A Value-based Approach to Co-designing Symbiotic Product-service system

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Abstract

For a sustainable service system, the symbiosis of stakeholders is one of the critical factors. In that the symbiotic relation between stakeholders can be sustained based on the mutual benefit, exchanging value in a reciprocal way is significant. However, it is a challenge to generate symbiotic solution producing mutual value in service system design due to the complexity of the network, involving the different interests of stakeholders. This study motivated from the new perspective on value exchange in terms of Product Service System and developed the Value based co-design model (VCM). It is the methodological model for generating symbiotic solution through value exchange between stakeholders with new perspective on the resource. The model is applied to the PSS workshop for promoting sustainable food production and consumption. Finally, the insights about the model in terms of generating symbiotic solution and the designers' role in this specific model are discussed.

KEYWORDS: co-design, value exchange, symbiotic solution, Product Service System, service design

Introduction

Symbiosis, defined as the living together of unlike organisms (Douglas, 1994) is increasingly accepted as a strategy for sustainability by enterprises and societies. Advocates of symbiosis argue that in designing of symbiotic relationships we have something to learn from the ecosystems in nature where different species exchange materials, energy, or information in a mutually beneficial manner (Chertow, 2007). A service ecology system involving various stakeholders can be considered in a similar vein. The sustainable service ecology is maintained by the actors exchanging value in ways that are mutually beneficial (Livework, 2008). Despite the acknowledgement of the importance of symbiosis, it is a challenge to

implement symbiotic solutions that provide mutual value to stakeholders due to the complexity of the value network, with its involvement of the different interests of numerous stakeholders (Briscoe, Keränen, and Parry 2012). In developing symbiotic solution, product-service systems (PSS) (defined as an integrated system of products, services, supporting networks, and infrastructure (Mont 2002)) is a potential strategy for generating mutual benefits among stakeholders. This is because PSS provides opportunities to deliver complicated services through outcome focused interactive activities between stakeholders which transcend the traditional disciplinary, functional and organisational boundaries of the consumer and firm (Barnett et al.). To manage the interactions based on needs, PSS studies have explored methods and tools to analyse both stakeholders (Van Halen, Vezzoli, and Wimmer, 2005), and the requirements of the systems they are embedded within (Arai and Shimomura 2004, Burger et al. 2011, Baek 2014).

One strategy to create mutual benefit for stakeholders is a value exchange. For example, Yang, Rana, and Evans (2013) developed a value analysis model (VAM) for generating symbiotic PSS solutions through value exchange in an industrial context. The model provides a new approach to resource management by considering one's redundant or surplus resources as having potential value for others. Adopting this approach, opportunities exist for stakeholders to exchange redundant resources with the resources of others. Yet it is challenging to identify intangible resources which was defined as 'functional relationship' or "usable and serviceable to human beings' (De Gregori, 1987). This type of resource includes intellectual, knowledge, information, human etc. (Diefenbach, 2006). As sometimes the intangible resource is not recognized or even devalued as a potential resource compared to tangible resources, it is also difficult to identify opportunities for service exchange (Yang, Rana, and Evans 2013). The resource exchange approach would thus benefit from stakeholder involvement to identify opportunities for value exchange during the design process. This is because stakeholders have expert knowledge of the detail of their own challenges and related issues (Meroni, 2007), generating their own viable solutions. However, building a symbiotic solution through value exchange requires collaborative ways for stakeholders' to become actively involved in the design process. However, stakeholder active participation may successfully build upon stakeholder agreement in the service ecology. As stakeholders have different perspective and stakes, their needs are also very different. In this respect, a co-design approach is considered useful for generating symbiotic solutions as it combines various views from individuals with different perspectives (Bradwell, Marr, and PricewaterhouseCoopers 2008); harnessing a mix of multidimensional skills for mutually beneficial solutions (Mukaze and Velásquez 2012). In this regard the value exchange model may be applied to PSS (Product Service System) or service design as a useful strategy for creating symbiotic solution.

