using automated 3D printing. Moreover, the participants of the private knowledge commons will be well versed with product development activities and product life cycle management across diverse geographical locations. Hence, they can provide assistance to the knowledge workers of the common pools of knowledge in deploying their components and sub-systems for the final assembly as a robotic system. The knowledge producers of the common pools of knowledge can utilize open source product life cycle management tools which enable the coordination of their design engineering activities with the production and supply-chain dynamics [31].

5.6 Enabling Access to Raw Materials by P2P Collaboration

The plastics, metals (both those that are abundant like iron and rare earth metals like Indium) and other materials should be obtained by recycling waste through programs such as the Plastic Bank initiative which takes waste plastic as a chance to help people out of poverty by self-sustaining entrepreneurship. The plastic waste can be further re-processed and used as feed for fablabs or by 3D printing for the components and sub-systems. Similarly, the rare earth metals essential for producing mobile phones and electronic devices must be recovered from specialized recovery processes after the electronic waste removed and sorted. The sorting activity can be carried out by local entrepreneurs in the same manner as is followed by Plastic Bank initiative.

The United Nations launched the Solving the E-Waste Problem (StEP) and Global e-Sustainability Initiative (GeSI) to enable public and private institutions to work together with policy makers to develop and exchange technologies for recycling electronic waste [32]. MBA Polymers Inc. has been successful result in building robust technologies for re-processing plastic waste for commercial use. These re-processing and recovery activities obviate the need for mining and extraction activities with their ecological and social consequences [33].

5.7 Concluding Points

Looking at the examples of open source development undertaken by Facebook and National Renewable Energy Laboratory, we can conclude that an alliance of cooperatives and non-profits (or even for-profits) enterprises can be established, or even contracted, for reprocessing waste material into starting feed stock for production. The funding mechanisms and governance related considerations are discussed in later sections.

One major concern that remains is the potential conflicts over intellectual property rights between companies who design and produce the electronics that land up as waste after disposal. If some companies claim ownership of extended product ownership including the recycling of their products as their commitment to sustainability, it could cause conflicts with other stakeholders.

6. The Role of P2P collaboration in Rehabilitation, Infrastructure Re-Development and Governance

6.1 P2P Collaboration for Co-Production and Good Governance

Prof. Victor Pestoff of the Institute for Civil Society Studies at Ersta Skodal University College in Stockholm describes the co-production of public services by citizens, or group of citizens, paid and volunteer, in collaboration with members of Government agencies and public institutions; and how such arrangements have altered the equation by making citizens, private and public institutions into more active participants in governance than less passive recipients [34; 35].

The commitment to maintaining the quality of public services through programs for education, healthcare reforms and infrastructure building is a daunting task in light of the aging population of Japan. A co-production mode that upholds the quality of public service starts with the acknowledgment of the presence of young, technologically savvy, population. Moreover, co-production helps to counter the austerity measures resulting from the global economic crisis and the democracy deficit at the national, regional and local levels.

Critical public services for citizens are an opportunity for active participation in both co-management and co-governance. Because, most of the co-governance entails at the input end of the formation of policy for governing the public services, while the co-management only addresses after the policy is implemented so as to steer the outcome. For instance, for-profit firms which have been contracted by the government to provide welfare services usually engage in democratic decision making in the form of user-participation.

An interesting case in Europe illustrated that parent cooperatives enable far more parent participation than either public or private services in terms of contributing time and money for running and maintaining the facility; active involvement in decision-making via mutual consent and participation for childcare related activities. Such parent cooperatives reduces administrative burden and the arduous task of defining the appropriate degree of care for the children in accordance to their parents, as they understand the needs far better. The public institutions can provide subsidies or partial funding for such parent cooperatives and even ensure checks-balances.

However, when it comes to funding education programs, infrastructure and healthcare we must acknowledge that these public services (even in the case of privatization) have complex management and accountability structures; whether the government or private corporation is building a bridge or developing a surgical device.

Therefore in the co-production for the three aforementioned public services (i.e. education programs, infrastructure and healthcare) citizens can form active collective groups to convey their requirements to the contractors who provide services to assure quality and the timely delivery of services. Likewise, companies who develop medical healthcare solutions like therapeutics and medical devices can gain access to substantial data concerning human factors engineering (such as ergonomics for easy-to-use features) and about patient safety before extensive clinical trials that can reduce the incidence of, and costs of, product failures. This approach can potentially lower development costs as well. Moreover, as stated in the previous sections, the public-private-commons collaborative framework can be used for providing quality therapeutics at lower costs [9].

The active collective groups can influence policy makers to commit funds for research and development in public/private research institutions in the areas of infrastructure development (such as earthquake proof bridges) and healthcare research (e.g.: therapeutics to treat radiation poisoning). Furthermore, the collective groups in collaboration with their public counterparts can determine the qualification of suitable contractors who would commercialize these essential public services by making a ‘decent’ profit and adhering to quality standards without violating safety and labor norms.

6.2 Evaluating the performance and potential of Co-Production in Public Services

It is critical that a thorough study be conducted of economic theory, anthropology and social sciences, political economy and behavioral sciences so as to comprehend the interaction between public sector, policy makers, peer-to-peer production communities and for-profit sector before engaging in co-production [36].We recommend piecemeal reform by opting for a “searchers” approach (such as William Easterly has advocated) so as to prevent the undesired consequences of Germany’s energiewende which unintentionally lead to higher emissions, according critics [37]. It is also critical that a public funded and democratic watchdog and investigative agency be established in existing policy structures so as to monitor the transparency of funding sources and the utilization of public services by the co-producers so as to avoid corruption and lobbying by public or private institutions. It would be ironic if peer-to-peer mode of production, which is democratic in nature and not as hierarchical, would require monitoring so as to ensure that no form of undemocratic collectivism is taken against a group of people, a citizen or a private enterprise [38].

