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An impactful crowdsourcing intermediary design - a case of a service imagery crowdsourcing system

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Abstract Crowdsourcing is usually implemented using an intermediary organization or directly coordinated by solution seekers. For those using an IT-based crowdsourcing intermediary, the important factors of intermediaries that impact the crowdsourcing outcome are yet unclear. In addition, little research was conducted on how to design a crowdsourcing intermediary that can address the combined challenges of considering different cognitive demand levels of solution providers' contributions, combining contributions and evaluating contributions. This paper identifies three important factors and provides a novel design of crowdsourcing intermediary to cope with these challenges. This study uses a case that focuses on how to assist small and medium businesses (SMBs) to develop their service imageries in triggering service innovation and designing their service experiences as to fulfill the desired outcomes of customers. Through the case, the benefits of our crowdsourcing intermediary design are demonstrated and justified. The three important factors are the crowdsourcing intermediary knowledge base, generative networks and empowerment of crowd members. This study shows that the crowdsourcing process can facilitate achieving a higher chance of attaining creative solutions for SMBs' innovation problems when the three factors are well incorporated and managed within the crowdsourcing intermediary design. This study also presents a novel design of crowdsourcing intermediary that can address the combined challenges of coping with different cognitive demand levels of crowd members and combining and evaluating crowd members' contributions, in order to attain impactful crowdsourcing outcome.

Keywords Crowdsourcing intermediary · Service imagery · Service value · Information system design · Open innovation

1 Introduction

Crowdsourcing refers to a process of leveraging the expertise of a wider pool of individuals or firms across different disciplines or sectors in the form of an open call format through the web, in order to accomplish functions that were traditionally performed by only a few specialized people (Howe 2006; Howe 2009). Marjanovic et al. (2012) proposed a conceptual model of the crowdsourcing process, including input, process, output and outcome. The inputs include problem specifications or advertisements of innovation challenges arising from solution seekers (i.e., users) and the identification of potential solution providers (i.e., crowd members). The process involves managing and coordinating the leveraging activities across multiple crowd members (that might play different roles in the crowdsourcing process with different reward structures). The outputs are the potential solutions and rewards for the solution providers. The output can generate benefits such as increased firm operation productivity, greater economic wealth, improved quality of life, collective social well-being, or sustainable environment, in accord with different purposes of a variety of crowdsourcing applications.

Crowdsourcing is often carried out using an intermediary organization or directly coordinated by solution seekers (Marjanovic et al. 2012). The first example is the Amazon Mechanical Turk (https://www.mturk.com/mturk/) that is an Internet crowdsourcing marketplace (i.e., an intermediary organization) that enables individuals or businesses (i.e., the users as called Requesters) to co-ordinate the use of human

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intelligence (i.e., the crowd members as called Turkers) to perform tasks (called Human Intelligent Task, HIT) that computers are currently unable to do. That is, its generated benefits rest on increased firm operation productivity. Requesters can ask that Turkers (anywhere in the world) fulfill certain qualifications for the given HIT. Payments for completing tasks can be redeemed by bank monetary transfer or Amazon.com's gift certificate (i.e., the reward structure), in which Requesters pay Amazon a 10 % commission for successfully completed HITs. The second example is FixMyTransport (http://www.fixmytransport.com/) that was an intermediary organization using the power of the community crowds using British public transport to notify operators of problems with bus, rail, tube or ferry services, leading to the improved quality of public transportation system with the government's support although it was closed since February 2015. The third example is Domino's Ultimate Delivery Vehicle design contest (an intermediary directly coordinated by Domino) started in August 2012 asking consumers to help design a better Domino's delivery car (TrendHunter Marketing 2012). This kind of contests are corporate marketing tools that market their brand name to a wide audience and engage them in a fun, involved and interactive way of acquiring their ideas.

Although applications of crowdsourcing are still in the formative stage, Whitla (2009) mentioned that firms have begun to utilize crowdsourcing for marketing-related tasks, such as product development, advertising and promotion or marketing research. Castillo et al. (2013) proposed a credible crowdsourcing information cascade for disaster management situations where many event news and rumors may arise. Abrahamson et al. (2013) exemplified different business models of firm crowdsourcing systems utilizing different open resources such as influence (e.g., commenting, reviewing), assets (e.g., collaborative consumption), capital (e.g., crowd funding or lending), data (e.g., big data), and labor (e.g., open innovation). Simula and Ahola (2014) also addressed four crowdsourcing configurations (internal crowdsourcing, community crowdsourcing, open crowdsourcing and crowdsourcing via a broker) for firms operating in networked contexts to facilitate their innovation processes; in particular, for crowdsourcing via a broker these brokers should offer value-added services that can mobilize knowledge to empower the participants in the crowdsourcing process.

Agafonovas and Alonderienė (2013) advocated that the upcoming trend of crowdsourcing-driven organizations is to create value especially for small businesses (SMBs) lacking funding for conventional forms of innovation or development. They emphasized the importance of dedicated crowdsourcing intermediaries that can facilitate value exchanges among a modest quantity of possible crowd members and stakeholders on behalf of SMBs.

However, Doan et al. (2011) identified the challenges of developing amenable crowdsourcing information system (IS), such as considering different cognitive demand levels of solution providers' contributions, combining contributions and evaluating contributions. Contributions of low cognitive demand levels mean easy contributions (e.g., answering a question with small efforts). They emphasized that further research is required to investigate issues such as contributors' breadth and quality, engagement of crowds to create value, the combination and evaluation of the contributions of crowd work, providing value-added services to existing crowds. In this study, we argue these challenges are actually correlated and could be examined within the design of crowdsourcing intermediaries in terms of investigating the factors that influence the impact of crowdsourcing intermediaries.