However, in the current approach to the model (Yang, Rana, and Evans 2013), there exists a lack of detail in how to involve stakeholders even though stakeholder participation is positioned as significant. To facilitate the application of the VAM model in the workshop with stakeholder, co-design method can be very useful as it provides generative supportive tools which make participants easier to be involved in the co-design process. Therefore in this study, we propose a co-design methodological model based on a value analysis model. It is a model facilitating stakeholders to be involved in the co-design process, from value exchange to symbiotic solution development. We call this approach, 'Value based co-design model' (VCM). As such the current study aimed to address the following research question: How do we engage stakeholders in co-designing symbiotic solutions using the value exchange model?

To address this question, a case study of the application of VCM was conducted and analysed to both further assess its appropriateness as tool for co-designing symbiotic solutions and its ability to provide increased value exchange.

Principle of Value exchange

The concept of value exchange, originating from 'industrial symbiosis (IS)', is defined as "a collective approach for the physical exchange of materials, energy, water or products' among industries (Chertow, 2000, p. 313)". Frosch and Gallopoulos (1989) argue that companies can obtain mutual benefits through value exchange because the waste or surplus from one company may be needed by another. Yang et al. (2013) suggest that companies can also achieve a higher value while obtaining more socially and environmentally sustainable systems through resource sharing. For validation, they adopt value analysis to develop a PSS which aims at facilitating the re-use of industrial wastes by matching needs and wastes of the firms in an industrial ecosystem. In this system the wastes, including not only physical waste but also intangibles such as information, knowledge and labour, are considered as surplus values which have their own value adding capacity rather than a literal physical waste. The Figure 1 shows a model of the process of a value analysis.

The process is divided into internal and external value analysis. Internal value analysis is composed of value waste analysis and needs analysis. Value waste is described as a surplus indicating redundant value which is larger than the requirement (e.g. under-utilised resources, over capacity of labour). On the other hand, value need is the need for the waste product of a potential recipient. As seen in Figure 1, internal value analysis aims to identify value waste and value need on both product and service sides. External value analysis is a process of analysing value waste and needs among different companies based on their individual internal value analysis. The approach aims to identify opportunities for value exchange among companies through a need-resource matching process (Yang et al., 2013). Through this process, the opportunities of value exchange are found and needs and values matched.
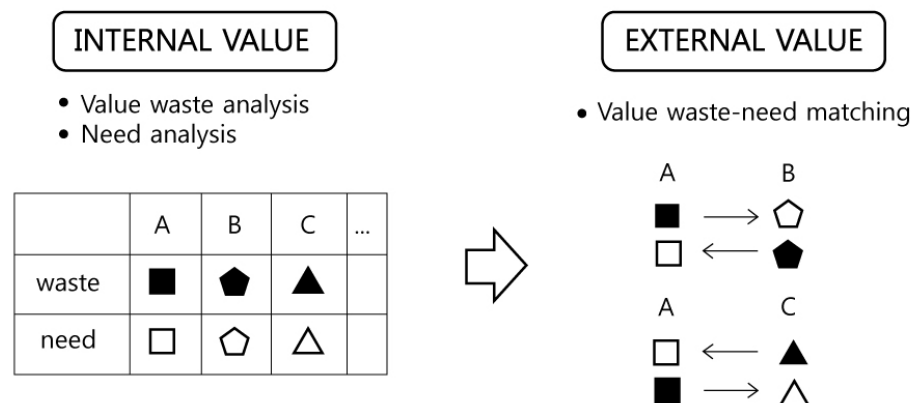
Figure 1 Process of Value analysis (Yang et al., 2013)

Method

The Value based co-design model (VCM) follows the process of the original model (Yang et al., 2013) but there are certain variations in facilitating the participation of stakeholders during the design process. Also, the construct of resource has been widened to extend to the opportunity for value exchange (i.e., we consider the capacity of stakeholders or the available resources around them as surplus value). These resources have the potential to be utilized directly and indirectly in a value exchange. We thus collectively refer to these as these 'resource'. Not only the resource stakeholders own, but also those accessible and available to them are within the scope of the definition. In VCM, resource and needs are extracted from various angles in that the symbiotic value can be created when the resource and needs are properly matched. Moreover, we adopted several design tools and applied them within the co-design process to facilitate non-designer participation. They include: resource cards, need matrix, stakeholder dialogue, and system map.