6.3 Need for Effective Coordination in Co-Production activities for Public Services

In addition to monitoring the utilization of and maintenance of technical infrastructure crucial to peer production activities, a robust management framework can help coordinate the progress of various public-private-commons peer production collaborations. Such collaborations may range from fabricating radiation-resistant robotics for decontamination, inoculation by genetically modified bacteria or plants for soil decontamination, or peer produced educational programs for the establishment of disaster management cooperatives. If the task is excessive, consultation with the private sector can help to locate those who possess years of interdisciplinary project management experience. However, the core moderators of the management framework would be accountable to the respective Governments and their legal institutions. Most important are the peer producers and citizens at large. We may need to explore the possibility of having active collective groups to hold the core moderators accountable, and even to elect them democratically.

6.4 Enabling an Advanced Degree of Collaboration in P2P Production

In addition to a robust management framework for coordinating peer production activities, we also need reliable tools to support interdisciplinary collaborations. Rapid scientific and technological progress has introduced information that far exceeds the capability of the human intelligence to co-relate and respond.

We will require in the future not only big data tools but also platforms dedicated to helping collaborators connect with each other and co-relate their knowledge so as to develop solutions for a sustainable future.

One possible platform is Explorer’s Wheel developed by Julian Gresser and his co-inventors. Julian Gresser, a lawyer with extensive experience in Japan, has devised a robust framework known as the Fukushima Explorers' & Innovators' Wheel helps to integrate the information related to the ongoing Fukushima crisis by addressing directly the fragmented nature of vital knowledge and experience. Gresser argues that such global integration of knowledge and wisdom in and of itself is critical for mitigating the crisis and setting the course for a more sustainable future [39].

The Explorers’ Wheel is envisioned as the epicenter for ideas, resources, expertise and knowledge, undergirding collaborative structures between institutions and stakeholders, and monitoring the response mechanisms. It provides its users a “Discovery Engine” that incorporates a wide array of advanced techniques for facilitating creative problem solving, and encouraging innovation and collaboration. As a result, the participants would be able to co-relate the interconnectedness and the connections between diverse fields such as role of robust telecommunication for communicating the outcomes of a disaster for deployment of an effective.

In addition, the Wheel can improve the knowledge and mental capacities of its participants by utilizing social media platforms, crowd sourcing and search technologies. The Wheel would not only provide personalized feedback to its members but would also learn and grow its own intelligence and facilitate learning between the members as well.

The Explorers’ Wheel is a unique software program which mines the intersections between diverse fields of science, technology, social and political research, ecology and economics that form a fertile ground for discovery and innovation. The Wheel can enable collaboration between “creative amateurs” and experts to resolving Fukushima-like crises. The Wheel can be also a powerful tool for predicting disaster and modeling the cascading effects so as to form suitable collaborations for either the mitigation or the prevention of future calamities.

Julian Gresser’s team of explorers have been working on the Wheel for around a decade and are in a position to deploy a coherent robust system for mitigating the Fukushima crisis [40].

6.5 Role of Governance in P2P Collaborations and Communication

We have witnessed a revolution in communication technologies that has brought the world closer and redefined the term “global village”. The last two decades has witnessed a spectacular rise in mobile-phone based communications, and the development social media, which has not only enabled communications across geographical boundaries, but has turned such networks into platforms for promoting good practices and governance.

Social media interaction between peers and individuals can promote both intellectual and political exchange and alter the equation in relationship between the people and their governments, and other private institutions [41]. Social media can also be, by contrast, a distraction from the issues of our age.

This changing paradigm has been subject to wide spread surveillance by Government agencies and other forms of interference because such horizontal networks are perceived as ‘threats’ to the current status-quo and in certain circumstances by private corporations engaged in forecasting the demands of their goods/services by utilizing ‘big data’ tools. The Asia Institute has explored the potential of big data and its risks through a series of seminars and reports, putting forth concrete proposals for a global "Constitution of Information" to uphold greater accountability in the collection, analysis and utilization of information in accordance with the stakeholders of our society. The Asia Institute has also put forth proposals for a use of social networks as a form of global governance for the response to the coming challenges of climate change [41; 42].

We need to comprehend that would peer-to-peer modes of production render collaborative intelligence far superior to the knowledge developed and built by a few experts in a certain specialized domain?

Mainly because, the expertise required takes years with substantial financial resources (which may not be in the case of P2P based production at the moment) to develop and so is the learning curve that requires the discipline and agility practiced in private or public organizations which are mostly hierarchical. Especially Government Labs which perform knowledge intensive research in the domains of clean energy (such as Space Exploration Technologies and Hydrogen Plasma) for which researchers spend years in study.

Also, the expertise built predominantly by the private sector has been controlled by strong proprietary mechanisms and increase the return on investment which further leads to only higher costs and limited scope of use. Even if the tacit and explicit knowledge is stored in robust knowledge systems to be only made part of the commons (either privately owned within a consortium or for humanity at large), it still requires time to access and even absorb the knowledge for a knowledge producer, especially in the form of training and practice for skill development. This raises the same question since antiquity that does the crowd possess deeper ethical insight as compared to a few experts, as encountered in the case of Socrates' trial documented by Plato [24; 43].

