COVALENT, a method for co-designing value exchange in community-centred design

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ABSTRACT

It is challenging to design for mutually beneficial relationships in a multi-actor service system when these actors have diverse and conflicting interests, and lack usable methods and tools that support the design process. This study introduces a novel method for co-designing value exchange (COVALENT). COVALENT integrates the value analysis model, co-design strategy and service design tools, to support the conceptualisation of reciprocal value exchanges based on the analysis of and matching between, stakeholders' needs and resources. Its perceived effectiveness was validated through application to the development of community business models in Ulsan, South Korea. This study contributes to the knowledge of co-design by providing a method for co-designing services that aim to achieve reciprocal value exchanges in the context of community-centred design and by discussing the effectiveness of that method as perceived by users.

1. Introduction

In a multi-actor service system, achieving mutual benefits among stakeholders is critical to the system's longevity. If we posit that any social behaviour is an exchange of goods (Homans 1958), maximising the reciprocal value of exchange is the primary reason for the continuation of such behaviour.[1] From the same perspective, perceived symmetry of value exchange influences one's willingness to maintain social or business relationships (Baek et al. forthcoming). Mutual benefits are thus critical to cooperation and collaboration in organisations. Cooperation occurs when one person or group helps another because the outcome of the act benefits both partners (Evans 2003). Collaboration is directed towards a mutually desired objective (Snow 2015).

An exemplar is community-supported agriculture (CSA), an alternative model for producing and distributing agricultural products in which consumers make a contract with local producers and pay at the onset of the farming season for a share of the anticipated harvest. In CSA, multiple actors collaborate for the common goal of promoting sustainable production and consumption of agricultural products. Successful CSA often consist

of a group of producers who work jointly to provide a variety of products that respond to consumer demands, and consumers who organise purchasing groups in order to form the critical mass necessary to implement the model. Above all, producers and consumers establish a direct network that shortens the supply chain and create environmental and social values as a result (Feagan and Henderson 2009).

Consideration of mutual benefits is particularly relevant in community-centred design. Community-centred design is a variation of user-centred design that focuses on a community as the beneficiary of design and considers the community as the agent of local change, and as a resource to be valorised and learned from (Meroni 2008; Meroni and Sangiorgi 2011). It aims to understand values and behaviours of the community as a whole and collaborate with it in conceiving and developing solutions (Ogilvy 2002; Jégou and Manzini 2008). In a community-centred design process, community members are often invited to participate in co-creating design outcomes so that these outcomes are better placed to achieve the mutual benefits of the involved actors beyond the fulfilment of individual needs.

Designing mutually beneficial solutions has been addressed in multiple domains. In design, various methods and tools have been introduced that engage stakeholders in the co-design process to ensure the results meet their needs (Hanington and Martin 2012). The roles of design aid tools vary from supporting participants to express their thoughts using visual aids (Lucero and Vaajakallio 2008); inspiring the participants' ideas by asking questions or showing cards (Baptista and Sampaio 2015); and motivating stakeholders using playful triggers such as role play games, Playmobil figures and drawing tools (Simsarian 2003; Vaajakallio and Mattelmäki 2014). Studies that have addressed reciprocal value exchanges between stakeholders have mainly consisted of case studies (Sanoff 2005; Cook 2011; Ssozi-Mugarura, Blake, and Rivett 2015).

In the design of product–service systems (PSS), which are integrated systems of products, services, supporting networks and infrastructure (Mont 2002), several methods and tools have been developed to describe and analyse stakeholder relationships (Van Halen, Vezzoli, and Wimmer 2005) and system requirements (Arai and Shimomura 2004; Burger et al. 2011; Baek 2014). For instance, system maps (Jégou, Manzini, and Meroni 2003), interactive storyboards (Manzini, Collins, and Evans 2004) and interaction maps (Morelli 2006), describe the relationships and interactions between the stakeholders. They are used to investigate stakeholder needs in service operation and how stakeholders interact and exchange resources.

Within marketing and business, win–win strategies or symbiosis have been increasingly emphasised in the context of corporate social innovation and sustainability. Related studies focus on theories and tools (MindTools 2017; Porter and Kramer 2011; Lenssen et al. 2013; Yang et al. 2014). For instance, value network analysis or value stream maps are used to analyse the current state of a value network and explore new opportunities (Allee 2008; Martin and Osterling 2014). Relevant to the design of mutually beneficial service systems, these studies provide useful theoretical and methodological approaches if combined with service co-design.

While co-design tools have the fundamental goal of supporting stakeholder symbiosis and democracy through design, we found a gap between the findings from stakeholder engagement and the design of service systems that ensure reciprocal exchanges. We thus developed a method for co-designing mutually beneficial service

systems with the involvement of stakeholders. Inspired by the principle of value exchange, ie the exchange of resources between stakeholders for industrial symbiosis (Yang, Rana, and Evans 2013), our method was named the *co-design method for value exchange* (COVALENT).