Tools for VCM

The resource toolkit used in the case-study was designed in the form of cards to facilitate ideation between stakeholders and improve focus upon available resources. Generating and expressing ideas may impose a burden upon the participants who may not be familiar with the design process. Therefore, the toolkit adopted gamification to intrigue participants into co-designing activity more actively and in an engaging way (Oliveira & Petersen, 2014). The gaming approach also aimed to provide certain information related to resources so that participants could be provided with a better understanding of the available resources and how they may best be utilized. The resource for value exchanges collected included from multiple sources: interviews with residents, databases of local infrastructure and heritage, and site visits.

The collected resources can be largely classified between tangible, intangible and human resources (Grant, 1991; Tukker & Tischner, 2006). Tangible resources include natural resources and man-made artefacts; intangible resource includes social, cultural, technological resources; and human resources include individuals' labour, talents, and capabilities. Information about each resource, i.e. characteristics of the resource, problem or need it had, were collected and synthesised into the resource cards. Figure 2 illustrates an example of resource cards. Each card shows the image of a resource on the front side and its description on the back side.

Figure 2 Resource cards

Stakeholder need matrix aimed at identifying the stakeholders' needs as a holistic picture in a systemic way, providing directions for needs identification between stakeholders (Figure 3).

Figure 3 Need matrix (Baek, 2014)

The needs matrix consists of axis X and Y, with stakeholders positioned against the two axis (e.g. axis X: producer, consumer, contributor; axis Y: producer, consumer, contributor). Thus the matrix aims to identify needs between and towards stakeholders. Their needs were identified according to the direction in the matrix filled with stakeholders in the system. In Figure 3, 'N11' is the need of stakeholder X towards stakeholder Y (Baek, 2014).

Stakeholder dialogue provided opportunities for all stakeholders to give advice or express their opinion upon towards solution from the multiple perspectives and diverse knowledge bases (Wahl and Baxter 2008). To handle these differences, the conversation between stakeholders is significant (Manzini, 2015). It is critical for generating symbiotic solutions as symbiosis can only be achieved through comprehension and agreement between stakeholders.

For concept development based on value exchange, the system map is used. The system map is a process of mapping the components in the system, with mapping usually drawn according to stakeholder groups (Segelström, 2010). It also shows the flow of resources within the stakeholders' network. Adopting this system map can be useful in concept development in that the symbiotic solution needs to be considered through a systemic view with consideration for various stakeholders.

Process of VCM

The process of VCM is composed of two sessions from value exchange perspective: Resource and need analysis, and need-resource matching (Figure 4). Resource and need analysis is conducted through source collection & analysis stage, and need-resource matching is done and evolved through concept generation and concept development stage. During the source collection and analysis stage, needs and resources are collected before and during a co-design workshop and analysed. First collection of the data related to users' needs, problems and resources are collected prior to the workshop and become input for the generative toolkit to be used during co-design. The data is collected through interviews and surveys with stakeholders. The resources in the region are then identified and stored as a database using interviews and desktop research. Second data collection of additional needs and resources is conducted in the workshop through stakeholder dialogue. Compared to the