7. The prospects of P2P Collaboration to bring about a Transformation of Japan and the Turn to Sustainable Energy

7.1 Japan's Energy Concerns after Fukushima and the potential of Thorium-based nuclear energy

This research project involved an interview with Prof. Takashi Kamei of Ritsumeikan University concerning the advantages of thorium-based nuclear energy in Japan and its potential role in the development of long term sustainability in energy. Prof. Takashi Kamei a scientist and a proponent of thorium-based nuclear energy has come to prominence in the wake of the Fukushima disaster as policy makers and economists have sought out cleaner (and renewable) forms of energy production that are safer and address Japan's growing energy needs [44].

Prof. Kamei notes that although Japan does not possess any Thorium deposits, nor possess any mining licenses in other countries, the potential of thorium remains great. He has been actively advocating for the establishment of a Thorium bank to assure that the environment is protected as Thorium is gathered as a by-product of the mining of other rare earth metals.

Prof. Kamei stated that there are a multitude of designs with their own specific fuel cycles depending on the magnitude of funding provided to develop novel and robust thorium-based reactors. Because the processing thorium oxide fuel remains expensive, in the case of the development of a 1 GW Molten Salt Fast Reactor in France currently underway the scale of funding is enormous. That situation makes it less lucrative for the private sector to make investments in thorium-based systems and commercialize them—unlike conventional nuclear reactors. Currently, a Fuji Molten-Salt Thorium-based Reactor that is being developed in Japan that b**e**ars similarity with the Molten Salt Breed Reactor. However, the Fuji reactor does not include an online reprocessing unit and despite of its simpler design, the energy output does not meet the desired expectations. Moreover, there remain significant technical challenges in the development of the heat exchanger section of the plant [45].

Prof. Kamei has authored an article titled "Recent Research of Thorium Molten-Salt Reactor from a Sustainability Viewpoint" (2012) in which he assesses the overall sustainability of nuclear energy (including thorium- based systems) for addressing future energy requirements. He notes that although humans have not been successful at controlling the nuclear reactions at Fukushima to go out of control, there remains a profound need for human wisdom and resourcefulness in policy making, education, manufacturing and operation to respond to the challenges of technology. We, at The Asia Institute identify with this perspective as an emphasis on the need for good governance and accountability and adherence to the highest standards of Research & Development, Education and Safety [46].

Contrary to Prof. Kamei's viewpoint, Prof. Kazuhiru Ueta who is a strong proponent of renewable energy transformation in Japan and a prominent member of the energy advisory board of the Japanese government discussed the critical role of the nation's behavioral and socio-economic circumstances in reducing dependency on nuclear energy and fossil fuels. He mentioned that post-Fukushima disaster, the people in general have become more mature in their increased commitment towards energy saving and sharing activities. He also pointed out that nuclear power plants (especially fission types) have additional external costs such as social unrest and conflict in the communities where these facilities are located which are not accounted for in the financial statements of the power utilities. Accordingly, he recommends a transformation to more clean and renewable forms of energy generation. Recently, in April 2014 he jointly authored a research article in Energy Policy (an Elsevier based journal) which assessed the economic and environmental impacts of changing the percentage of electricity generated by nuclear power with respect to varying the mid-term green house gas (GHG) emissions reduction target by using the quantitative approach of the global macro-econometric E3MG model. Their studies revealed that phasing out of nuclear power would have minimal reduction of the Gross Domestic Product of Japan with a positive increase in employment. On the other hand, the carbon tax rate would have to be very high in order to attain a 25% reduction in GHG emission target by 2020 while concurrently denuclearizing the energy sector in Japan.

The following sub-sections describe the role of peer-to-peer systems in co-production in collaboration with state and private institutions for provision of public services and good governance.

When thorium-based nuclear energy is compared to conventional nuclear reactors (including Fukushima Daiichi plant) which utilizes enriched uranium fuel to be converted into plutonium; although there are well established techniques for recycling the waste, there is a high degree of hazard owing to its radioactive nature for thousands of years. Proponents of Thorium based nuclear energy state that as the material does not contain enough fissile potential to sustain a nuclear chain reaction, thus discouraging any form of nuclear proliferation unlike plutonium. The Thorium can be mixed with 10% plutonium oxide thorium-MOX (mixed-oxide) which can be formed into rods and used in conventional reactors and is far less expensive to enrich, less hazardous and no additional plutonium is generated in the fuel cycle [47].

Likewise, Thorium mixed with plutonium and other forms of actinide based waste could be used to continuously power modified conventional reactors for multiple cycles in a reusable manner as opposed to one to two cycles of mixed uranium fuel. The research was done at the University of Cambridge in England. The Nuclear Decommissioning Authority in the UK has decided to commit funds in the range of a few billion pounds in the 2013-2014 financial year for facilitating such technologies [48].

In 2013, Thor Energy, a Norway based company has built a small scale test reactor in the Norwegian town of Halden for gaining deeper insight into the Thorium fuel cycle. The reactor would use Thorium-MOX rods to provide steam to a nearby paper mill and would be operational for 5 years after which the characteristics of the fuel would be analyzed to determine the readiness level for commercial reactors. The first batch of Thorium-MOX pellets in the rods were fabricated in Germany and the future batches would be made in Norway with the hope that commercial grade pellets would be manufactured by National Nuclear Laboratory in the UK. Westinghouse Electric Company is one of the major investors of Thor Energy who had also supplied the nuclear reactor for the Fukushima Daiichi plant [47].