The principle of value exchange is related to social exchange theory in sociology. From a social exchange perspective, every social behaviour is an activity of exchange between two or more persons, whether tangible or intangible, and whether rewarding or costly (Crews 2010). When forming relationships, people exchange goods and services as well as emotional support and interaction. Value creation is considered the key purpose of all exchanges because people choose to stay in relationships when the exchange is beneficial (Honkanen 2014). Some studies in industrial ecology have utilised this principle of exchange with the aim of achieving industrial symbiosis and environmental sustainability. The concept of value exchange from the perspective of industrial symbiosis is defined as 'a collective approach for the physical exchange of materials, energy, water or products' between industries (Googins and Rochlin 2000). Companies can gain mutual benefits through value exchange because the waste or surplus of one company may be a resource for another (Frosch and Gallopoulos 1989).

Among the studies that suggest methodologies for generating symbiotic solutions between companies, Yang, Rana, and Evans (2013) provide a model called the value analysis model. The model provides a process for analysing stakeholder needs and resources that may have potential value for others. This process is divided into internal and external value analysis. Internal value analysis consists of analysing value wastes and value needs, where the former describes a surplus: a redundant value that exceeds requirements (eg under-utilised resources, over-supply of labour). By contrast, the latter is a potential recipient's need for the waste product. Internal value analysis aims to identify the value wastes and needs of both product and service. External value analysis is the process of analysing value wastes and needs of companies based on their individual internal value analyses. The value analysis process allows companies to identify the opportunities for value exchange with others by matching the needs and resources (Ibid.).

Building upon the value analysis model, COVALENT provides an approach to guide stakeholders to become actively involved in identifying their needs and designing service system concepts utilising available resources. In this paper, we introduce the process of COVALENT's use and validate its perceived effectiveness. In doing so, we address the following research question: how effectively does the method engage stakeholders in the co-design of mutually beneficial service systems? This study contributes to co-design knowledge with a methodological framework for finding opportunities for reciprocal value exchanges and develop mutually beneficial solutions in the context of community-centred design. We anticipate that COVALENT would be useful in designing services where the value of reciprocity is emphasised.

This paper is composed in the following order. Section 2 describes the process of developing the method; Section 3 introduces two case studies in which COVALENT was applied for validation; Section 4 discusses the benefits and limitations of the method; and Section 5 concludes with notes on the contributions of this research, future plans and the wider contexts to which COVALENT is applicable.

2. A method for co-designing value exchange

2.1. Method development

The value analysis model provides a conceptual model of the value exchange in a PSS design process. However, it lacks methodological details related to how this process may be implemented. For instance, it does not explain how the analysis results are fed into solution development. Neither does it describe if, and by what means, stakeholders become involved in the process. Stakeholder involvement is important because their knowledge is essential to identifying the value needs and potential waste in a value network.

Building upon the conceptual process of the value analysis model, COVALENT provides strategies and tools to engage stakeholders in co-designing mutually beneficial solutions inspired by co-design and service design knowledge. Co-design methodology can be described as the tools and processes employed to facilitate the collective creativity of designers and non-designers collaborating in the design process (Lee 2008; Sanders and Stappers 2008). It is adopted to engage stakeholders throughout the design process and to facilitate concept generation. Service design methodology is used as a means to analyse the needs and interactions of stakeholders and design solutions in the form of a service system. COVALENT consists of three steps: (1) need and resource analysis, (2) need and resource matching and (3) concept development. Table 1 compares the value analysis model with COVALENT.

In the COVALENT approach, we have replaced the term 'value waste' with 'resource', ie a resource that is available for value exchange. In the value analysis model, value wastes are determined by the current value propositions and surpluses such as under-utilised or over-supplied resources (Yang, Rana, and Evans 2013). However, through the application of the COVALENT approach, we discovered that in some contexts, it is more challenging to define what the value wastes would be. There are no criteria for judging waste and the perception of the same resource differs from person to person. We also use the terms 'need and resource analysis' and 'need and resource matching' instead of 'internal value analysis' and 'external value analysis', respectively. In community-centred design, community assets are an important resource that affects the competitiveness of any solutions. However, consideration of the commons is missing in the notions of internal and external analyses, and only the companies' private resources are taken into account. To avoid any complications, we have removed the distinction between internal and external values, and treat them as either needs or resources.

Table 1. Comparative table of VAM and COV.

	Value analysis model	COVALENT
Process	(1) Internal value analysis	(1) Need and resource analysis
	(2) External value analysis	(2) Need and resource matching
		(3) Concept development
Resource identification and analysis	Conducted by the stakeholders	Conducted by the design team and the stakeholders
Outcome	A conceptual model of mutually beneficial value exchanges for sustainable business models	A methodology to design mutually beneficial solutions for sustainable service systems

2.2. Design tools in COVALENT for the co-design process

2.2.1. Stakeholder dialogue

Stakeholder dialogue is a tool for exchanging views by providing opportunities for all stakeholders to give advice or express their opinions on solutions from multiple perspectives and diverse knowledge bases (Wahl and Baxter 2008). Sanoff (2008) argues that 'real' consensus comes about as a result of adequately agreed-to outcomes attained through a dialogue where differences are creatively explored. Such a dialogue can happen through a process of co-sensing, where people listen to each other's perspectives. It takes a certain attitude to be constructive together, including agreeing to suspend judgement, being honest and trying to build on each other's ideas (Buur and Larsen 2010).