To cope with the challenges of considering different cognitive demand levels of solution providers' contributions and combining/evaluating contributions, the research purposes of this study are two folds: (1) Identify the factors influencing the impact of crowdsourcing intermediaries (Section 3) (2) Design a novel crowdsourcing intermediary system (Section 4) addressing these factors to attain amenable crowdsourcing outcome using a case demonstration and evaluation. The intermediaries referred in this study include ones used for crowdsourcing marketplace, community or contest, using the configuration of crowdsourcing via a broker (offering value-added services that can mobilize knowledge to empower the participants of different cognitive demand levels in the crowdsourcing process requiring to combine/evaluate contributions). However, this study won't discuss the issues like the organizational interventions required on the implementation of crowdsourcing (Saxton et al. 2013; Lüttgens et al. 2014). This study's novelty is to provide a systematic approach to the development of crowdsourcing intermediaries, considering those correlated factors and various IT-enabled affordances.

This study uses a case study of crowdsourcing intermediary system implemented to provide service innovation directions (called service imagery that will be described in Section 2) for agricultural leisure SMBs, where service innovation works toward improved customer value co-creation (Vargo and Lusch 2004). This system is developed as a crowdsourcing intermediary for service imagery creation that can facilitate the imagery co-developing process among those SMBs and their crowd members, creating more meaningful and customer-centric service imagery. Agricultural leisure SMBs' image formation relies on the destination image, the cooperation among SMBs and the accumulated tourists' experiences that could be regarded as the potential crowd members. The design of our crowdsourcing intermediary system features the consideration of the cognitive demand levels of crowd members and the combinations/evaluations of contributions. Through the evaluations of simulated experiments and field demonstrations using the system (Section 5), the influences of these factors can thus be justified.

This paper focuses on designing an impactful crowdsourcing intermediary and thus the remainder of this paper is organized as follows. Section 2 provides a brief

background about service imagery. Section 3 describes the three factors influencing the impact of a crowdsourcing intermediary. Section 4 presents our crowdsourcing intermediary system design. Section 5 is the evaluation phase intended to verify the factors' impact. Section 6 provides some implications, followed by suggestions for future work and conclusions given in Section 7.

2 Background of service imagery

As global competition intensifies, the focus of innovation has shifted from s product emphasis to emphasis on service experiences. Service-dominant logic (Vargo and Lusch 2008; Lusch and Vargo 2014) emphasizing value co-creation has been regarded as a new paradigm of continuing evolution toward innovation, in which service value is characterized as idiosyncratic, experiential, contextual, meaning laden, and uniquely determined by the customer (i.e., a customer-centric value). In addition, Strijbos (1995) and Barile et al. (2012) addressed the importance of system thinking by referring to the configuration of a system of entities to co-create value, produce innovation opportunities and comprehend market behavior in uncertain conditions. Spohrer et al. (2008) mentioned that a service system represents a value co-creation configuration of people, technology and value propositions connecting internal and external service systems, and shared information in order to achieve customer-centric value. A service system creating advances in customer-centric value can make competition irrelevant by opening up entirely new markets (Chan and Mauborgne 2005; Borgianni et al. 2012).

To further the examination of customer-centric values, Boztepe (2007) identified the three main approaches to the definition of value - value as exchange, value as experience and value as a sign. Value as exchange means that value is the monetary sacrifice that customers are willing to make for a product or service. Value as experience means that value is the result of the interactions between what the product/service provides and what the customers bring in terms of their goals or needs. For value as a sign, value is viewed as communication (certain messages and images independent of their use) and acted upon by products/services, and the range of benefits (social psychological, cultural or environmental) that products/services provide to customers including ends such as prestige, identity, style or image (Baudrillard 2006; Bourdieu 1984; Veblen 2001). Baudrillard (2006) addressed that value as a sign often disrupts the other two value approaches. In addition, Verganti (2009), Norman and Verganti (2014) also emphasized similar concept that the it is important to radically change the emotional and symbolic content of products (i.e., their meanings), through a deep understanding of broader changes in society, culture and technology, toward radical innovation.

In the traditional marketing domain, communication, maintaining dialogue and connecting with target customers through brand image is an important issue (Gardner and Levy 1955; Aaker and Biel 2013). Enterprises concentrate on building brand image to differentiate themselves from their competitors (Oxenfeldt and Swan 1964; Roy and Banerjee 2014; Hwang and Han 2014). Recently, the notion of service imagery (Hsieh and Yuan 2012a) has extended the capacity of brand image to consider the feelings associated with service innovation, value as a sign, and service system design.

Service imagery refers to a meaningful statement that can be proposed to customers as a set of values such as the emotional, psychological, socio-cultural or environmental dimensional consumption going beyond the utilitarian perspective of the classic economic model (Hsieh and Yuan 2012a). An example of service imagery is the expression statement as "paradise-like place". This statement indicates the service experience is like being in paradise that is characterized with the service features being both emotional and environmental. In addition, service imagery can also describe customer preferences that can be regarded as human images affecting their decision making in terms of goals and value cognition and strategy planning (Beach 1990). Service imagery is also different from advertising slogans. Advertising slogans refer to short and memorable set of words used in advertising campaigns to draw attention to some distinctive feature of a corporate product (Sharp 1984). They are often connected to product functional benefits defined from the provider's perspective, instead of the customer perspective as advocated in service-dominant logic that emphasizes the benefits are uniquely determined by customers and evolved over the time.

A meaningful service imagery statement can be computed and formulated into a set of social psychological image attribute words described as a set of emotional adjectives. These adjectives have been assigned into a Color Emotion Image Scale (Kobayashi 1991). For instance, the service imagery of "paradise-like place" can be computed and formulated into a set of social psychological image attribute words {nice, prosperous, idyllic, beautiful, sweet, comfortable, great, plentiful, perfect, wonderful, unique, lovely, etc.}. With the Color Emotion Image Scale, these image attribute words can then be computed, compared and combined based on the mapping relations between the emotional words and the colors that can be represented with quantitative values using standard colorimetric systems such as the RGB color model or CIE color space (Yang and Yuan 2010).