Meanwhile, a brief conversation through social media interaction via Facebook with an 501(c) 3 educational advocacy organization and a non-profit named The Thorium Energy Alliance. The Thorium Energy Alliance comprises of engineers, scientists, and concerned citizens interested in reducing the cost of energy with a strong focus on Thorium based energy.

When a brief discussion about the safety considerations between Fukushima Daiichi nuclear plant and Thorium based nuclear reactors was conducted the group members revealed that the back-up generators at the Fukushima Daiichi plant which delivered power to the cooling system during emergencies survived the earthquake but unfortunately were compromised by the Tsunami. As a result, the loss of the coolant to the spent fuel created the problem of radioactive contamination and leakage as we know it today. On the other hand, the dual-fluid Liquid Fluoride Thorium Reactor (LFTR) has a secondary tank below the main reactor core. And in between the core and the secondary tank is a pipe which is actively cooled for the fuel mass to be kept solidified in order to form a plug. In the event of a power loss, the cooling system shuts down and the solidified fuel mass inside the pipe melts and drains into the secondary tank. From there it spreads out eventually to lose it shape and reactivity.

However, many experts who were proponents of renewable and non-renewable modes of energy production (including Hydrogen Plasma Fusion Reactors and Peaceful Nuclear Explosive Reactors) openly admitted that no option is entirely safe and clean.

Although experts and proponents of Thorium based nuclear energy have assessed it to be a far more viable option for addressing Japan’s growing energy requirements and also being a far more cleaner source of energy;

even though it is under development for wider implementation across the globe.

A careful observation by critics of nuclear energy have illustrated the negative learning curve of this particular energy option which is not only limited to escalation of real-term construction costs but even ecological costs with respect to the life cycle of building, maintaining and disposing the nuclear energy facilities (and the reactors). This also includes the life cycle of the materials, especially the thorium based fuel which is a by-product of mining rare earth metals which in itself are emission intensive [49].

Similarly, the rare earth and minerals which are extensively used in solar panels and energy storage systems are obtained through mining which is not only emissions intensive but also is exploitative in terms of human labor in developing nations such as India and Africa [50].

On the other hand, there are many joint University and Private sector partnerships (e.g.: California Institute of Technology and Dow Chemical Company) for the development of solar panel photovoltaics which utilize abundant less expensive materials such as copper and zinc as opposed to rare earth metal like indium and gallium [51]. Such innovations would offer new hope and lesser dependency on scarce materials which have strong geo-political influence onto a nation's energy future.

Therefore, Takashi Kamei had proposed an international mechanism for assuring the safe extraction, storage and eventually distribution of thorium. Because the mining activities for the rare earth metals and minerals of which Thorium is a radioactive by-product is known to cause considerable damage to the environment [52]. Similarly, Jim

Kennedy of the Thorium Energy Alliance proposes the establishment of a "Thorium Bank" which would oversee and store thorium gathered from rare earth processing operations. Furthermore, the institution would assume liability for thorium, which governments should regulate owing to its mild radioactivity. Consequently, this would ensure a reliable supply chain of thorium for a thorium nuclear power future. Also, the Thorium Bank would work in conjunction with a rare earth co-operative which would oversee rare earth processing and the extraction of thorium from the rare earths [53].

Furthermore, ThREE Consulting and Thorium Energy Alliance have presented a thorough study on the dominance of China over the access of rare earth metals, minerals and thorium deposits. The rare earth metals and minerals are critical for the production of semiconductor based products such as cell phones, lithium ion batteries, solar panels and energy storage systems for ensuring the viability of renewable energy.

Therefore, as Japan is predominantly as US ally it would have to reconfigure its geo-political strategy while considering the future of its energy requirements in accordance with the desired economic growth rate, whether they are consciously committed to sustainable forms of energy or not [54].

Acknowledging the geo-political implication of nuclear fission based energy production, many experts have stated that nuclear fusion as opposed to nuclear fission in conventional nuclear energy methods is far safer and cleaner approach to generating energy as it does not produce radioactive waste which poses contamination related hazards. However, even though many successful milestones have been attained in fusion some experts have stated that the commercial viability would require another decade. Thus, suffering from the same dilemma of requiring additional time to address our immediate needs. Meanwhile, there is a stronger focus on nuclear fission with improvised designs that do not necessarily require mechanical pumping to cool reactors in case of an accident or emergency shutdown.

On the other hand, in case of a natural disaster the fusion based reactor would eventually cool down due to passive cooling technique as opposed to the cooling methods present at the Fukushima Daiichi plant which required the involvement of both machinery and human operators that could be out-of-service under such overwhelming circumstances.

In addition, the conventional nuclear ‘fission’ based energy sector has devised far more innovative ways to counter the impediment of radioactive waste. For instance, International Isotopes are building a special facility for re-processing the uranium enrichment byproducts into less hazardous forms with the production of specialty gases that have applications in thin-film solar photovoltaics, computer chips and other electronic devices. Likewise, the byproduct of nuclear fusion is Helium which is a high-demand industrial material.

At the moment, nuclear fusion utilizes Hydrogen-Boron based fuel such as the method of “Focus Fusion” comprises of Fusion with Dense Plasma Focus and Hydrogen-Boron Fuel. The Hydrogen-Boron fuel only produces charged particles which can be directly converted into electricity using specialized energy transformers. This obviates the extra material and financial investment in the contemporary pathway of generating electricity by way of heat produced from nuclear fission which is used to produce steam for driving a turbine for electricity generation.