To design solutions that provide mutual benefit to stakeholders, it is necessary to focus on the views that stakeholders agree or disagree about, and facilitate further reflection on them among the stakeholders themselves.

2.2.2. Need matrix

The need matrix is a tool that enables the collection and arrangement of needs according to their direction (Baek 2014). As seen in Figure 1, the need matrix consists of X and Y, with stakeholders positioned against the two (eg axis X: producer, consumer, contributor; axis Y: producer, consumer, contributor). Thus, the matrix aims to identify the needs among and towards the stakeholders. For example, in Figure 1, 'N11' is the need of stakeholder S1 towards stakeholder S1. The need matrix was adopted because it makes the needs of the stakeholders visible as a holistic picture in a systemic way, indicating directions along which to identify needs between stakeholders. By contrast, a conventional needs analysis (McKillip 1987) identifies a party's needs with little consideration for the directional aspect of the need. Identifying the direction of a need was considered useful for our objective of searching for value exchange opportunities, as it allowed us to uncover the interrelations between needs.
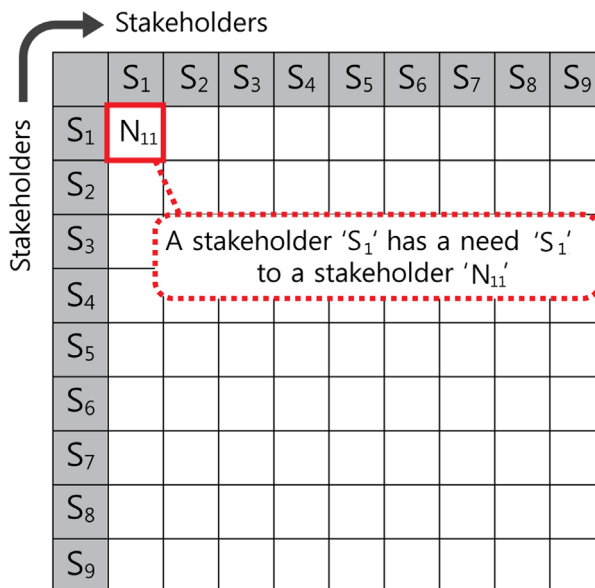

Figure 1. Needs matrix (derivative reproduction).

2.2.3. Affinity diagram

The affinity diagram, also known as the KJ method, was devised by Kawakita Jiro in the 1960s, with the aim of organising a large number of ideas into their natural relationships. It is effective for identifying patterns and establishing related groups that exist in data-sets (Shafer, Smith, and Linder 2005). It was thus adopted during the needs analysis process to support participants to organise stakeholders' various needs and look for patterns which could be useful for identifying value exchange opportunities. The affinity diagram was used in the following order: (1) The needs were randomly placed on the board, (2) the needs that seem to be related were sought, (3) the needs were sorted into groups, (4) the process (2)–(3) were repeated until no more groups could be formed, (5) the groups and sub-groups were represented with keywords.

2.2.4. Resource cards

Cards are a useful means not only to engage participants from non-design fields in the design process, but also to inspire their ideas (Halskov and Dalsgård 2006). Based on the finding that card sorting facilitates the expression and organisation of potential ideas (Sanders, Brandt, and Binder 2010), the resource cards were invented. They show the visual and text data of available resources in the form of cards. They support stakeholders in describing and organising their ideas for mutually beneficial solutions, taking into account the resources available and potentially useful to them. These resources are categorised as tangible, intangible and human resources (Grant 1991; Tukker and Tischner 2006). Tangible resources include natural resources and man-made artefacts; intangible resources include social, cultural and technological resources; and human resources include individual labour, talents and capabilities. Figure 2 shows an example of each type of resource card designed for this study. The tangible resource cards included underutilised spaces, historic buildings, production facilities, farms, agriculture training centres, community centres and other physical assets that were of potential use to address the identified problems. The intangible resource cards included the cultural heritage, technologies, knowledge and other intangible assets for value exchange. The human resource cards included individuals and organisations who could be considered for partnerships in the new service development. They included local producers, public officials, retail dealers, unemployed women, local bakeries and local community/social enterprises among others.

Figure 2. Resource cards.

2.2.5. System map

For the visualisation and development of value exchange ideas, the system map was adopted. The system map is a visual description of actors, components and the flow of material and immaterial resources in a service system (Jégou and Joore 2004; Morelli 2006). The map explains how the whole system works by describing the flows of financial, informational and material resources between the actors.