The notion of service imagery enables service value to be represented by using images that can be analyzed and created based on customer feedbacks. With appropriate analysis of customers' experiences, images can disclose service features and propose the value of a service value network. When service value represented by using image attribute words is continuously analyzed and updated based on customer feedback, the outcome of service experiences continues to accumulate service imageries for describing the services co-created by customers and businesses.

The role of service imagery is not only to serve in value communication but also to promote the elements, resources, and value outcomes being created by a service value network design (Hsieh and Yuan 2012b). Service imagery can exist in the service design and experience process. The identification of service imagery for services, businesses, and environments can help configure both functional and customer-driven types of value network design. That is, service imagery can play a generative and active role for stakeholders in a value network and open up innovation opportunities for stakeholders.

On the other hand, SMBs are important entities which have contributed to economic miracles in many countries because the proportion of SMBs in business is comparatively high in these countries such as Italy, Japan, China, Taiwan. In order to provide extraordinary service for customers, many SMBs are "transformed enterprises" attempting enterprise-level change and implementation (Valerdi and Nightingale 2011). However, it has been widely recognized that SMBs have limited resources and capability to trigger innovation or transformation, though their building of brand image in recent years has increased noticeably. However, the majority of research related to SMBs business transformation has focused more on adoption of e-business technologies to support the business operation management in face of external pressure or employ online advertising to strengthen their brand image as a way to achieve commercial success (Taylor and Murphy 2004; Ifinedo 2011). There has thus far been relatively little research on how SMBs can build their brands from the service innovation perspective, i.e., creating service imageries to promote the meaning and essence of SMBs' services (services embodying particular imageries) and configuring value networks to collaboratively acquire or create markets. As for the extent to which these service imageries are an approximation of the value perceived by customers, it is not within this paper's scope owing to space limitation.

This study adopts the crowdsourcing approach to SMBs' service imagery creation mainly due to the cost-effective benefits of gaining access to a wide pool of experts and stakeholders (including customers) who can solve the innovation challenge of creating suitable SMB service imagery.

3 Factors influencing the impact of crowdsourcing intermediaries

As mentioned in Section 1, prior research about crowdsourcing lacks the integrated investigation of the factors that influence the impact of crowdsourcing intermediaries. We argue there are three important factors that would influence a crowdsourcing intermediary's impact (Fig. 1). The simple reason behind these factors' choice rests on how to effectuate the management of crowdsourcing process and crowd members with various IT-enabled affordances on the cognitive, action and motivation.

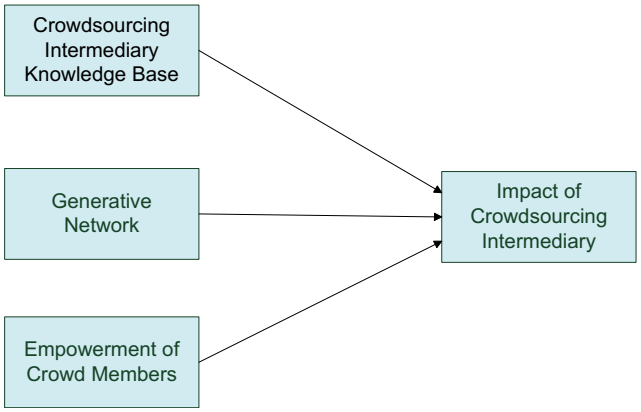


Fig. 1 The three factors that affects the impact of a crowdsourcing intermediary

This paper's focus will be resting on the development of impactful crowdsourcing intermediaries and use a case to demonstrate the impacts. (Further future empirical research can be conducted to develop relevant theories involving these factors).

Factor 1 (crowdsourcing intermediary knowledge base) The first factor that affects the impact of a crowdsourcing intermediary is crowdsourcing intermediary knowledge base, which is defined as the need for a crowdsourcing intermediary to be able to suitably manage a knowledge base that can facilitate the value co-developing journey of crowd members from the aspect of IT-enabled affordances on the cognitive, action and motivation. Since this study consider those intermediaries that use the configuration of crowdsourcing via a broker (Simula and Ahola 2014) offering value-added services that can mobilize knowledge to empower the participants in the crowdsourcing process. Accordingly, a design, construction, and management of an effective infrastructure to support knowledge acquisition and management can make important contributions to the realization of viable knowledge-based organizations (Holsapple et al. 1996). In addition, Feller et al. (2012) addressed a crowdsourcing brokerage should offer services that can mobilize knowledge by helping solution seekers to specify their problems. Crowdsourcing can accordingly be viewed as an organization of the dynamic boundary needing the knowledge-based infrastructure to process the acquiring of the crowd members' contribution knowledge and combining/evaluating their contribution knowledge. The first argument is thus be made as follows:

> The better the management of a crowdsourcing intermediary knowledge base is, the more efficient the crowdsourcing process is and the higher the impact is.

Factor 2 (generative networks) Feller et al. (2012) addressed that crowdsourcing brokerage should offer services that can find an appropriate set of crowd members who can learn or derive

enjoyment from attempting to solve the problem. The second factor affecting the impact of a crowdsourcing intermediary accordingly refers to a generative network, which is defined as the need for a crowdsourcing intermediary to be able to dynamically identify suitable boundaries of crowd members within which they would be willing to interact with one another in a user's dynamic context. Such identification and interaction often lead to amenable outcomes from the aspect of crowd member management. Busquets (2010) regarded a generative network as the optimum combination of resources by a multi-disciplinary network for innovation and co-creation. Innovation happens in an optimum condition when network behavior is orchestrated to engage in co-creative activities. Co-creative activities refer to bringing interpreters into the co-developing journey, such as business partners, end customers, and domain experts, to boost communication and exert autonomy. The interpreters can include people who are directly involved in the production and investigation of social meaning, such as artists, sociologists, marketers, the media, technology suppliers, designers, research institutions, or firms in other industries. (Verganti 2009; Jepsen et al. 2014). The second argument is thus made as follows:

> The better the management of the generative networks of interpreters is, the more amenable the outcome of the crowdsourcing process is and the higher the impact is.