7.2 Feasibility of adopting a P2P Collaboration for developing Advanced and Cleaner Energy Technologies

From our research in terms of interviews with various experts to determine the feasibility of considering P2P based collaboration for developing advanced clean energy technologies such as Thorium based nuclear energy or Hydrogen Plamsa. Towards the end we learnt that there are many justifiable barriers in terms of clearances to work on this project which sometimes is dual-purpose in nature and require advanced research facilities. Therefore, a peer-to-peer collaboration between pertinent institutions (similar to the P2P model of the National Renewable Energy Laboratory [23]) appears to be more feasible with some limited degree of crowd sourcing to the stakeholders for comprehending the degree of safety and reliability.

For instance, an email based interview with Mr. Russ Wilcox, founding member of Transatomic Inc. which is a spinoff from the Massachusetts Institute of Technology which has devised a novel reactor design which is meltdown proof and utilizes spent nuclear fuel from other nuclear reactors. The design does not require fabrication of fuel rods and eliminates the need for expensive waste processing. He also clarified that such technologically complex systems are not only challenging to develop based on the engineering learning curve which is not widely available and is highly specialized; nevertheless, such advanced technologies can only be developed when Government funding agencies and regulators (who define the regulatory process, export controls and purchasing norms) create conducive environment for private investors as well.

Therefore, a peer production or open source collaborative method for developing such advanced technologies are limited due to the regulatory controls in terms of clearances required to work in technical areas pertaining to radiation and nuclear energy, including Thorium based nuclear energy. Similar impediments can be encountered for developing other technologies (as outlined in Section 4, 5 and 6) as well for mitigating the ongoing Fukushima crisis.

On the other hand, we as concerned citizens need to not only acknowledge but even encourage youngsters to build a keen interest in participating in advanced science and technology for the benefit of humanity and their future in general. Because, since the previous decade there has been a spurt of young amateur scientists (around 17 years) who have gained keen interests in nuclear fusion and attained considerable practical skills in building and operating experimental reactors.

Similarly, such enthusiastic and talented amateur scientists can transform the current scenario of developing advanced sustainable technologies which till date has been within the reach of specialized expertise and facilities located within formal institutions. These amateur scientists can deliver the cost advantage on various aspects during the technology development process (as stated in Section 5) and this would also build their knowledge to be successful scientists of the future and facilitate social and economic growth.

The innovation in imparting education for such youngsters can be achieved by a mechanism similar to the Explorers 'Wheel and its Discovery Engine and novel Peer-to-Peer (and Collaborative Commons) based education programs to deliver higher quality education and far lower costs.

7.3 A crisis of perspective caused by forcing our form of order onto Nature's "chaotic" structure

Kurt Cobb's eye opening article on the Fukushima crisis titled "How Our Inability to Calculate Risk Opened the Doors for Fukushima" in oilprice.com in October 2013 reveals a much more comprehensive perspective on the complexity surrounding the Fuksuhima crisis which illustrates the travesty of our industrialized civilization [55].

The earth's entire biosphere has existed prior to the arrival of human beings and the human civilization as we know today. Therefore, even though complex and chaotic systems (in terms of chaos theory) such as oceans, rainforests and rainfall have existed for around millions of years and have settled into more predictable patterns. However, unfettered industrialization has placed the burden of enormous ecological cost which cannot be easily elucidated in the form of financial costs bearing in mind that global currencies and their underlying principles have been formulated since a few centuries when the scientific working of our ecosystems were not well understood, except a more philosophical oriented explanation in the scriptures of antiquity and mythological tales.

Most of the known financial evaluation methods for risk assessment and compensation mechanisms are based on the fundamental concept of 'substitutability' which implies that an undesired impact can be compensated in financial terms [56]. One needs to comprehend that financial resources whether in the form of currency notes or transference of electronically coded signals wired via financial institutions in itself denote the accessibility to other material and non-materials resources such as machinery for removing construction rubble for saving victims lives in the case of an earthquake or healthcare services to be provided to citizens in the case of an outbreak of a poisonous chemical from a factory. These tangible resources are further dependent on the ecological dynamics of our environment to provide raw materials such as cotton, petroleum or natural biologicals in the case of certain medicines. Consequently, the onslaught of man-made climate change undermines the ability of the Earth's biosphere to deliver us these base materials for our very industrialized economy and furthermore, compromises the 'sink function' which is responsible for rendering pollutants and other noxious chemical entities harmless.

The climate change induced by human activity, including the ones from opting for renewable energy (esp. using rare earth metals and inadequate policy implementation) have injected a higher degree of unpredictability within these complex natural systems [37; 50]. In addition, the presence of nuclear energy which is around 70 years far lesser than the existence of mankind and our biosphere. The nuclear facilities and reactors are designed using advanced and complex engineering spanning across diverse scientific disciplines including systems engineering; chemical, electronics and mechanical engineering and nuclear chemistry. Moreover, even though the most robust design is implemented with a higher degree of safety and reliability against natural disasters (single or multiple) and accidents. One has to admit that contractors who build such advanced reactors would encounter a pareto optimal frontier in which one parameter (such as safety) cannot be improved without worsening the other (such as higher emissions or costs); even if public-private partnerships (with substantial regulatory controls) are formed to incentivize the development of the most reliable nuclear reactor.