first collection, this is more specified to participants' personalized experience compared to initial data collection which is more general needs. The needs are additionally collected and organised by using need matrix tool. After collection, the needs are clustered according to their similarity. In concept generation stage, the collected resources and needs are matched based on the need clusters. In concept generation and development stage, the resource toolkit is utilized for conceiving the ideas towards need-resource matching. With matching process, the concept ideas are elaborated and developed into a system map.
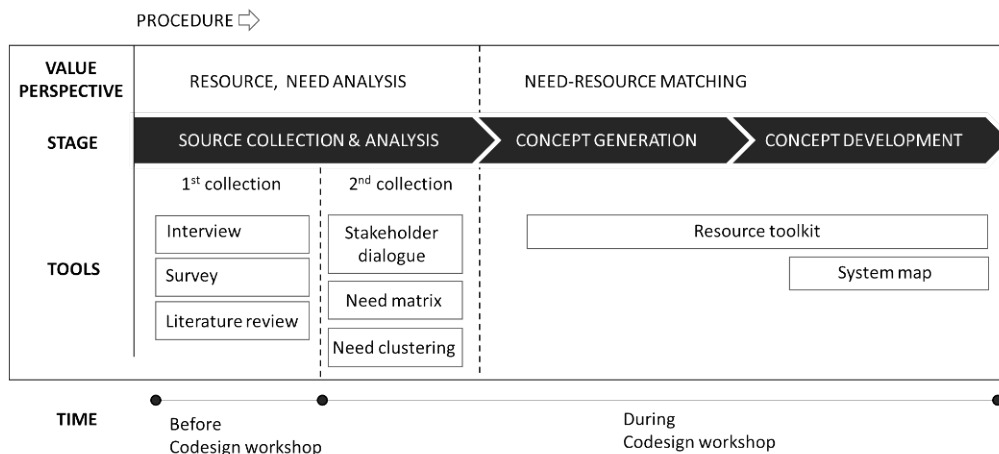

Figure 4 Process and tools for VCM

Model application

The Value based co-design model was applied to a workshop to promote sustainable food production and consumption in Ulsan, South Korea. The aim of the workshop was to develop community enterprise models in the form of PSS. Prior to the workshop, the project team conducted a preliminary investigation on the perception of the local food. Through interview and survey, the problems in the production and distribution were collected from producers; those in administrative support from officers in the local government; those in sales from distributor; and those in food purchasing process from consumer. The resource analysis was also conducted to identify potential resources in the region including their characteristics, needs and problems. Tangible resources identified in the case were local firms, local productions, farm land, administrative agency, agriculture training centre, community centres, community business centre, and direct trade market; Intangible resource included an online platform, social media, delivery service, application, community, enterprise, etc.; Human resources included local producer, public official, housewife, retail dealer, etc. The collected data was then developed into the resource toolkits including the information of available resources such as need, problem and characteristic as seen in Figure 2. These toolkits were then used to drive the idea generation during the co-design workshop.

The workshop involved various stakeholders such as consumer, producer, entrepreneur and administrator. There were four stakeholder teams consisted of different stakeholders, with the design process conducted respectively within each team. In the workshop, stakeholders discussed their stance and arranged their needs on the needs matrix as seen in Figure 3. Designers helped them to fill in the matrix while adding the needs driven by preliminary research. After arranging the needs on the matrix, stakeholders were asked to cluster those

which were associated to one another. Thus, needs were clustered to identify the relation between needs and find opportunity for need-resource matching.

The needs were matched with resources on the consideration of how the value could be exchanged between stakeholders. While matching the needs and resources based on the need and resource analysis, the ideas were generated. As seen in Figure 5a, resource toolkits were actively used to match with relevant needs. In addition to the existing resource cards, participants were able to create their own resource cards if necessary and use them during the concept generation. The participants described resources in blank cards with text and visual information.

(a)   (b)
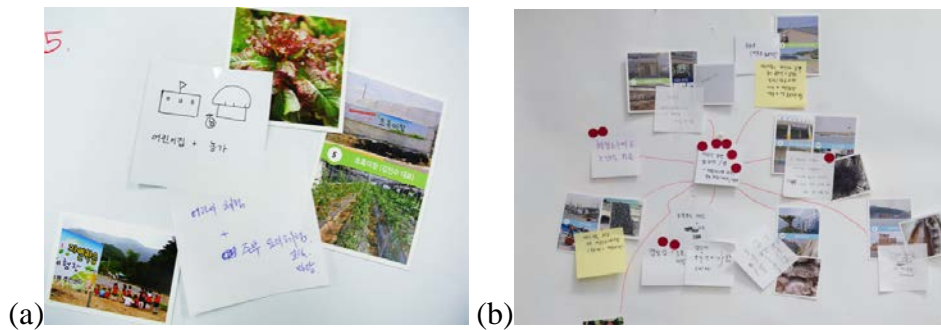
Figure 5. need and resource matching (a) and idea selection through voting (b)

To develop the ideas into combined ones, an approach to choosing the ideas was needed. Among the ideas based on value exchange, participants voted for the best ideas using stickers as seen in Figure 5b. The concepts were then further developed focusing on the main ideas which had the highest score. Based on matching the needs and resources, the ideas were combined and developed into a system. The idea generation was activated by using the resource toolkit and developed in a form of system map.