Factor 3 (empowerment of crowd members) Feller et al. (2012) addressed that the viability of crowdsourcing brokerage rests on the continued participation of solution seekers and providers. The third factor affecting the impact of a crowdsourcing intermediary is the empowerment of crowd members, which is defined as the need for a crowdsourcing intermediary to be able to achieve power transfer from a central body to crowd members in order to sustain their continued participation from the aspect of crowdsourcing process management. Service Dominant Logic (Vargo 2011; Vargo and Lusch 2004) addressed the importance of empowering service system entities in order to engage them in value co-creation. Self-determination theory (Deci and Ryan 2000) suggests that supports for competence, autonomy and relatedness are essential to better implement a power transfer process. Accordingly, the perceptions of supports for competence, autonomy and relatedness drive individuals' actions (Deci and Ryan 2000). This is analogical to the situation that crowdsourced workers responding to customer requests result in greater task satisfaction because the empowerment of greater decision authority and access to customer-relationship information (Ichatha and Ellen 2013). The third argument is thus made as follows:

> The greater the empowerment of the crowd members in regard to competence, autonomy and relatedness is, the more effective the value co-creation of the crowdsourcing process is and the higher the impact is.

Impacts of crowdsourcing intermediaries To this point, we have described the factors of crowdsourcing intermediary influencing the crowdsourcing process and outcome, assuming the crowdsourcing intermediary is IT-based. We have done this to simplify the exposition of the factor model (Fig. 1) and emphasize significance of IT, as well as to address the rich potential for future IS researchers to investigate recent crowdsourcing movements. Abrahamson et al. (2013) also addressed different types of potential impacts such as influence (e.g., commenting, reviewing), assets (e.g., collaborative consumption), capital (e.g., crowd funding or lending), data (e.g., big data), and labor (e.g., open innovation).

4 A case of service imagery crowdsourcing system

This study designs a novel crowdsourcing intermediary system as a case used to demonstrate and evaluate the influences of the aforementioned factors on a crowdsourcing intermediary's impacts. The design of the crowdsourcing intermediary system is a design research (Hevner et al. 2004) that involves the design of novel or innovative artifacts for a better grasp of a problem. Our proposed design aims to resolve the different cognitive demand levels of crowd members and combine/evaluate contributions. The system is developed in accord with the aforementioned factors within the service imagery application. Through the simulated experiments and field demonstrations of the system, the influences of the factors can be justified.

This case focuses on how to assist SMBs to develop their service imageries in triggering service innovation and designing their service experiences as to fulfill the desired outcomes of customers. Considering the lack of ability of SMBs to development service imagery and the benefits of crowdsourcing in acquiring other actors who can enhance the effectiveness and efficiency in co-developing the service imagery, this study proposes a crowdsourcing service imagery creation framework that considers imagery co-creation and generative networks. We have also implemented the crowdsourcing service imagery system. By co-creating and co-producing service imagery in an open innovation style, the expected impacts of the crowdsourcing intermediary are to facilitate the co-creation of service imageries that are more unique/creative for SMBs as well as more feasible for SMBs than for other competitors.

A few assumptions behind this case include: (1) Our crowdsourcing service imagery system is an anytime algorithm, which means the co-developing journey could break off anytime and output the current potential problem solutions (i.e., service imageries). (2) The service imagery evolves session by session during the crowdsourcing process. (3) The

focal SMB represents the central crowdsourcing network which can determine the boundary of the solution providers (also called interpreters/actors in this study) engaged in the service imagery co-developing journey.

4.1 A crowdsourcing intermediary design

Figure 2 presents a design of a service imagery crowdsourcing intermediary, in which there are three main modules (Default Imagery Reasoning Module, Network Boundary Module, Co-Developing Module) and one knowledge base (Imagery Bank) as described below:

- Imagery Bank: Imagery bank is a knowledge base (i.e., relevant to Factor 1 of Crowdsourcing Intermediary Knowledge Base) that aims to facilitate the whole co-developing journey as an important co-creation resource that can grow over time to ensure its diversity and richness. That is, the imagery bank is a source of service innovation that plays an important role in supporting, mediating, and dealing with the interactions among interpreters/actors.
- Network Boundary Module: The objective of the network boundary module is to identify which network level of the SMB should be included in the co-developing process for potential interpreters (i.e., relevant to Factor 2 of Generative Networks). However, the network boundary should be delimited according to certain rules/patterns of context. This module applies the rule of commitment (Busquets 2010) to compose a network, compute the proper network boundary and send invitations for proper interpreters/actors to cooperate/co-create service imagery. The system also devises a heuristic to associate interpreters to commitment levels in accord with their cognitive demand levels, for finding an appropriate set of crowd members who can learn or derive enjoyment from attempting to solve the problem (Feller et al. 2012).
- Default Imagery Reasoning Module: After analyzing the contextual information related to SMB competences, relationships and cultural behaviors, this module can take the default imagery from the imagery bank as the status quo of the SMB's service imagery in terms of computing the similarity scores between the SMB contextual adjective descriptions and representative imageries descriptions from the imagery bank (i.e., relevant to Factor 3 of Empowerment of Crowd Members).
- Co-Developing Module: The co-developing module aims to facilitate the SMBs and the interpreters to co-create/co-produce/co-develop imagery in the system. In the co-developing process, the actors are empowered to provide their ideas about imagery (which are also stored into the imagery bank), and the system can combine, suggest, conflict-negotiate and recommend imagery to the focal SMB (i.e., relevant to Factor 3 of Empowerment of Crowd Members).