Experts in the field of risk evaluation and probability sciences have illustrated that it is next to impossible for calculating the accuracy of small probabilities of man-made systems, because experts in science and engineering who develop such advanced man-made systems do not entirely understand the interaction of their systems with nature's far more complex and chaotic systems. As the interactions are unpredictable which leads to these experts to underestimate the consequences of smaller probabilities, let alone the probability of incidents that could occur every million years.

Nassim Nicholas Taleb known for his book "The Black Swan" stated that in 2003 Japan's nuclear energy safety defined the limit of fatalities resulting from radiation exposure to civilians living near any nuclear installation in the country would be no more than 1 in every 1 million years. On the contrary, 8 years since which is 2011 the real limits have exceeded far than anticipated because radiation has now been detected in food and water not only near the Fukushima plant but even in tuna fish near the state of California as well. The fatalities which also refer to excess cancer deaths caused by radiation exposure could take years to show their symptoms and hence may not make it into the statistics; thus making policy makers underestimate the extent of harm caused by the accident.

The Fukushima disaster is glaring example of our inability to foresee devastating outcomes and overestimating the reliability of the developed technologies. For instance, a considerably advanced nuclear reactor (even though considered an old design at the moment) had its sea wall breached by the Tsunami and flooded its emergency generators for powering the pumps to cool the reactor core and fuel rods in cases of a power outage. The back-up batteries were exhausted within a day and the hydrogen explosions damaged the buildings which ultimately compromised the fuel rod storage leading to massive leakage.

7.4 Renewable Energy Transformation by P2P Production

Since the past decade there have been many successful endeavors to propagate the adoption of renewable energy across households and small medium enterprises with either the active participation of the Government or with minimal Government support by virtue of the Peer-to-Peer (P2P) collaboration. The P2P based approach encompasses open source educational and training modules for building solar panels and installing wind turbines to financing via Peer-to-Peer financing, crowd funding and even creating a crypto-currency such as SolarCoin.

Moreover, start-ups such as Open Utility founded in UK by young entrepreneurs who have developed specialized software with 'big data' tools for creating a Peer-to-Peer online marketplace for consumers to buy and producers to sell renewable energy which is produced locally. The start-up secured a few thousand pounds worth of funding from British Gas which exemplifies the keen interest of large energy companies who acknowledge the role of stakeholder participation in renewable energy generation for both social and environmental sustainability [57].

Meanwhile, it is essential to acknowledge the instrumental role of State based initiative and policies which encourage the adoption of renewable energy in the case of Germany's 'energiewende' and even facilitate P2P production. For instance, British gas provided initial funding for the aforementioned start-up Open utility.

However, there is another aspect to the adoption of renewable energy on a wide scale, because Germany, despite its well known "Energiewende" (transformation from coal, nuclear and gas to renewables) has recently opted for reducing the government spending and subsidies for renewable energy. As the energy prices in Germany have become more expensive mainly due to the increase in shale gas production United States which has pushed fuel prices down [58]. This instance illustrates the influence of international geo-politics and political economy outcomes in the domain of energy supply and demand dynamics.

In addition to subsidies by the German government, billions of euros worth of surcharge has been billed to the German consumers for subsidizing electricity from renewable energy and the surcharge is anticipated to rise further. One of the major shortcomings of renewable energy is the irregular supply depending on the time of the day and weather (probably caused by climate change and rare earth metals for solar panel could exacerbate it further [50]). Because sometimes there is abundance and in the other times there is enormous scarcity. Moreover, the technology for storing surplus energy is not yet robust and does not receive enough incentives. Although, we at The Asia Institute ascertain that some of the P2P collaborative structures and examples can be considered for developing low cost and effective energy storage systems. In fact the German law places higher priority to electricity from renewable sources in the grid; as a result, the gaps caused by the aforementioned fluctuations needs to be bridged by conventional power plants for which “cheaper” coal is preferred over gas. Hence, some critics state that ‘every solar panel and wind turbine casts a dark shadow’ [58].

Therefore, at this particular moment Thorium based nuclear energy seems to be the most clean energy option to fill in the gaps of the fluctuations caused by the supply of renewable energy sources. As discussed previously that Thorium based nuclear energy related technologies are still under development and are undergoing a slow cycle of adoption which is anticipated to absorb another few more years.

This scenario may undesirably push us again to be dependent on conventional non-renewable energy sources (with dependency of the utility companies) to fill in the gaps.

Meanwhile, Germany's energiewende creates conflicts with the European Emissions Trading System due to the each kilowatt hour of energy produced by renewable sources gives rise to enormous emission offsets, thus reducing their prices. These lower priced emission offsets are then sold to other polluting industries across Europe, such as the Spanish cement industry, German steel plants and Polish lignite plants. Therefore, we need to comprehend that every positively conceptualized initiative could have undesired negative consequences [37].

The objective of this section is to convey that every form of energy production is not entirely clean and safe bearing in mind the impending climate change crisis threatening our industrialized society.

8. The revenue generation mechanisms for P2P Collaborations

This section although would begin discussing the remuneration and revenue generation mechanisms via P2P collaborations. In addition, there would be a considerable focus on the political economy facets of P2P collaboration in accordance with the predominant mode of production within our society and its current economic underpinnings. Simply, because a robust and coherent economic framework outlined by policies, community ethics/practices and governance is crucial for stimulating sources of income for knowledge workers.

The remuneration to the knowledge workers for the peer production collaborative could be brought about some or all of the following methods:

1. Public investment by the respective governments for which in some cases small scale venture capital investment would be a viable option for launching pertinent technologies in order to secure government contracts. However, from the previous failures of both the Government to hold the private sub-contractors accountable for not adhering to safety norms and the sub-contractors who blatantly violated them as well; could render this option less reliable [11].

