

Community Innovation in Sustainable Development: A Cross Case Study

Tingan Tang, Kimmo Karhu and Matti Hämäläinen

Abstract—Although in sustainable development field, innovative solutions have been sought worldwide by environmental groups, academia, governments and companies for many years, recently, citizens and communities have emerged as a new group and taken more and more active role in this field. Many scholars call for more research on the role of community and community innovation in sustainable development. This paper is to respond to the calls. In this paper, we first summarize a comprehensive set of innovation principles. Then, we do a qualitative cross case study by comparing three community innovation cases in three different areas of sustainable development according to the innovation principles. Finally, we summarize the case comparison and discuss the implications to sustainable development. A unified role model and innovation distribution map of community innovation are developed to better understand community innovation in sustainable development.

Keywords—Community innovation, grassroots innovation, sustainable development, sustainability.

I. INTRODUCTION

WITH the drastic increase of the world population, the world is facing increasing pressures in environment deterioration, energy crisis and resource shortage. Sustainable development, which was first proposed by United Nations World Commission in Environment and Development (WCED) in 1987 [1], has become even more imperative than ever.

In the past decades, there is a burgeoning interest in innovation toward sustainable development [2]. For years, innovative solutions to sustainable development have been sought worldwide by environmental groups, academia, governments and companies. Recently, one new group has emerged to contribute their part. Despite the complexity of these problems, citizens and communities have taken more and more active role in solving them. Due to this development, many scholars call for more research on the role of community and community innovation in sustainable development. For example, Seyfang and Smith call for an agenda for community-level sustainable development research and policy [3], [4]. Bergman et al. reinforce the gap to research bottom-up grassroots innovation in sustainable development [5]. This paper is to respond to the calls and fill the gaps.

Currently, there are no universally accepted definitions for community innovation. Basically, it's regarded as a form of bottom-up or grassroots innovation. Grassroots innovation is defined as "innovation generated by civil society (individual citizens, community groups, etc.), rather than government, business or industry" [5], which includes user innovation [6],

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[7] and community innovation [8]. In a similar way, we define community innovation as innovation generated by community groups.

There are some researches on community-based approaches and activities in different areas of sustainable development such as climate change [5], environment conservation [9], energy [10] and housing [11] among others, though some of them don't label themselves as 'innovation'. Seyfang and Smith argue that community action is a neglected but potentially important source of innovation [4]. Another gap is that these researches mainly focus on a specific area of sustainable development such as energy and housing. There is little research on comparing different areas of community innovations in sustainable development.

Based on the research gaps, the main research questions are: What are the similarities or common features between different areas of community innovation in sustainable development? What are the implications of community innovation to sustainable development?

In order to answer the aforementioned research questions, we use cross case study by using a similar approach described by Yin [12] and Eisenhardt [13]. First, we do a literature review to identify different innovation principles for our case comparison. Then we compare three community innovation cases from different areas of sustainable development by the innovation principles. Finally, we summarize the case comparison and discuss the implications to sustainable development.

The rest of the paper is organized as follows. In section 2, we introduce the innovation principles for our case comparison. In section 3 and Section 4, three community innovation cases from three different areas (electric car, housing and renewable energy) are introduced and compared respectively. Section 5 summarizes the case comparison and discusses the implications to sustainable development. Section 6 concludes the whole paper.

II. INNOVATION PRINCIPLES

To make a case comparison for different innovation cases, we need some common framework to compare innovation. After analyzing and synthesizing the existing literature on innovation comparison, we determine the following innovation principles for our case comparison:

A. Organizational Form

Seyfang and Smith compare the organizational form between market-based innovation and grassroots innovation [4]. For our case comparison, organizational form specifically means in what ways the community members are organized.

B. Roles and Incentives of Actors

Lee and Cole compare the authority and incentives between firm-based innovation and community-based innovation [14]. Similarly, Seyfang and Smith compare the driving force between market-based innovation and grassroots innovation [4]. Because all innovation involves a range of actors [15], we don't limit our comparison on authority but include all main actors involving in the innovation process. We define the principle as roles and incentives of actors.