4.2 Imagery bank

When a service imagery is applied to a service system, it implies that the configuration of people, organization, value

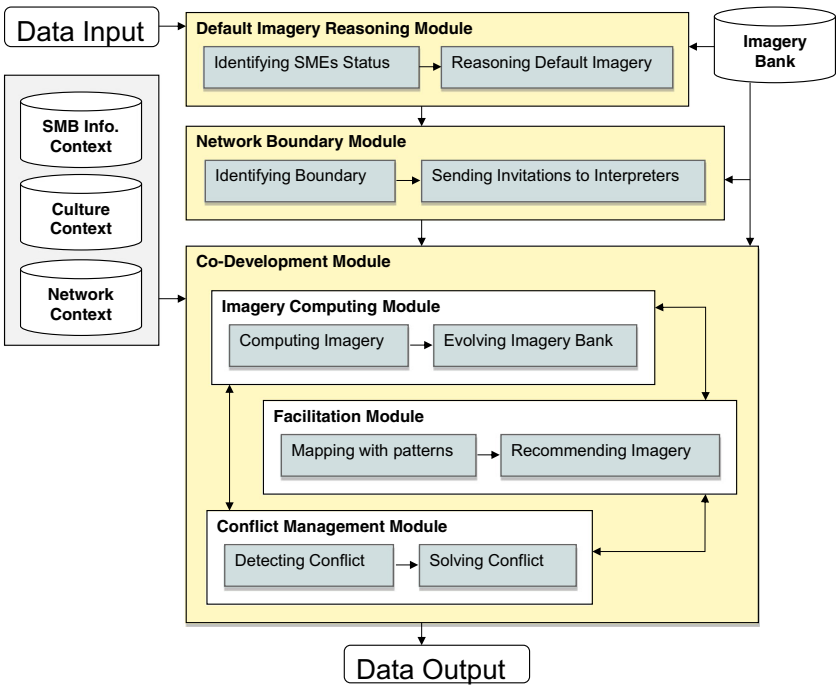


Fig. 2 The framework of service imagery crowdsourcing

propositions and their relationships manifest some particular forms of service delivery toward service innovation. That is, a service imagery can characterize the customer-centric value delivered by a service system and its system entities. Figure 3 shows the ontology of the imagery bank that is extended from the traditional brand image model (Keller 1993).

Each service imagery in the imagery bank has two parts: the first part refers to the attributes that include a SMB's direct-competency-related imagery (i.e., competency which describes the SMBs current status quo or their service features that surpass other competitors) and non-direct-competency-related imagery (i.e., interaction patterns with business partners and customers). The second part refers to the benefits that put the user value concept into practice and include different kinds of product perception values in the customers' minds. The constitution of each concept is shown in Fig. 3 (i.e. interaction pattern, competency, functional, experimental and cultural) and the traits/characteristics of each can be viewed as the meta descriptions and initial materials of the concept modeled in the imagery bank.

For non-direct-competency-related imagery, there are three types of the value: (1) functional value is the value that appears after customers find out about the SMB's service competency (2) experiential value is the value that is derived after or during the period in which customers experience the services, (3) cultural value is the value that the customer feels when the SMB brings its own cultural context into designing the service experiences and delivering them to the customer.

For direct-competency-related imagery, Street and Cameron (2007) developed a concept model that describes the characteristics of external relationships that influence the management processes/strategies/performances of small businesses. It contains four types of characteristics: (1) individuals characteristics, (2) organization characteristics, (3) relationship characteristics, and (4) environmental characteristics.

The imagery bank aims to facilitate the co-developing process, and also grow over time in terms of its diversity and rich materials, as explained in Section 4.1.

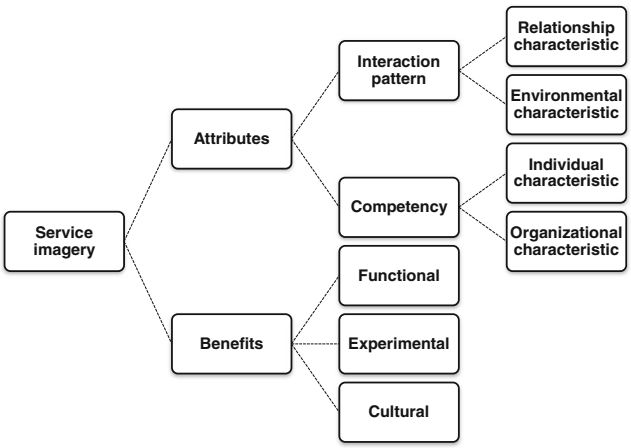


Fig. 3 The ontology of imagery bank

4.3 Network boundary module

There are two sub-modules. The first one identifies the boundary of a proper network level according to the interaction label from the previous information input. The second one sends invitations to interpreters in order to link the network and the possible interpreters by confirming who is included in the co-developing process. The boundary identifying sub-module is described as follows.

Haakansson and Snehota (1989) pointed out that no business is an island by using a network concept from the business strategy perspective. A network model involves bounded organizational entity that can exchange resources and values continuously within an environment, organization and entities. A service system also configures different entities or even different service systems to guide a network toward service innovation (Busquets 2010). In this study, the network not only plays the role of identifying possible partners and customers in the co-developing process, but also distinguishes the possible target customers or business partners to compose an entire service system. However, the network is not a fixed, unchanged network. It might expand or shrink depending on time or other context factors, which means that there is a kind of boundary for the network. This boundary might be determined based on the relationship between actors and entities in accord with their varied commitments.