We considered the system map useful for the following reasons: first, it is relatively intuitive to read with items represented through colloquial language and simple icons, thereby lowering the barriers to adoption among non-design experts in a co-design process (Morelli 2006). Second, it allows the description of the resource visually together with the potential input and output of each stakeholder in the service system, which is relevant to the description of needs and resources in the value exchange. Third, our empirical evidences show that people not only describe but also conceptualise and make decisions about the service system while using the system map. This is similar to the argument that prototyping is a thinking process as much as a making process (Brown 2005). We thus anticipated that the tool would help people develop their value exchange concepts.

3. Application

3.1. Introduction to case studies

COVALENT was applied to two case studies in Ulsan, South Korea. These studies were sponsored by the district office, and aimed at building sustainable community enterprise models that address communal problems in the region that mutually benefit stakeholders. Each case study consisted of a series of co-design workshops: four workshop sessions in the first study and three sessions in the second (Table 2).

In the first case study, the co-design workshops were conducted with the aim of promoting the production and consumption of local food in the Ulsan city area. An interdisciplinary team consisting of a sustainable designer, a service designer, a business consultant and research assistants majoring in design and management experts was organised to prepare and run the workshops. Participants among the local food stakeholders were recruited from the region through online and offline channels. A total of sixteen people were recruited and

Table 2. Structure of case studies.

	Case study 1	Case study 2
Aim	To develop sustainable local food business models	To develop community enterprise models that respond to problems in the region
Preparation	• Preliminary study • A pilot study	• Preliminary study • A pilot study
Workshops and activities	• Workshop 1-1 Identifying local food-related problems and stakeholders' needs • Workshop 1-2 Ideation based on need and resource matching • Workshop 1-3 Building community enterprise models by synthesising the ideas • Workshop 1-4 Revision and evaluation	• Workshop 2-1 Identifying problems and stakeholders' needs related to the issue • Workshop 2-2 Ideation based on the need and resource matching • Workshop 2-3 Building community enterprise models by synthesising the ideas and evaluation

grouped into four teams. Each team consisted of a producer, a consumer, an entrepreneur and a public officer from the district office. Three people — one producer, one entrepreneur, and one public officer — dropped out after the first session. The teams were also assigned with a moderator and note taker (research assistants involved in the project).

Before the workshops, a small-scale pilot study was conducted to assess any potential problems with the process and settings. Four people representing producers, consumers, entrepreneurs and public officers participated in a 6-h workshop and explored the implementation of the co-design process. The main workshops were conducted four times over a period of two weeks, with each workshop lasting for 3 h. In the beginning, a short tutorial introducing the concept of community enterprise together with success cases were provided, and the project goals were shared among the participants. During the first session, the participants explored local food-related problems and identified stakeholders' needs. They then generated solution ideas based on need and resource matching. These ideas were synthesised and further developed in the form of community enterprise. At the final stage, the models were refined and delivered to the business consultant and service designers for refinement and evaluation.

The second case study followed the format of the first, but with an open theme and a shortened duration. The change in format was requested by the district office which wanted to organise workshops on other issues with less time and management resources. As a result, a lean version of the method was developed. Unlike the latter which had a specific focus, the former had an open theme, the participants proposed the topics they wanted to tackle such as raising children in healthy learning environments and improving the quality of life of senior citizens living alone. There was also a greater diversity in the participant composition including housewives, teachers, retired seniors, entrepreneurs and agricultural producers. A total of 16 people participated, divided into 4 teams according to their interest in the issues. Six research assistants with design, engineering and/or management majors participated as moderators. Three-hour workshops were held once a week for three weeks. The process was identical to the first study except that the revision and evaluation which had been held at the fourth workshop were shortened and moved to the third workshop.

In both studies, the design team conducted a preliminary study before the workshops to identify local resources, and developed resource cards for idea generation. During the workshops, stakeholders were encouraged to generate value exchange ideas guided by moderators, and to develop business models based on these ideas using the design toolkit. At the end of the workshops, participants were surveyed to assess the effectiveness of the co-design process and toolkit. The entire workshop series was recorded in audio and video, with each team's outcomes collected at the end of each session (need matrix, affinity diagram, resource and need matching map, system map).