Results

In VCM, value exchange is a core concept to generate symbiotic solutions. For that, needs analysis becomes the starting point for finding the opportunity and resource analysis facilitates participants' ideation. The following section describes how the participants were engaged in needs and resource analysis, and concept generation and development during the value exchange process.

Need analysis

To find opportunities for need and resource matching, the participants were encouraged to identify the needs according to the need matrix and then cluster collected needs according to the similarity. It was found that the need clusters sorted by participants showed several patterns such as (1) common needs; (2) associated needs; (3) symmetric needs.

Common needs indicated the same need which stakeholders shared. As an example, the common need between producers was mutual exchange of farming related information or knowledge. Common needs were normally derived from the same stakeholders but even different stakeholders had common need. For instance, an example consumer needs was to

obtain appropriate knowledge of organic foods and producer's need toward the consumer also was that the consumer had a better understanding of organic food to promote their consumption. Like this, the different stakeholders could also have common needs even though the motivations of different stakeholders were often different.

Associated needs include the needs which are different but associated by some common theme. This pattern of need cluster was most frequently observed. For instance, consumer's need toward producer was diversity of agricultural produces in small quantities and producer's need was additional labour for selling product in diverse and small quantities. In this case, the common theme was diverse product in small quantity; another consumer's need toward producers was learning farming knowledge through experience while producer's needs toward consumers were activating farm tours. Their needs could be clustered around common themes of farming experience.

Symmetrical needs indicate the similar type of needs heading for each stakeholder. For instance, consumer's need toward producer was getting credible information of organic produces and producers' need was to obtain information about what the consumers' needs might be. As such, both stakeholders' needs were related to certain information which their stakeholders had.

Resource analysis and need & resource matching

In the ideation session for need and resource matching, participants were first encouraged to find the resource for direct exchange between stakeholders as approach for fulfilling each other's needs, based on the collected resources. For instance, producers wished to obtain useful agricultural information and were able to provide their own farming experience and knowledge as intangible resources in exchange. On this, stakeholders could exchange their resources from actor A to B in a direct way.

Some ideas were related to outsourcing resources because the stakeholders did not have capable resources to fulfil other stakeholders' needs. For instance, consumers had a need to buy various products in small portions, but producers could not have extra labour to fulfil their needs. In this way, the producer's need for labour was matched with the labour resource of elderlies, relieving them from their boredom in their village life. Producers gained value through a reduction of their burden of labour by outsourcing the bundle making job to elderlies in the neighbourhood. In this case, elderly people were engaged to procure a resource in need. There was another case of indirect value exchange through other stakeholder engaging in the same process of needs matching. For instance, there was a producer need for labour for a farm tour program. A student labour was derived as resource for this in that students were required to do community service obligatorily. In terms of value exchange, the need of the students was satisfying through credit. Producer did not have appropriate resources fulfilling student's academic need but the public certificate from administrative office was derived as alternative resource which had be value for the students. Local government has an authority to certify student community service and were willing to do it as it had common need with producers to activate local food businesses.

Concept development

We introduce two out of four concepts developed as the result of the workshop. The first concept from the workshop is entitled Neighbouring Farmers. There are three stakeholder groups exchanging values, consumer, producer and elderly people. It is a food box delivery service which periodically offers the harvests of local producers to neighbouring consumers based on subscription. In this community, the social media become medium enabling the producers more fluently communicated with their consumers so that they know their consumer's needs better; in the meanwhile, consumers were provided more information from producers or instantly provided feedback about their products. The produces are sold in a form of bundle package and the need of producers about labour for bundle making jobs was fulfilled by the elderly people nearby them. The elderly people provided their labour resource while obtaining the value of earning some profits and enhancing self-esteem. The community also involved several local producers and it becomes the platform where they could collaborate and exchange useful information.