2. Crowd sourcing of funds to recover a fraction of the labor, administrative and materials expenses. The crowd sourcing could be in the form of 'Guilds' formed by a group of small investors and even local governmental bodies without any corporate middlemen quite similar to the Lynneten Wind Farm which was initiated for promoting wind energy within the region [59]. Moreover, the participating companies in the public-private-commons peer production collaborative framework which are publically listed on stock markets can promote themselves as entities for "Socially Responsible Investing" in order to attract investment (either via share purchases or mutual fund investment) from investors who are conscious about the environment and society [60]. Likewise, some of the private corporations can issue fixed deposits for investments with a attractive rate of return and advertise that the fund would be used for socially relevant projects, such as the one discussed in this white paper.

3. The revenue generated from the Peer Production Licenses (or other suitable intellectual property rights and revenue exchange agreements) given to the private companies who would utilize the knowledge

generated out of these peer production collaborative endeavors with the stakeholders [6]. Furthermore, the relatively subsidized cost of developing and expediting advanced engineering systems such as robots which operate in high radiation environment could eventually propagate space exploration where such radiation resistant technology is in high demand.

4. As the private corporation(s) participating in the peer production collaborative endeavor which directly benefits society in terms of contributing to knowledge growth and indirectly towards to income distribution of the surrounding community. Accordingly, the corporation(s) can reduce the budget of their corporate social responsibility and utilize the same funds for the peer production collaborative endeavor under consideration.

5. Decentralized crypto-currencies which deliver more value to stakeholders in terms of sustainability such as the SolarCoin. Although, SolarCoin is anticipated to promote the people in general, Small Medium Enterprise owners (and even large corporations) the adoption of solar energy. We need to acknowledge that the viability of such crypto-currencies is based on the acceptability by its community of users for exchanging goods/services, the adoption of the crypto-currency, the reliability of the solar energy generating equipment and the permission to exchange the crypto-currency for any of the internationally recognized currencies [61].

6. Likewise, there have been successful cases of utilizing peer to peer financing for accelerating renewable energy projects and accordingly, suitable strategies can be used for accelerating the implementation of various mitigation techniques which are both technological and oriented towards disaster management [62; 63].

However, if the lending is done via crypto-currency or traditional currency, the lending peers should account for the social and economic challenges of the Fukushima victims and surrounding regions. And therefore, form appropriate payment norms and interest rates. It is critical that even if P2P lending claims to eliminate commercial banks as middle men, it should in no manner become predatory in nature.

The remuneration mechanisms also need to placed within the context of the current political economy with reference to the potential disruptions that can be caused by open source development on the economy at large. It has been well discussed that the P2P based collaborative commons (not the collaborative commons of private consortiums such as the Toxicogenomic Cross-Validation Consortium [7]) mainly focuses on the production of knowledge and goods/services for its 'use-value' for its community of users and humanity in general rather than 'market value' which is based on purchasing power and income.

Meanwhile, it is a matter of concern that if knowledge and goods/services are produced in a massive scale (or over abundance) with an ever increasing rise in the no. of knowledge workers working for a P2P based collaborative commons, then we encounter a situation in which we attain an exponential rise in 'use value' while linear or even very little increase in 'market value'.

This not only creates a political economy scenario of disrupting the form of capitalism as we know it which is based on scarcity accumulation of capital and other forms of resources (knowledge, human, financial and material); nevertheless, it also creates a world of low income or even income-less knowledge workers in a P2P collaborative commons economy. In simple words, zero marginal cost society could also lead to zero income in many circumstances. Therefore, if the knowledge workers have low or no incomes then their purchasing power to consume goods/services from companies in the current capitalist system is dramatically diminished.

As in this white paper, we advocate the harmonious co-existence of diverse forms of production to complement each other, such as the Peer-Production License that is based on reciprocity between parties who intend to commercialize value from the collaborative commons meant for the humanity at large and the knowledge workers who contribute value to the same commons [6]. We envision that the governments can actively contribute to such harmonious co-existence by implementing good governance policies, providing tax benefits, subsidies or even grants for P2P based collaborative commons that would maintain the infrastructure and even provide income for the knowledge workers. Likewise, the knowledge workers could be provided with a special 'basic income' which includes additional bonuses and other perks to reward as well as incentivize the knowledge workers. Meanwhile, corporations can do something similar which has already been done previously such as IBM's support to the non-profit Linux foundation with subsidies and providing remuneration to the knowledge workers [8].

We are also aware that eventually for a more sustainable society in which P2P based collaborative commons plays a dominant role may require the democratization of the means of monetization in our economy in general which would have a crucial role of for-benefit associations, ethical entrepreneurial coalitions and Partner States [8].

To add further, the ever expanding power of computing technologies is transforming the whole economy in a disruptive manner and as result making many existing jobs and professions far more redundant at a rapid pace, while concurrently creating new opportunities for socio-economic growth. This is causing a modern day 'luddite scenario' in which wages are falling and fewer people have jobs while productivity is soaring. Mainly, because there seems to be a considerably gap in time period between the creation of new employment opportunities and for the population which is negatively affected by the transformation to transition to the newly disrupted economy. Accordingly, MIT professors namely Erik Brynjolfsson and Andrew McAfee who in their latest book 'The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies' have recommended the transformation of the current education system to gain benefit from the growing computing power that would advance the economic growth. We, at The Asia Institute believe that the P2P based collaborative commons with specialized educational frameworks such as The Explorers' Wheel and its Discovery Engine would play an instrumental role in accumulating and disseminating knowledge and education at very low marginal costs which would reduce considerable burden on formal institutions.