3.2. Process

The COVALENT process consists of three stages: (1) need and resource analysis, (2) need and resource matching and (3) concept development (Figure 3). At the need and resource analysis stage, interviews, surveys and literature reviews were conducted in order to identify stakeholders' needs related to the issue, together with the resources available to the stakeholders. The results were later presented at the co-design workshops so that participants could be informed about the context of design before engaging in the actual design process.
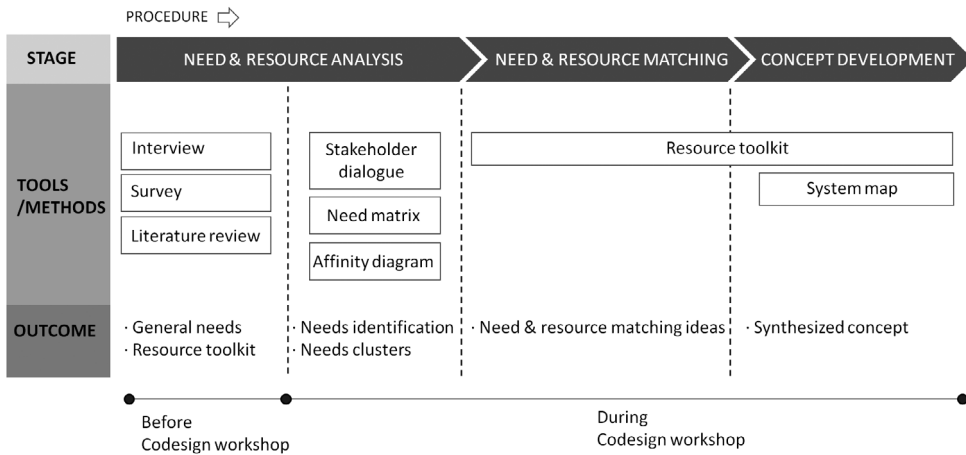
Figure 3. Tools and outcomes according to each stage of COVALENT.

During the workshops, the participants identified their own needs using stakeholder dialogue, and analysed them using the need matrix and affinity diagram. At the need and resource matching stage, the stakeholders' needs and local resources using needs were matched using Post-it notes and resource cards. Solutions that address these needs using the available resources were brainstormed and further developed into community enterprise models. These business models were visualised using the system map.

3.2.1. Need and resource analysis

At the initial stage of the need and resource analysis, a preliminary study was conducted by the design team prior to the co-design workshops. The preliminary study aimed at: (1) identifying the stakeholders of the local food business in the region, (2) collecting qualitative and quantitative data on the stakeholder needs, (3) identifying the local resources available and potentially useful to the stakeholders and (4) promoting the workshops and recruiting participants. To this end, the design team surveyed 20 producers and 172 consumers, and interviewed on site 7 producers, 1 distributor and 1 public officer. The team also conducted an analysis of local resources through site visits and literature reviews. The scope of resources included both private and public. Since a community enterprise is an organisation 'run by a community as well as for a community' (Locality 2015), community assets were considered as a valuable resource, and the local district, which permits the utilisation of these assets, an important stakeholder. The results of the preliminary study were synthesised in a report to be shared during co-design.

The co-design workshops began with an introduction describing the purpose and process of the event. This was followed by a tutorial which presented to the participants the preliminary study results. Then, teams were made and assigned with a moderator and a note taker. The participants began introducing themselves and shared the problems related to local food production and consumption. After defining a common problem, the participants discussed their specific needs related to it. This step was further broken down as follows. (1) The teams noted down their needs on Post-it notes. They also indicated on the notes whose needs they were and whom they were directed to. For instance, if a need was directed from a consumer to a producer, they labelled it as 'consumer → producer'. (2) Notes were

then stuck onto the need matrix. Each stakeholder used a Post-it note of a different colour. (3) The needs organised on the matrix were photographed for record and then rearranged thematically using the affinity diagram. Figure 4 illustrates an affinity diagram developed during the workshop.

3.2.2. Need and resource matching

During need and resource matching, the stakeholders brainstormed ideas to fulfil the identified needs in a mutually beneficial way using the available resources. The participants
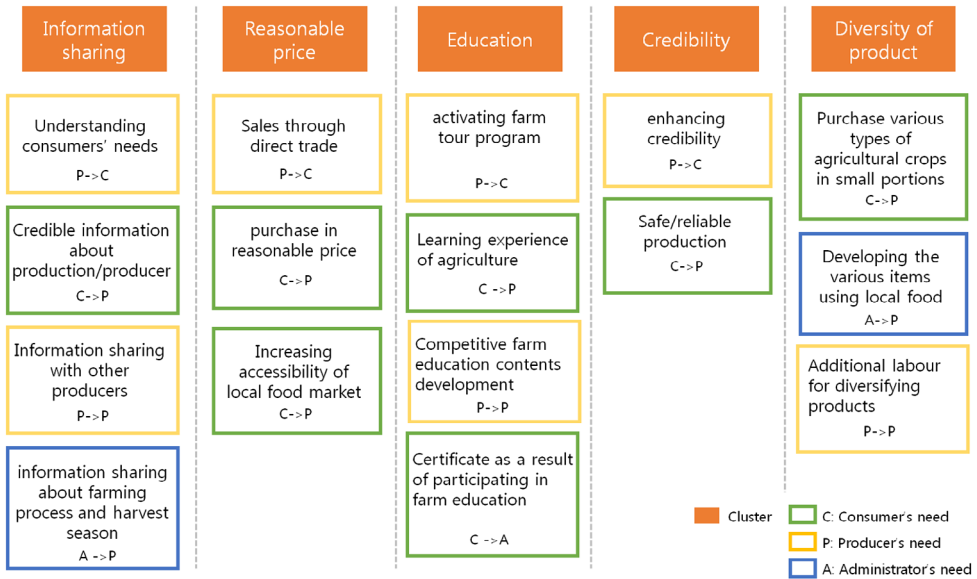