Busquets (2010) presents a framework of modes of commitment for innovation as shown in Fig. 4. There are three commitment modes including digitally enabled commitments, co-creation and new dominant business logic. Digitally enabled commitments represent the basic status constructed by the rules set for digital platforms. Co-creation adds more autonomy that lets the actors search for complementary resources. New dominant business logic is related to a dominant design which can lead to a new innovation path. To connect commitment and network orchestration and to propose our network boundary setting, this study applies the rule of the commitment addressed by Busquets (2010) to compose a

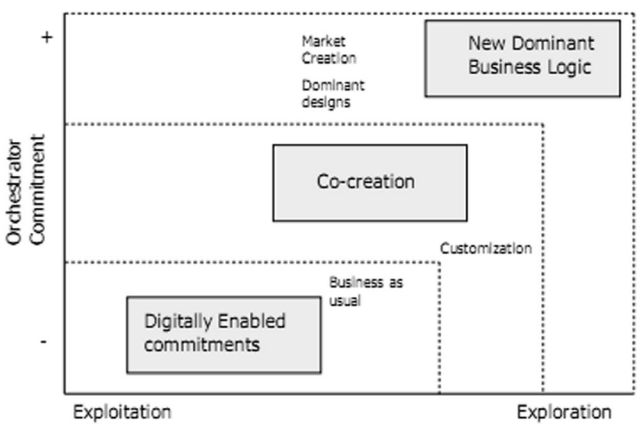


Fig. 4 Modes of commitment for innovation. Source from (Busquets 2010)

network. Different commitment modes require different cognitive demand levels of interpreters. That is, the boundary of a network interpreter can be identified according to the desired commitment levels.

To understand the commitment level of an interpreter, for the sake of simplicity, this system classifies interpreters into four types (reward, curiosity, joiners and creators) along two dimensions (extrinsic motivation and intrinsic motivation) as shown in Table 1. Extrinsic motivation and intrinsic motivation represent the motivations for joining the co-developing process. That is, the interpreters join the process to meet some basic demand or in the spirit of fulfillment. In addition, we assume the brand concept in the interpreters' mind influences their contribution in the co-creation process. The dimensions of "less important" and "important" distinguish interpreters according to their attitudes towards the knowledge of the service imagery and indicate whether an interpreter regards the knowledge of the service imagery to be important or less important to service innovation.

When each interpreter enters our system, the system classifies the interpreter into one of these four types based on their registration information. Each co-developing process might have different network boundaries, and different types of interpreters receive invitations from different co-developing processes.

4.4 Co-developing module

This module contains three sub components that are designed to cope with the possible conditions in the co-developing process - the Imagery Computing Module, Facilitation Module and Conflict Management Module.

4.4.1 Imagery computing module

The purpose of the imagery computing module is to compute/evaluate the proposed imagery from the co-developing process and increase the size of the imagery bank when necessary. When the system starts a co-developing process, the default imagery can be seen by every interpreter in the session. The interpreters propose suitable imageries that are recommended to the focal SMB as their service innovation imagery. After the proposal procedure in each round, the imagery computing component evaluates the proposed imagery by mapping it into the imagery bank and identifying the existing ontology position of the proposed imagery. If the proposed imagery does not belong to the imagery bank and most of the interpreters view the proposed imagery as an important imagery (i.e., the voting weight is over the threshold) because it could better represent service innovation imagery for the SMB, the evolving imagery bank component is triggered to insert the proposed imagery into the imagery bank. The imagery computing component and evolving imagery bank component are described below.

Table 1 Four different types of interpreters

	Extrinsically	Intrinsically
Less important	Reward	Curiosity
Important	Joiners	Creator

The imagery computing component figures out the closest imagery in the imagery bank. Each proposed imagery is transferred into a series of imagery attributes through Google API (Veale and Hao 2007). These imagery attributes are then mapped into the imagery bank materials by semantic similarity analysis. We apply DISCO API to retrieve the semantic similarity between arbitrary words (Kolb 2008). It outputs a semantic similarity score. A higher score represents higher semantic similarity. If the score is over a specific threshold, the imagery attribute can be tagged as matching and recorded.

In the end of the matching process, if half of the imagery attributes are tagged as matching in the imagery bank, this proposed imagery is recorded as existing in the imagery bank so that the system knows the recommended imagery position for the interpreters in the imagery bank. If the tagged imagery attributes do not exceed the threshold, but more than half of the interpreters vote for the proposed imagery, the evolving imagery bank component is triggered. That is, the evolving imagery bank component adds this proposed imagery into the imagery bank. The proposed imagery is represented with a new meta description in the imagery bank. By decomposing the meta description into the target and vehicle, the proposed system then retrieves more materials through Google API to enrich the descriptions of the proposed imagery.

4.4.2 Facilitation module

The facilitation module is built for recording the interaction preferences of the SMBs and recommending possible imagery according to their interaction preferences. The interpreters present a proposed imagery for the SMB. When an interpreter proposes an imagery, the system computes the semantic similarity between the proposed imagery and the representative attributes in the imagery bank; if the similarity surpasses a specific threshold, the system recommend imageries that contain the same adjectives as the proposed imagery to give the interpreters more ideas. This autonomy also increases the competency of interpreters.

There are two components in the facilitation module. The preference mapping component records and computes the semantic similarity of the chosen imagery. When the calculated semantic similarity exceeds a given threshold, the system recommends the mapped meta descriptions as the imageries that

exhibit frequent appearances in the co-developing process, as recommended by the imagery recommending component.

4.4.3 Conflict management module

The conflict management module aims to resolve the problems which arise when the proposed imagery and the current focal imagery are too divergent. The system defines a conflict as a condition where the imageries proposed by the interpreters are too dissimilar to the current imagery. After computing the semantic similarity, a score is given. For a dissimilar imagery, the score is lower than a specific threshold. Such conflict not only means the opinions of the interpreters are different or even contradictory, but also reduces the efficiency of the co-developing process. Thus, this module is designed to play the role of an automated mediator in order to coordinate the ideas of the interpreters and resolve the condition of divergent imageries.