With reference to such socio-economically disruptive technological growth, it is important to note that extensive research conducted by economists such as Prof. Mariana Mazzucato, University of Sussex, UK have revealed and exemplified the role of the 'Entrepreneurial State' in which the Government not only corrects market failures by investing in research and/or re-structuring the taxation system but also promotes innovation that leads to a thriving private sector. Likewise, we at The Asia Institute perceive a 'Partner State' approach to enable a 'smoother as well as a faster transition' within the rapidly transforming economy for which robust policies are essentially required to be formulated and implemented via the 'searcher' method as recommended in William Easterly's 2006 book *The White Man's Burden*.

Furthermore, we also anticipate the critical role of communities, for-benefit associations, ethical entrepreneurial coalitions and Partner States to help define 'sustainable progress' and the 'meaningfulness' of our lives [43].

The readers need to understand that as the society and its various communities are slowly adapting to the rapid changes in technological growth and adoption that eventually disrupts markets and even our political economy in general, thus further raising questions on our current professional and social practices and compels us modify our culture toward sustaining the society. Michael Nielsen, the author of 'Reinventing Discovery: The New Era of Networked Science' illustrated the role of advanced cognitive tools and the interconnectedness actualized by the internet in expediting scientific discovery by building on the collective intelligence of the crowd.

In a 2011, Tedx Waterloo seminar he explained the success of the Polymath Project; nevertheless he also highlighted the potential pitfalls that await such open source collaborative projects that lack inherent leadership by both, the group members who initiate it as well as the community members (new and existing). The inherent leadership could be defined primarily as the sense of commitment towards participating and contributing to the open source collaborative project.

He discussed one such case-in-point of the Quantum Wiki (qwiki) project initiated by a graduate student at Caltech University. The qwiki project was envisaged to be similar to Wikipedia but with a specific focus on building a repository of information and knowledge pertaining to quantum computing which would compile the contributions from experts in the stated field. Unfortunately, even though many potential contributors and users were impressed with the vision and expressed a desire to contribute; nonetheless they always were under the impression that 'someone else would make the contributions' and they did not invest the efforts required to contribute to the project, thus leading to its failure and similarly, many more such open source collaborative projects became "virtual ghost towns".

One of the core reasons for the existence of such 'ghost towns' as discussed in the Tedx Waterloo seminar was the conflict of interests between contributions to humanity in general and the users' remuneration/incentives. For instance, the Polymath project resulted in a published paper which named all the contributors, unlike many other open source projects in which contributors may not be directly acknowledged in the produced knowledge or goods/services which would ultimately lead to a stable source of income for the knowledge producers. This implies that certain conservative methods of remuneration and accountability are still crucial for the success of these open source collaborative projects. For example: During the Human Genome Project, a list of Bermuda Principles were formed and conveyed across all the participating researchers that whenever any data obtained should be shared in the public domain (including open access databases such as GenBank). The point to be conveyed by the speaker was that even though the participants knew that sharing in the public domain was 'obvious' did not necessarily mean that they would actually do it.

Accordingly, the speaker who is also an advocate of open science movement and like his peers desires to change the culture of scientific research in which the people within the scientific community are motivated to share their knowledge, information and data in the public domain. This, in his opinion would also entail changing the values of individual scientists to engage in sharing as a part of their job. Even though the ultimate goal is the progress of science and delivering appropriate compensation to these researchers, the speaker clarified that it would indeed be a daunting task. However, till a cultural transformation takes place, we would surely have to acknowledge the irony that a P2P based open source development project which explicitly illustrates the importance of free interaction and participation of contributors/users would still require some policies to be implemented and even enforced in a ‘top-down’ manner such as the Bermuda Principles.

9. Concluding Points and Role of Culture and Philosophy in the Success of Peer-to-Peer Collaboration

We desire to conclude this white paper by re-iterating the philosophical underpinnings that explicitly govern our approach towards perceiving the affected stakeholders of the Fukushima crisis, the methods we use to evaluate and fathom the consequences of our initiatives and our actions which we plan for course correction.

The knowledge disseminated in this white paper objectively illustrates that no form of collaborative framework and technology is entirely fool proof to resolve the Fukushima problem. Hence, a wide plethora of collaborative structures are needed with a conspicuous role of Peer-to-Peer production. The collaborative structures should further be conjugated with reliable technologies which would complement each other so as to minimize their weaknesses.

With the goal of illustrating to individuals in key positions within Government, Policy making institutions, corporations and peer production communities that a long term mutually beneficial cooperation is a realistic and achievable objective.

We further shed light upon the most quintessential fact of our very human civilization that no form of production and economic theory, whether capitalist or communist or socialist is an absolute replacement for ethics and morality within the society. Because, the Nobel prize winning Paul Krugman clearly stated that the role of the economy is to serve the people who are in need and from which we imply that a system that essentially empowers people also leads to a healthier economy where thriving private enterprise complements stakeholders and public services [64].

Japan’s rich cultural traditions and values of hard work, commitment and tenacity would form the cultural and social capital to primarily initiate an inner transformation amongst its citizens, be it from public or private institutions before it opts for the peer-to-peer production modes discussed in this white paper to set the course for their own future.

Our only hope lies in a Leap of Faith!

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