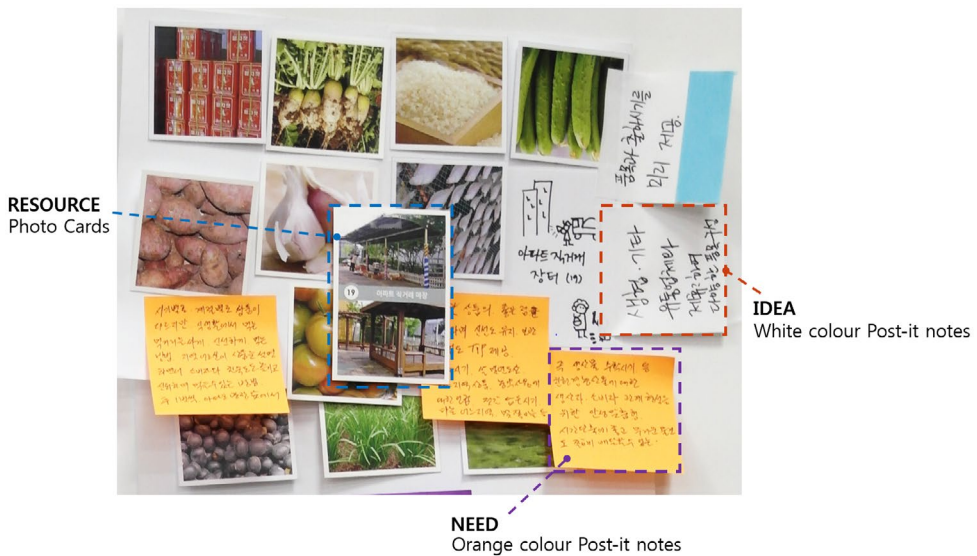**Figure 4.** An excerpt of the results of the need clustering.

Figure 5. Idea generation based on need and resource matching.

described their ideas next to the matching of the needs and the resource cards (Figure 5). If there were any resources missing in the cards, they were added to the pool using empty cards. If a need could not be fulfilled with the available resources, outsourcing was considered. The following examples illustrate the matching process.

- The consumers wanted credible information about the products they consume, while the producers wanted to be informed about consumer demands. In response, the participants brainstormed a direct communication channel between the two groups using social network services through which producers uploaded production information, such as what and how they were producing and when the production period would be, and consumers asked questions related to production or provided feedback on the produce.
- Another need of consumers was to purchase diverse agricultural products in small quantities. However, this was a burden on the producers because they then needed extra labour to package the bundles, which they did not have. To address this issue, participants proposed utilising elderly people in the village who might be interested in earning an additional income. As a result, consumers could purchase the local food bundles, and producers would diversify the sales channels, while the elderly could exchange their labour with the value of increased income and self-esteem.
- Some producers were interested in developing farm tour programs that can attract consumers and increase the awareness of local food consumption. To design programs that are unique and respond to consumer needs, they decided to collaborate with local universities. The university students would participate in developing competitive programs and in return get paid or obtain a certificate from the district office which is accredited by the universities as voluntary work. As a result, producers and students would exchange their resources, the district office supports the local food industry, and the universities provide more options of voluntary programs to the students and contribute to reinvigorating the local community.

3.2.3. Concept development

In this stage, the solution ideas from the previous stage were developed into business concepts. In each team, the participants selected the better ideas through voting, and synthesised them into a business model. The system map was used at this point to determine who would participate and how they may exchange values, and finally to visualise the service system (Figure 6). The moderators with the experience of using the tool led the visualisation process, while the participants made decisions on how the resources would be procured, which stakeholders would join the business and how to attract them, and what resources they would exchange. The participants also built and tested their cost and revenue models assisted by the business consultant and the research assistants.

4. Result and discussion

4.1. Perceived effectiveness of COVALENT

The method was validated by asking the participants about the effectiveness of the tool in co-designing mutually beneficial solutions. This perceived effectiveness does not reflect the
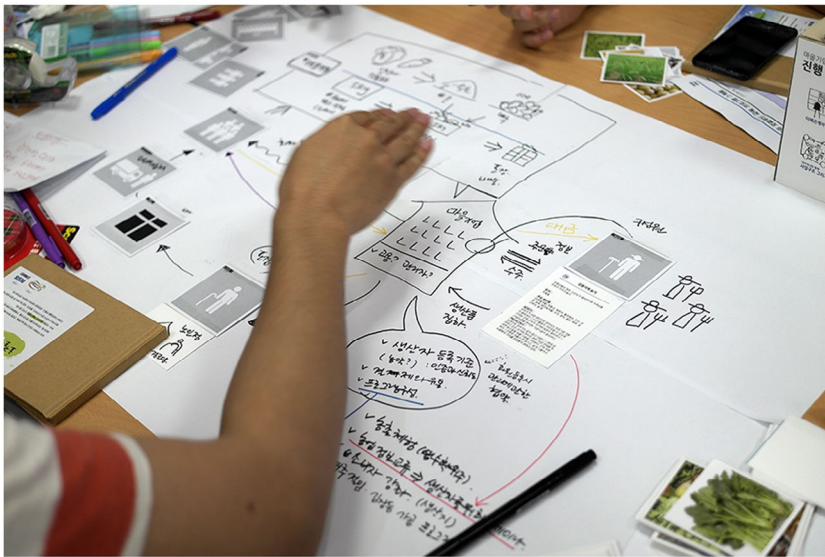
Figure 6. Idea development through system mapping.