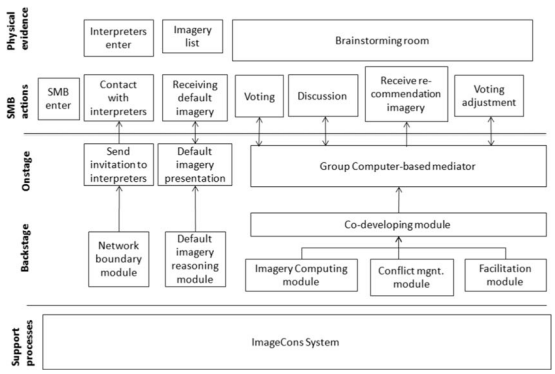
The components of this module are as follows: the conflict identifying component detects the gap between proposed imageries and the current default imagery. If the gap goes beyond the threshold (i.e., the semantic similarity is low), the system does not trigger the imagery computing module, rather, the conflict management module deals with the conflict.

Compromise is one method of handling human conflict (Tessier et al. 2006). This method deals with conflict through negotiation between opponents. This study applies this concept to design a conflict management method to obtain a common consensus between interpreters by figuring out the center of the distance. When the proposed imagery has low semantic similarity, the interpreters might have completely different ideas for the SMB. After identifying the distance between the proposed imageries, the system computes a new imagery by analyzing the materials in the imagery bank and finding an imagery positioning in the middle of the conflict imageries (i.e., an imagery that has a higher semantic similarity). This autonomy also increases the relatedness of interpreters.

5 Case evaluation

We implemented the service imagery crowdsourcing system (e.g., Fig. 5a) that aims to facilitate SMBs in triggering service innovation through an imagery-based approach. Figure 5b provides a service blueprint showing the interactions between SMBs and our system in terms of the practical workflow of interactions between SMBs and the system's modules within the onstage and backstage processes. For the evaluations, with the developed system we conducted the simulations and did the field interviews. That is, the evaluation phase is intended to assess the system through a series of simulated experiments and field demonstrations in order to justify the arguments made in Section 3.

(a) An exemplar screendump of our implemented crowdsourcing system



(b) The service blueprint that shows the interactions between SMBs and our system

Fig. 5 The implemented crowdsourcing system and its service blueprint

Since the proposed factors influencing the crowdsourcing intermediary's impact are the first of their kind, it is difficult to find related crowdsourcing systems to use as a benchmark. In IS research, the utility, quality, and efficacy of a design artifact must be manifested rigorously via well-completed evaluation methods (Hevner et al. 2004); simulation experiments and observational field studies are popular evaluation methods. Consequently, our evaluation phase at the system level is unfolded in two ways (simulated experiments and field interviews) to collect and analyze the evaluation data and to attain findings. In our case evaluation, there will be three sets of experiments, each of which aims to examine the relationship between a factor and the impact of the crowdsourcing in accord with the factor conceptual level (Fig. 1). Before detailing each set of experiments, we will provide the descriptions of those experiment parameters used for the simulation experiments.

5.1 Parameter design for simulation

As follows, we provide descriptions of a set of simulation parameters, mainly borrowed from the information retrieval domain (Powers 2011), for our simulated experiments.

- Recommendation Index

Since our system is implemented through recommendation, interpreters and SMBs get some recommended imageries (in the facilitation module) during the co-developing process. Evaluation in existing recommendation systems is conducted by considering precision and recall performance (Oard 1997). In this study, we apply two recommendation indexes (equations (1) and (2)) and define the variables used in the formulas based on Table 2. In the conflict management module, the detecting rate is the recall rate and the solving rate is the precision rate.

$$Recall\ (\%) = \frac{Found}{Found + Miss} \tag{1}$$

$$Precision\ (\%) = \frac{Found}{Found + False\ Alarm} \tag{2}$$

Note: *Found* is what the system recommends and SMB also accepts the recommendation.

Miss is what the system doesn't recommend but SMB would accept it if recommended.

Table 2 Variables of recommendation index

	SMB's selection	
	Accept recommendation	Reject recommendation
System recommend	Found	False alarm
Don't recommend	Miss	Correctly rejected

False alarm is what the system recommends but SMB rejects the recommendation.

- Evolving Index

As mentioned in Section 4.2, the imagery bank grows and evolves in the co-developing sessions. The evolving times represent how many imageries have been newly inserted into the imagery bank. For example, assuming that the imagery bank initially has 100 imageries, after the co-developing process, the total amount of imageries in the imagery bank could increase to 150 imageries. That is, the index of Evolving Times is then 50. Thus, to observe changes of the imagery bank, we define the evolving related indexes as shown in equations (3) and (4).

$$\textbf{\textit{Evolving times}}(\textbf{\textit{Eti}}) = \textbf{\textit{total amount of the newly added imageries in the imagery bank during a session i}} \tag{3}$$

$$\textbf{\textit{Evolving times avg}}\ (\textbf{\textit{times}}) = \frac{\textbf{\textit{Et}}1 + \textbf{\textit{Et}}2 + \textbf{\textit{Et}}3 + \ldots..\textbf{\textit{Etn}}}{\textbf{\textit{total round}}(\textbf{\textit{n}})} \tag{4}$$

- Conflict index

In the conflict management module, we want to monitor the detecting, the solving conditions (i.e., the "solving" status indicated in Table 3) of conflicts. Conflict means that two imageries have a low similarity score that falls below a given threshold. The solving condition means the system detects a conflict and recommends a new imagery that has been agreed upon and selected by most of the co-developing interpreters, adopting the idea of using the third party of arbitrator to facilitate the conflict resolution (Tessier et al. 2006). However, the occurrences of conflict times and the chances of solving them are uncertain. Hence, the four indexes are defined in equations (5) to (8).