C. Human Resources

Chesbrough argues that in closed innovation paradigm, firms will try to employ the smart people in the field. Whereas in open innovation paradigm, firms will tap into the knowledge and expertise of smart individuals both inside and outside the firms [16]. Similarly, Lee and Cole specify that one difference between firm-based innovation and community-based innovation is membership restriction [14]. After synthesizing these ideas, we define the principle as human resources which means what kind of members firm and community look for as innovation sources and where to get them.

D. Financial Resources

Seyfang and Smith compare the resource base between market-based innovation and grassroots innovation [4]. In order not to overlap with the preceding human resources principle, we adapt the resource base principle to financial resources principle to specifically mean monetary resources.

E. Locus and Role of R&D and Innovation

Chesbrough argues that in closed innovation paradigm, firms depend on internal R&D and innovation to win. Whereas in open innovation paradigm, firms capitalize on both internal and external R&D and innovation [16]. We conceptualize this principle as locus and role of R&D and innovation.

F. Capitalization of Ideas

Chesbrough argues that in closed innovation paradigm, firms will create most and best ideas in the industry by themselves in order to win. Whereas in open innovation paradigm, firms will make best use of internal and external ideas [16]. We conceptualize this principle as capitalization of ideas that doesn't limit on making money but means how firm or community exploits ideas for their aims.

G. Innovation Focus

Jacobs argues that innovation can be classified into technical and non-technical innovation [17]. Similarly, Bergman et al. maintain that there are different foci of innovation such as technical and social innovation as shown in Fig. 1 [5].

Seyfang and Smith use "principal type of innovation" such as technological innovation and social innovation to compare market-based innovations and grassroots innovations [3]. We rename this principle to innovation focus.

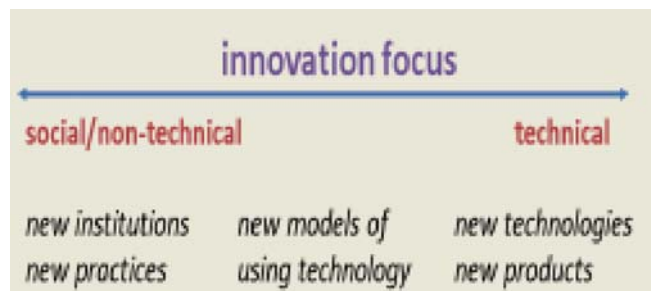


Fig. 1. Socio-technical axis of innovation (from [5])

H. Economic Context

Seyfang and Smith compare the context such as market-economy and social economy between market-based innovations and grassroots innovations [4]. We rename this principle to economic context to make it clearer to understand.

I. Niche

Seyfang and Smith compare the niche between market-based innovation and grassroots innovation [4]. According to Rogers' diffusion of innovations theory, an innovation usually takes place in a niche before accepted by the mainstream [18]. The niche here doesn't limit to market context but in broader social context. Niche is defined as a place outside or peripheral to the mainstream but provides space for new ideas, technologies and practices to develop [4], [5].

J. Control of Intellectual Property (IP)

Chesbrough argues that in closed innovation paradigm, firms will control their IP to prevent competitors from profiting from it. Whereas in open innovation paradigm, firms will both license-out their IP to make profit and buy others' IP as long as it advances their own business model [16]. Similarly, Lee and Cole use IP ownership to compare firm-based innovation and community-based innovation in knowledge creation [14]. After synthesizing these ideas, we define it as control of IP.

K. Knowledge Distribution

Lee and Cole compare knowledge distributed between firm-based innovation model and community-based innovation model [14]. We adopt this principle for our case comparison.

L. Means of Communication

Lee and Cole compare the dominant mode of communications between firm-based innovation and community-based innovation [14]. We adapt this principle to means of communication to show how firm or community members communicate with each other.