level of mutuality in the value exchanges of the proposed business models. We think that measuring the mutuality in a service system requires further work beyond the scope of this study. We thus concentrated our efforts upon measuring the perceived effectiveness, and indicate the usefulness of the proposed method. A survey was conducted with the workshop participants at the end of the second case study, to find out if the need and resource analysis, and the need and resource matching, were useful for the concept development of mutually beneficial solutions. The survey also identified how and in what ways they were useful. Sixteen out of 28 participants responded.

4.1.1. Need and resource analysis

The two tools used in this stage — need matrix and resource cards — were evaluated. Sixteen participants responded that the need matrix was useful for the idea generation. Eleven explained that it expanded their understanding of other stakeholders' perspectives ($n = 7$), and provided rich information about stakeholder needs when they generated ideas ($n = 4$). We observed that the need clustering had not only allowed the participants to organise the various needs of different stakeholders but also led to new opportunities for value exchange. Clustering similar needs seemed to make it easier for the participants to discover further connections between them. Through collective thinking, they then identified possible value exchange scenarios. For instance, in the cluster titled 'education', there were the needs of a consumer to provide her children with experiences in farms (and nature) and of producers to attract people to their farm tour programs with novel contents. Among the resources were the local university students who could bring fresh ideas for the farm tour program. The idea that eventually developed was a rural mentoring centre composed of five organic farms in partnership with a local university research lab that produces educational content about the farm tour programs. In this exchange, the centre generates a revenue by selling the educational content to local farms. The farms sell the farm tour experiences and their produce to consumers, the consumers then receive the education from the farms and the

university students are provided with a remuneration and/or acknowledgement of their voluntary activities certified by the district office.

Sixteen participants replied that the resource cards were helpful for idea generation. Ten of them explained that: the card tool helped them come up with more specific and realistic ideas by utilising the resources indicated on the resource cards ($n = 3$); they discovered and utilised local resources that they had not known before ($n = 2$); the cards were helpful in stimulating new ideas ($n = 2$), and the cards helped them generate feasible ideas by utilising the resources available to them in their region ($n = 3$). Among the responses stating that the tool was not helpful, there was an opinion that it did not provide enough information about local resources. We speculate that this is in part due to the design team's lack of knowledge about the locality (none in the team were from the region) and the limited information it can obtain during the preliminary study. Alternatively, the design team could utilise the knowledge of the local people by engaging them in the discovery of the resources. For instance, senior people may play the role of a knowledge reservoir for their communities, or the distributed knowledge combined with information communication technologies can empower open map making (http://opengreenmap.org).

4.1.2. Need and resource matching

Fifteen people replied that the process of need and resource matching helped them generate ideas. Nine of them explained the following reasons: the process was very specific, which made the idea generation easy ($n = 5$); the resources and needs were presented in visual forms, so they could match them effectively ($n = 3$); and the matching process functioned as the connection between problem and solution ($n = 1$). The survey results indicate that the resources and needs matching process supported the idea generation by making the process specific and easy to follow with contextual and visual information. However, matching needs and resources was not always straightforward and sometimes challenging. This happened for instance when a participant could not locate from the resource cards the resource that directly fulfilled their needs. We have two suggestions to overcome this. Firstly, the design team may add more resources to the database so that the participants have more options to consider. However, adding more resources also has the counter effect of increasing the participants' cognitive load during the resource and need matching. Secondly, the participants may identify a new actor(s) who possesses the resource in need and is willing to exchange it in return for the resource in the pool. This requires a creative process to brainstorm new value exchange opportunities. The latter case was observed during the workshop 1-1 when a group of producers and consumers wanted to establish a direct sales network. The consumers needed a variety of agricultural products in small quantities, while the producers were used to selling a limited number of products in bulk. The entrepreneur in the group, who was also one of the producers, suggested inviting more producers from other regions to diversify the products, and to utilise the elderly people in his village to package the products in small quantity. He argued that his would then fulfil the needs of both the producers and the consumers, and generate economic values for the elderly as well.