The second concept is entitled, Farm mentoring centre, a mentoring platform providing consumers with producers' knowledge and farming experience. There are four stakeholder groups exchanging values, consumer, producer, local student and local government. This community consisted of several producers and various educational contents utilizing producer's own know-how and experiences for a farm tour program. The target group of mentors ranged from children to adults who were interested in farming or organic food. In this community, the capacities of local university students were used as useful resource. The need of producers to develop contents was fulfilled by local university students' unions, which had the capacity to develop contents and the need for extra farm tour labour. The university students participated as developers and helpers for mentoring and farm tour programmes. In return they received certain benefits for their service such as monetary profits or a certificate from local government which is helpful for earning credit in the university. Local government achieved its purpose of activating local food businesses by supporting the contributing participants. In addition, the farms made profits not only through the mentoring and farm tour programme, but also from the direct transaction of local food on the farm.

Discussion

The case study applying VCM has indicated how the PSS (Product Service System) solution idea was generated and the concept was developed based on value analysis. We discuss the benefits and effectiveness of VCM in terms of engaging stakeholders in co-designing symbiotic solution and the implications of its use.

Needs analysis as a means to discover opportunities for value exchange

Analysing stakeholders' needs becomes the base of discovering opportunity for value exchange. The needs matrix is characterized as a way of arranging needs considering directional aspects as whose needs towards whom, while the conventional way of need analysis (McKillip 1987) identifies one's need without much consideration of the directional aspect of the need. Through application, adding directional aspects in need matching was

shown to be beneficial to identify the interrelations between needs and find the opportunity for value exchange.

The association of needs were clustered as followings: (1) common needs; (2) associated needs; (3) symmetrical needs

These associated needs became the bases of ideation for resource exchange. In the case of common needs having the same purpose, it was revealed that participants were likely to find the opportunity within themselves and counterparts. In the application, the common needs were directed toward the same stakeholder. One of the examples was the producer and producer's needs for obtaining beneficial information from farming. The ideation for value exchange started from this associated needs and the opportunity was found between the stakeholders themselves, having rich information as potential resource. The associated needs with different purposes enabled participants to think about other sources from which they might obtain other resources. For instance, there existed a consumer's need for diversity of agricultural produces in small quantity and producer's need for labour for selling product in diverse and small quantity. Even though they had common theme of 'product in diverse and small quantity', there was a lack of capacity to fulfil these identified needs. Therefore the opportunity was likely to found from other stakeholders. In terms of symmetrical need, consumer's need for credible information of production and producers' need of consumer's need information were identified. Both stakeholders' needs related to sharing information were, in this way, directed towards one another. This symmetry provided an opportunity to think about exchanging resource between the stakeholders so that they were better able to fulfil their respective needs.

In these three types of associated needs, opportunities for value exchange were found. To fulfil these needs, the exchangeable resources were searched and sometimes the appropriate resources were found within the stakeholders. In this way, value analysis through VCM provided greater opportunities to understand how to generate the idea of value exchange by revealing the opportunity through identification of interrelation of needs between stakeholders.

Resource analysis as a means to facilitate stakeholders' ideation for value exchange

In VCM, the resource collection is critical in that the value exchange process depends on the identified resources. The resource was additionally collected in the need matching process and it determined which and how the values were exchanged. In this value exchange, two means of exchange, direct and indirect were identified. In direct exchange, two actors provided benefits to one another as A gives to B, and B to A while indirect exchange referred to instances of exchange where actors gave benefits to another and eventually receives benefits from another, but not from the same actor (Molm, Collett, & Schaefer, 2007). In our case study analysis, the most frequent means of exchange was identified as direct resource exchange.

In the ideation session for need and resource matching, participants firstly attempted to identify the resource for direct exchange between stakeholders in a way that best fulfilled each other's need, based on the collected resources and needs. However because of the limited resources, it appeared a challenge to exchange every resource in a direct way. If the

resource could not be exchanged in a direct way, further ideation for appropriate resource and need matching was required.