III. CASES

In this section, we first briefly introduce the three community innovation cases in three different areas of sustainable development (electric car, housing and renewable energy).

A. eCars-Now! Community (E)

The eCars-Now! Community was born at 2007 in Hikiä, Finland. Initially, it was started when some enthusiasts want to build electric cars for themselves. Later, these enthusiasts get their inspiration from the success of open source projects in IT world. They initiated eCars-Now! open community to devote high quality electric car conversions for everyone at reasonable price. In the 2nd of November 2009, the community officially presented their first prototype called “eCorolla” which was created by converting a used Toyota Corolla into an electric car. Now the community has grown into a truly global community with many local groups in many other countries like Australia, Canada and India etc [19].

B. US Cohousing Association (U)

Contemporary citizens are facing a list of pressures in housing such as environmental degradation, social isolation and affordability. Cohousing is a bottom-up community innovation to address these issues [20]. Cohousing is a form of housing co-operative which has four common characteristics [21]:

- Social contact design (SCD): the physical design encourages a strong sense of community.
- Extensive common facilities: as an integral part of the community common areas are designed for daily use to supplement private living areas.
- Resident involvement in the recruitment, production and operational processes.
- Collaborative lifestyles offering inter-dependence, support networks, sociability and security.

Cohousing originated in Denmark in late 1960s when a group of double-income families were dissatisfied with existing housing and communities and searching for better childcare and a way to share evening meal preparation. Nearly 300 projects have been completed in Denmark since the first community was completed [20]. Since then the Cohousing movement has spread to other parts of the world.

In 1988, two American architects Charles Durrett and Kathryn McCamant introduced cohousing to the US. In 1997, the Cohousing network was born. In 2003, the network was renamed to Cohousing Association of the US. In 2008 National Cohousing Conference, the Association documents 113 occupied cohousing communities across the US [22].

C. Samsø—Denmark’s Renewable Energy Islands (S)

In 1997, Samsø island in Denmark won a government competition to become a model renewable energy community. By getting the support from the government, local people have been able to turn the island to have 100% of its electricity come from wind power. To produce the energy, islanders have funded and built two wind farms, one offshore and one inland. Islanders have also established an organization called Samsø Energy Academy to act as a knowledge resource centre where know-hows and hands-on experiences from the renewable energy projects are shared. Last year, one of the key persons in the project, Sören Hermansen, was awarded the Göteborg Award for his work in the field of sustainable development.

IV. CASES COMPARISON

In this section, we compare the cases by the innovation principles introduced in the section 2. The case study analysis and comparison are based on the information available in respective web sources of these community innovations, namely the eCars-Now! Project Wiki [19] and official web site [23], the official web site of the US Cohousing Association [22] and 10 years of Development and Evaluation—report by the Samsø Energy Academy [24].

A. Organizational Form

1) *E*: eCars-Now! is a non-profit voluntary community group. The project per se isn’t a legal entity.

2) *U*: The US Cohousing Association is a non-profit voluntary association that is composed of board, staff and volunteers. The cohousing project per se is housing cooperative.

3) *S*: There are several organizations involved in the activities. The Samsø Energy and Environmental office is the island energy organisation (NGO) with the most direct relationship with the public at large. Samsø Energy Academy is the knowledge resource centre for all renewable energy projects and Samsø Renewable Energy Ltd. is a company that takes care of all business operations such as operating the wind turbines.

B. Roles and Incentives of Actors

1) *E*: The main actors in the electric car project:

- eCars-Now! Community—The community is the orchestrator in the project. The community develops the electric car prototypes like eCorolla and eSmart, promotes the project in fairs, conferences and media like Youtube and YLE (The Finnish Broadcasting Company), acquires contacts and negotiates sponsorships and helps consumers purchase batteries, used gasoline cars and other components from suppliers. The incentives of the community are to help consumers get high-quality electric cars at reasonable price and contribute to the climate change.
- Electric car buyers—The buyers include individual buyers and company buyers like Norway’s Enviro Elbilsag Company who sells electric cars. The buyers determine the R&D of electric car prototypes and the continuing development of the project. For example, the Toyota Corolla is chosen for the first eCorolla prototype after initial poll of prospective buyers. The incentives of buyers are to get reasonably priced modern electric cars and contribute to the environment.
- Partnering companies—They sponsor the project like Fortum Energy Company; provide components and technology supports like Finnish Electric Vehicle Technologies (FEVT) Company who supplies battery and battery technology support; do the conversion work like Garages. The incentives of partnering companies include getting business opportunities and free advertisement opportunities.
- Government—Government has no direct involvement in the project. However, Finland government has publically

shown their support to the development of electric cars and projects. For example, Finnish Prime Minister Matti Vanhanen published an article to support the development of electric cars on his official blog. Also, government taxation toward electric cars is an important factor for the purchase and technology development of electric cars.

2) *U*: The main actors in the US Cohousing movement:

- The US Cohousing Association—The association is the orchestrator in the cohousing movement. The roles of the association include: promoter and educator of cohousing ideologies; cultivator for cohousing market; matchmaker for cohousing professionals and cohousers; supporter for existing cohousing communities.
- Cohousers—They are the buyers of cohousing houses, co-creators and co-designers of the cohousing communities. The incentives of cohousers include affordability, better children care, environmental concerns and common interests etc.
- Cohousing professionals—They are the main donors for the association and professional supporters like architects, developers and consultants for cohousing. The main incentive is to do business, though there are also non-profit professionals.
- Government—Government grants provide modest revenue for the association. Government may provide subsidy and tax credit to specific cohousing projects. The main incentives of government are social and environmental concerns.

3) *S*: The main actors in the Samsø renewable energy island project:

- Community members—The project was initiated by few active islanders who were motivated by the environmental cause and who saw the economic opportunity for the islanders as well. Since then, the group has grown significantly and islanders have established several organizations for different operations.
- Islanders—They get cheap energy from the wind farms. It seems that the project has been able to engage the whole island, increased tourism and in general activated the life in the island.
- Windmill and other manufacturers—They provide the technology that islanders use in their projects.
- Government—Government initiated the competition and supported and funded the project in the beginning. Islanders have funded the windmills themselves but it would have not been possible without government guaranteeing certain price for the energy for the critical first years.

C. Human Resources

1) *E*: The community is composed of core members and average members. The core members are long-time electric car users and experts in battery technology etc. They are more active in the project. The majority are average members who are ordinary citizens with different backgrounds and keen on electric cars.

2) *U*: The members of the Association are people with different backgrounds, expertise and careers. They are passionate advocates of cohousing across the US.

3) *S*: The human resources include the local people living in the island. There are some “champions” that have taken more responsibility and encouraged others to join the project. Different government offices and energy companies have provided their know-how and resources to help the islanders.

D. Financial Resources

1) *E*: The community is a non-profit organization and supported by volunteers. Some R&D funds come from sponsors like Fortum Energy Company. The community puts Google advertisements on their websites and sell small commodities like T-shirts and cups with the community logo, which can generate modest income for the community.

2) *U*: The Association is a donor-supported voluntary organization. The donors include professional partners, community partners and other contributors. Advertising on their website offers significant contribution. Events like cohousing site tours, workshops and conferences, grants like foundations, corporate giving and government grants make modest contributions.

3) *S*: Participants take loans from the bank. Government backs up by guaranteeing certain price for the energy for a fixed period of time.

E. Locus and Role of R&D and Innovation

1) *E*: The community develops the electric car prototypes. The purchase of used gasoline cars, batteries and other components are outsourced to companies already working in the sectors. Garages do the final conversion work.

2) *U*: The R&D is supported by cohousing members and professionals.

3) *S*: Do not do R&D themselves. Utilize the R&D from outside.

F. Capitalization of Ideas

1) *E*: Everyone can propose ideas and freely start an operation that seeks profit based on their own or other people's ideas, or ideas that are born by working together.