4.2. Strengths and weaknesses of COVALENT

Based on the concept of value exchange that was developed to achieve industrial symbiosis and sustainability, COVALENT aims to support the design of mutually beneficial solutions

in the context of community-centred design. Mutual benefits or symbiosis in multi-actor service systems is important for both sustainable business and society. When we develop these systems, whether it is a company or a community, their sustainability depends on our understanding of and designing for, the interdependence between system actors (Senge, Smith, and Kruschwitz 2008). However, taking into account the needs and perspectives of various stakeholders and coordinating them towards design goals, increases the complexity of problems and solutions as compared with considering those of specific stakeholders (eg service providers, customers). Theories, methods, tools and cases that support the design of the systems enabling mutual benefits are thus needed. This background is also aligned with the fundamental principle of co-design, ie to ensure that design outcomes meet the needs of all stakeholders (McArthur 2014).

COVALENT has several advantages. It provides tools to engage stakeholders in developing mutually beneficial solutions. It expands value exchange ideation by encouraging the utilisation of under-used or under-recognised resources possessed by (potential) stakeholders. It also contributes to value co-creation by supporting stakeholders in conceiving ideas which better leverage value exchanges in a more direct and reciprocal way. By establishing a closer network between stakeholders, the method facilitates a reduction in unnecessary use of resources. In addition, COVALENT contributes to forming new social and business ties by inviting new stakeholders to the service system. In this study, the design team and the workshop participants explored the potential of local resources and stakeholders to generate solutions that are viable in the local context, and in doing so, discovered new stakeholders. For instance, people such as the senior citizens or local university students who had not previously been considered as stakeholders in the local food system were discovered and included in the service systems.

Validation of and reflection on the method has also revealed some limitations. We speculate that there is a methodological gap between the ideas resulting from the resource and need matching, and viable service concepts. In this study, this gap was filled by the expertise of the business consultant. An approach to fill this gap with a more structured process of concept development will make the method more useful. We also observed that during idea generation, the participants were reluctant to add new resources to the pool created by the design team. A strategy to harness the locals' knowledge to reinforce the resource pool during the co-design workshop is thus needed. For instance, a creative session to make resource cards using keywords or referential examples. Lastly, COVALENT would benefit from a consideration of the dynamic nature of multi-actor service systems. Multi-actor service systems are dynamic because the stakeholder relationships are contingent in nature, their needs and resources are subject to change and so is the surrounding environment. The effectiveness of mutually beneficial services is hence subject to change over time. Community enterprises thus need to constantly monitor stakeholder needs, available resources and opportunities for new partnerships, and plan their service strategies accordingly. For this reason, we cautiously suggest that COVALENT be run repeatedly, especially when there are significant changes in the service environment. The effectiveness of the repeated use of this method remains to be validated in a future work.

While COVALENT is a co-design method, it does not start with a co-design process: the professionals first conduct the need and resource analyses. The data collected from the literature reviews, site visits, surveys and interviews with stakeholders are

used as input for the co-design activities. In our preliminary study, the COVALENT approach strengthened co-design outcomes by generating a more comprehensive dataset than individual opinions at the workshop, delivering more objective information with richer contents for the resource cards. We find preliminary interventions useful when the co-design process requires inputs beyond the scale the participants can provide. However, we also think that some parts of this step, if not all, can be reinforced by the involvement of stakeholders and supporting tools as evidenced by existing projects. For instance, we mentioned earlier a case in which the distributed knowledge of locals was harnessed into the collection and representation of local resources using a map making platform. In another case, citizens report, view and discuss local problems using an online platform (http://www.fixmystreet.com). Having scope for improvement, we do not position COVALENT as a finished method. Instead, we anticipate further work that will continue to develop the method by adopting, for example, new activities and tools that support design for mutually beneficial solutions.

5. Conclusion

COVALENT suggests a practical approach to the design of mutually beneficial solutions by adopting the notion of value exchange in co-design processes. Case studies adopting the method in the development of sustainable service systems illustrate how participants can be engaged in developing their ideas into community enterprise models. The validation of COVALENT is limited as the current assessment relied on the participants' perception and the design team's observation of the effectiveness of the tools during idea generation. Future works include reinforcing the method by applying the model to different contexts and measuring the level of mutuality in a value exchange. The latter is related to the evaluation of mutually beneficial solutions, and includes the development of criteria by which to evaluate the design outcomes generated by co-design workshops.

Despite these limitations, this study enriches the knowledge of co-design with a methodological guide to finding opportunities for reciprocal value exchange and developing solutions based on the systematic need and resource analysis. While this study introduces COVALENT in the context of community-centred design, it is also applicable to the design of any services that aim at achieving a reciprocal value exchange among multiple stakeholders. The method of identifying and designing for value exchange extends the applicability of co-design to designing solutions involving collaboration between stakeholders and/or end users. We expect COVALENT to be particularly useful in the design of services which aim to achieve mutual benefits and reciprocal relationships between stakeholders. For instance, community services, social innovations or sharing services. Enhancement of the perceived reciprocity and the resulting satisfaction in the value network would contribute to the sustainment of these services.

Note

1. We define value broadly as anything that has the potential to be of worth to stakeholders (Harrison and Wicks 2008), and value exchange as the exchange of tangible and intangible resources that are considered of worth to stakeholders in a service system.

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