During the workshop, the resource toolkit was used to facilitate ideation by providing visual references for a resource pool. Not only the one prepared by the design team before the workshop, but also the resources added by the participants. The resources varied in types ranging from cultural, human, and physical resources. This process allowed the design team to harness the "knowledge of details" specific to time, place and events that are only available to the owners of a problem (Murray, 2009). The participants' comments after the workshop reflected the effectiveness of the toolkit in its ability to facilitate ideation. After the co-design workshop was completed, we conducted surveyed asking about how the methods influenced their ideation. All of the participants gave comments that the visual material made ideation easier and facilitated them to come up with new idea. Participants' qualitative responses were classified as followings: As the reasons, 32% of participants said that they could articulate their ambiguous idea into concrete one by watching the specific resource images; 13% stated they could find the new resources which they did not know before; 10% said that they could come up with new idea which they had never been thought. 6% of participants mentioned that they could derive more specific and realistic idea by utilizing available resources provided in the toolkit.

Integration of ideas into a PSS concept as a means to create mutual benefits

In VCM, the separated value exchange ideas are integrated and represented using system mapping. For instance, in the case of Farm mentoring centre, there was a value exchange between producer and consumer; producer and student; producer and local government; local government and student. Likewise, there were various needs from different stakeholders but they were combined in a symbiotic way creating mutual benefits. In that a symbiotic solution is built upon stakeholders' collaboration, the integrated concept needs to be developed with consideration of the stakeholders' collaboration network in a system.

Developing a PSS concept using system mapping enabled stakeholders to think about how they could play a role as a resource provider and also as a receiver in a system. The system map was useful not only in defining and describing the role of stakeholders but also describing what values are exchanged by them and how within a system to achieve a symbiosis. With the consideration of the mutual benefit of stakeholders and the service context, the value exchange ideas became elaborated and developed in a symbiotic way.

The implication of VCM

VCM is positioned here as a means to provide opportunities for co-designing of symbiotic solutions. The reason that mutually beneficial solution is challenging is because of the complexity of needs from various stakeholders. As such, VCM could be beneficial in handle those relationships by adopting the concept of value exchange. In this, the approach affords useful insights into how the various needs and resources of stakeholders could be integrated into a PSS producing mutual values. VCM also indicates ways of identifying opportunities for value exchange through in-depth need and resource analysis.

In terms of application, the value based design model is applicable to any service design or PSS design model which intends to build symbiotic relationship among stakeholder in a way that best provides mutual benefits. Social design area solving local problems in a symbiotic way is one example of the potential of the approach in a relation based service such as collaborative service (Meroni, 2007).

Conclusion

We suggested the Value based co-design model (VCM) as a co-design process for facilitating stakeholders to generate symbiotic solution producing mutual benefit. We introduced the means by which symbiotic solutions based on intensive need and resource analysis may be generated while engaging stakeholders' active participation. Through our presentation of a case study adopting the VCM approach, it was shown how participants were engaged and develop their ideation. Through resource and need analysis by using toolkits, they identified the needs and found the opportunity to match appropriate resource. The need-resource matching also facilitated them to develop concept. VCM systematically analyses needs and resources for value exchange by providing new perspective on resource exchange. Therefore the practitioners can uncover the potential resources for value exchange and create new economic, social, and environmental value.

However in applying VCM to our co-design workshop, there were some limitations. It was observed that some stakeholders already had some idea in their mind at the beginning of the workshop and adhered to their own idea rather than generating totally new idea. Even though the generative toolkits facilitated participants' ideation, some participants' fixed idea disrupted the development of more novel ideas. Methodologically, because ideation was based upon limited resources, value may be exchanged unfairly. If the exchanged values are considered unequally, it could decrease stakeholders' motivation to take part in the service system (i.e. high burden of labour vs. small amount compensation). Also, there appeared to be a lack of validation of this model as current assessment regarding effectiveness of applying the model relies on participants' subjective feedback.

For the further study, we expect to conduct more case studies of the application of the VCD approach and examine the efficacy of the model. The model could be more elaborated and developed through further applications.

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