2) *U*: Every members of cohousing community can propose his ideas. Almost all cohousing communities use consensus as the basis for group decision-making.

3) *S*: Utilize proven and selected ideas from outside that fit into needs of the project. Community also tries out all kinds of experimental ideas that local people might have come up with in their daily lives.

G. Innovation Focus

1) *E*: The community use existing electric car technologies. The technological supports such as battery technology come from the companies who have already work in the fields. The innovation focus of the project is to provide a new model of using technologies and a new practice to help consumers get reasonably priced modern electric cars.

2) *U*: Cohousing is new practice to design and develop more sustainable housing rather than technological innovation [25]. Development and other professionals.

3) *S*: Utilize technological innovations from outside but apply them in an innovative way into their own environment and living in the island.

H. Economic Context

1) *E*: The community doesn't do any business or seek profit. It belongs to social economy context. Whereas the companies like battery companies who involve in the project do business and make profit, they belong to traditional market economy context.

2) *U*: The Association is a non-profit organization. What they look for is social benefits instead of economic advantage. For the cohousing professionals, there are traditional commercial professionals. There are also non-profit professionals like the non-profit developer Affordable Housing Associates (AHA).

3) *S*: People who have invested into windmills seek to make monetary profit from them. On the other hand, people do it for the environment cause and for the island as well, which are more on the social economy side. The windmill and other manufacturers are in the market economy context.

I. Niche

1) *E*: The community doesn't sell anything. What they do is to help consumers get modern, full-functioned electric cars at reasonable price by converting used gasoline cars, which are not available from the electric car manufacturers.

2) *U*: The reasons for cohousing include affordability, better childcare, environment and common interests, which are not satisfied by traditional commercial housing.

3) *S*: The niche mainly comes from local needs of the island such as developing local economy, creating job opportunities and attracting more settlement.

J. Control of Intellectual Property (IP)

1) *E*: All of the knowledge produced in the project is public including the communication between commercial and community partners.

2) *U*: The Association has some copyrighted materials, and some of which has been published under other licenses (Creative Commons). Different cohousing communities have their own IP policies.

3) *S*: Do not own any IP and share all their knowledge.

K. Knowledge Distribution

1) *E*: Knowledge is distributed by community website, Wiki, Blog, forums, mailing lists, conferences, Youtube and Facebook etc.

2) *U*: Knowledge is distributed by website, Blog, site tours, workshops, mailing lists, conferences, webinars, books and films etc.

3) *S*: Knowledge is distributed locally and globally through web site and the academy.

L. Means of Communication

1) *E*: The community use Blog, forums, mailing lists, IRC channels and Facebook group for communication.

2) *U*: The Association does not have a central office. Its part-time staff and administrative are located around the country, using the Internet for central archive and communication.

3) *S*: It seems that most of the communication is face-to-face as part of islanders daily life and in different events organized by the organizations. The whole project was initiated by one of the key persons visiting the local people in person and convincing them to join the project.

V. DISCUSSION

In this section, we summarize the main similarities or common features between the community innovation cases and discuss the implications to sustainable development.

A. Organizational Form

The organizational forms of the community innovations are diverse including voluntary community, association, cooperative and social enterprise. This finding confirms Seyfang and Smith's argument that the organizational forms of grassroots innovation are diverse and complex [4].

1) *Roles and Incentives of Actors*: After analyzing the roles and relationships between different actors in the three community innovation cases, we develop a unified role model to better understand the community innovations.

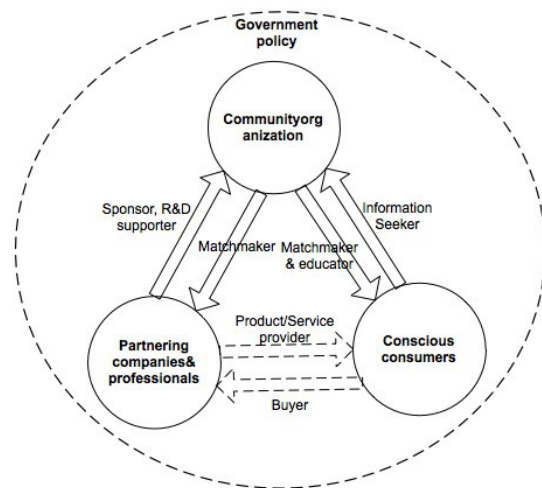


Fig. 2. Unified role model of community innovation

From Fig. 2, we can see that community organization is in the leader or orchestrator position of the whole community innovation process. This is applicable to the role of the three community organizations: the eCars-Now! Community, the US Cohousing Association and the Samsø Energy and Environmental Office. Conscious consumers are those people who are particularly interested in the community innovations. They can be the electric car buyers in eCars-Now! case, the cohousers in cohousing case and local people in the island in

the Samsø renewable energy island case. Community organizations promote the awareness of conscious consumers to the community innovation and help them connect and negotiate with partnering companies and professionals. The partnering companies and professionals can be battery company in eCars-Now! Case, developer in cohousing case and windmill manufacturer in Samsø case. They sponsor community organizations and provide R&D and professional expertise support for the community innovations. Government policy has an effect on all three actors.

From this model, we can see that community innovation process involves different types of actors with different roles. On the one hand, this confirms MacKenzie and Wajcman's argument that all innovation is a creative process which involving a range of actors [15]. On the other hand, we can see that in community innovation, community is the orchestrator who orchestrates the collaboration and negotiation between partnering companies and conscious consumers. The whole community innovation process is a complex process that consists of different inter-connected actors.

B. Human Resources

The human resources principle of closed innovation and open innovation focuses on smart people, either by employing smart people or tapping into the outside bright people [16]. But in the community innovation cases, the membership is open. Everyone who is interested with the community innovation is welcome to join and contribute. This finding is consistent with the Botero et al.'s corresponding community innovation principle [8] and Lee and Cole's membership restriction principle of community-based innovation [14]. Emphasis on smart people might cause firms to neglect the contributions from "not-so-smart" people.

C. Financial Resources

The financial resources of community innovations is diverse, including voluntary input, company sponsorship and donation, limited commercial activity and bank loan. This finding confirms Seyfang and Smith's argument that resource base of grassroots innovation is pluralistic. Post-start-up financial resources poses significant challenges to the sustainability of community innovation [3], [4].

D. Locus and Role of R&D and Innovation

The locus of R&D and innovation of community innovation is distributed. The role of them doesn't limit on economic gain but include social and environmental needs. These findings further confirm Botero et al.'s corresponding principles of community innovation [8]. Whereas in closed and open innovation paradigm of firm-based innovation, the role of R&D and innovation focuses on profit [16]. The implications to sustainable development are that community innovation can complement the areas where firms might neglect for economic reason. On the other hand, community innovation might bring business opportunities for companies, which has been demonstrated in our cases.

E. Capitalization of Ideas

Community innovations are more flexible and inclusive than firm-based innovation in exploiting ideas to fit into their needs. This means that community innovation can have broader sources of ideas than firm-based innovation.

F. Innovation Focus

After analyzing and synthesizing the innovation focus and economic context principles, we draw a two-dimensional innovation distribution map to map the main actors in the three community innovation cases (Fig. 3).

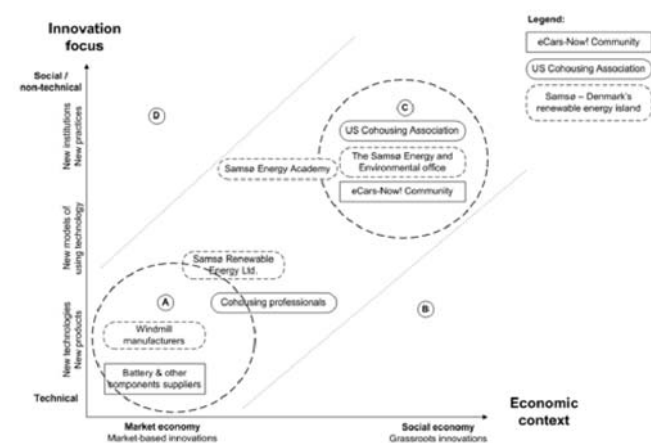


Fig. 3. Innovation distribution map of community innovations

Before discussing the findings in this part, we first introduce the innovation distribution map in Fig. 3. The vertical axis of Fig. 3 is the innovation focus from technical innovation to social innovation (see Fig. 1). The horizontal axis of Fig. 3 is the economic context from market economy to social economy. Next, we map the different innovation actors to the map. In eCars-Now! case, as discussed in Section 4, the community provides a new practice to develop electric cars and new models of using existing technologies. So we put the eCars-Now! Community in the intersection of social economy and the middle of new models of using technology and new practice. The battery and other partnering companies in the eCars-Now! case are traditional business companies and provide electric car technical support, so we put them in the intersection of market economy and technical innovation. Similarly, we map the innovation actors of the other two cases in the map. Different cases are represented by different textbox line patterns (solid line with right-angled corners for eCars-Now! Case, solid line with round corners for US cohousing case and dashed line with round corners for Samsø windmill case).

Now we discuss our findings from Fig. 3. The partnering companies of community innovations more focus on market economy and technological innovation where we mark in the dashed circle (label A) in Fig. 3. This area is the locus of traditional technological innovation and market economy. The community organizations like eCars-Now! Community and US Cohousing Association are on the social economy

and social innovation area where we mark in another dashed circle (label C) in Fig. 3. This area is also the locus where many scholars believe that it's understudied and call for more research attention [3]–[5], [26]. We agree that this area is the core part of community innovations and need more research. But from Fig. 3, we can see that the whole community innovation process of each case actually is distributed in the region between the two dashed parallel diagonals, which spans from market economy to social economy and from technical innovation to social innovation.

Based on this, we can see that community innovation is a distributed process that involves different types of actors and different types of innovations and cannot be treated separately. Therefore, we call for more research on the interaction and collaboration between different types of actors and different types of innovations. Another interesting finding from Fig. 3 is the two blank space areas above the upper parallel diagonal (label D) and below the lower parallel diagonal (label B). It means that in the community innovations, partnering companies mainly focus on technical innovation and are driven by market, while the communities mainly focus on social innovations by using existing technologies instead of innovating new technologies. But for the limitation of our case numbers, it doesn't allow us to make a more generalized claim on this.

G. Niche

These community innovation niches come from different values like social and environmental values rather than just economic value. This confirms Seyfang and Smith's argument that community action is a potentially important site of innovation niches [4].

H. Control of IP

Knowledge is more public and used for achieving social goals than making profit. This finding confirms the corresponding principle of Botero et al's community innovation principles [8] and Lee and Cole's IP ownership principle of community-based innovation [14]. Whereas in firm-based innovation, knowledge is private and seen as an asset to make profit [14], [16], which might prohibit the sharing of knowledge.

I. Knowledge distribution and means of communication

Knowledge is distributed globally by using all kinds of tools on the Internet. This confirms Lee and Cole's argument that in community-based innovation, knowledge distribution extends the boundary of community [14]. The means of communication in community innovation is diverse. Community will choose all kinds of communications that best fit their needs.

VI. CONCLUSION

In this paper, we do a qualitative cross case study on three community innovation cases in three different areas of sustainable development. We summarize the case comparison and discuss the implications to sustainable development. We

develop a unified role model and innovation distribution map for community innovation. Based on these, we argue that community innovation is a complex and distributed process that involves different types of actors and different types of innovations and should be studied as a whole. We call for more research on the interaction and collaboration between different types of actors and different types of innovations in the community innovation process. We hope this paper can provide some insights to sustainable development from community innovation's perspectives.

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