Table 3 The variables of evolving index

	SMB's selection	
	Accept conflict resolution recommendation	Reject recommendation
Conflict detecting	Solving	Detecting
Don't detect	Miss	Correctly ignored

$$Detect\ times = Solving + Detecting \tag{5}$$

$$Solving\ times = Solving \tag{6}$$

$$Detecting\ Rate\ (\%) = \frac{Solving}{Solving + Miss} \tag{7}$$

$$Solving\ Rate\ (\%) = \frac{Solving}{Solving + Detecting} \tag{8}$$

Note:

Solving means SMB accepts the recommended imagery when the system detects a conflict.

Detecting means SMB rejects the recommended imagery when the system detects a conflict.

Miss means a condition that SMB accepts an imagery under no conflict detected.

- Network Types

In order to model the agreement rate in the co-developing process, without loss of generality, Table 4 illustrates three kinds of networks that represent the behavior of the interpreters for a particular imagery. The agreement rate is the probability that the particular imagery will be accepted as the new imagery. Taking a small network as an example, 80 % of interpreters in the small network should consider that the imagery should be viewed as the new imagery. To connect the network types to the four types of interpreters (reward, curiosity, joiners and creators) as mentioned in Section 4.3 (Table 1), for the sake of simplicity, we can start by including only the creator type of interpreter in the small network type, which can be expanded into a medium or large network type when including the interpreters of the other types, including joiner, curiosity and reward, in sequence.

- Interpreters' Proposed Imagery Behavior Model

In the co-developing process, the interpreters propose imageries. To model possible behaviors of the interpreters, impressions of the imageries proposed by the interpreters can be simulated based on their similarity distances from the default imagery of the SMB. For the sake of simplicity, we can roughly model the interpreters' behaviors using three network types. For instance, the proposed imageries in the small network type could be the randomly selected imageries from the imagery bank within the top 20 % of similarity scores in relation to the default imagery. The broader a network is, the larger the range of similarity scores of the proposed imageries randomly selected from the imagery bank. The details are provided as follows in Table 5. This can simulate the reality of crowd members of different cognitive demand levels.

- Round Time Setting

Each network type is tested independently for four rounds, and each round goes 1000 times. Considering that we try to monitor different results for each network type, each network type should be independently simulated with the imagery bank initialization.

- Imagery bank initialization

We believe that the materials in the imagery bank influence the overall efficiency of our system design. Since we try to monitor the impact of the imagery bank, different bank initializations should be used to verify our premise. Thus, there are certain variation settings between the simulation approach and field interview approach as indicated in Table 6.

5.2 Field interview design

Considering that the needs for imagery building, we selected Zhenshan Agricultural Leisure Area at Yilan of Taiwan as our field study.

- Field Background

Zhenshan Agricultural Leisure Area was established in 2009. It was the first agricultural leisure area in Taiwan. According to the commission of Zhenshan Agricultural Leisure Area, the number of SMB residents is 34. There are three service types in Zhenshan: lodging, experiences (i.e., orchard and farm), and merchandise (i.e., specialty goods). In order to facilitate SMBs' improvement and innovation through imagery building, we select certain SMBs as the

Table 4 Three network types

Network level	Description	Agreement rate
Small	Small network represents that the homogeneity of interpreters is assumed to be higher and they will have more probability to achieve the mutual agreement for a particular imagery (regardless of from what the interpreters propose or from what the system recommends).	80 %
Medium	Medium network delineates that there are more interpreters in the co-creation process, such as stakeholders or alliances. Compared with the small network, the agreement rate for the new imagery would be lower	50 %
Large	Large network is considered as the broader network that contains numerous interpreters. They have various domain knowledge, perspectives, and special skills. Therefore, the agreement rate for the new imagery is set to be only 30 %.	30 %

Table 5 The behavior model about interpreters' proposed imagery

Network level	Description	Similarity score
Small	The interpreters in the small network would be more homogeneous. Therefore, according to the default imagery, the proposed imageries could be randomly selected from the imagery bank within the top 20 % similarity scores in relation to the default imagery.	Top 20 %
Medium	The interpreters in the medium network might have more different ideas from the default imagery. Thus, the proposed imageries could be randomly selected from the imagery bank within the top 50 % similarity scores in relation to the default imagery.	Top 50 %
Large	The interpreters in the large network come from various domains and occupations. Hence, the proposed imageries could be randomly selected from the imagery bank within the top 70 % similarity scores in relation to the default imagery.	Top 70 %

interviewees. The information of the interviewees and focus group is shown in Tables 7 and 8, respectively.

- Field Data Analysis

The field interview data will be analyzed through the data encoding approach (Saldana 2009) of qualitative research method (Miles and Huberman 1994), which is an interpretive act symbolically assigning summative, salient, or evocative attributes for a portion of the interview data (that can be further analyzed to attain an in-depth understanding of human behavior or decision-making and the reasons behind it). There are two coding cycles. The first cycle uses vivo coding (i.e., coding mostly taken directly from the text) to identify the preliminary codes (each will be represented with a prefix identification number followed by its associated italicized code). To verify the hypotheses, the second cycle then classifies the themes of the preliminary codes into the final codes (each will be represented with a prefix identification number followed by capitalized code).

5.3 Evaluation data and analysis

5.3.1 Experiment 1 - evaluation of the imagery bank

Experiment setting Experiment 1 includes a set of simulated experiments for evaluating whether the imagery bank can store the possible imagery elements that contain different kinds of value and whether the imagery bank can evolve continuously through sessions by itself, in order to contribute to the value co-creation journey (i.e., our first argument). This is relevant to examine the relationship between Factor 1 of crowdsourcing intermediary knowledge base and the impact of crowdsourcing intermediary.

In order to compare the evolving situation, the precision and the recall rate, we design the same setting in the control and experimental groups, except for the addition of bank initialization as indicated in Table 9. First, bank initialization represents the original imageries available in the imagery bank. Since we would like to observe the influence of the imagery bank, we attempt to simulate the two stages of the imagery bank. In the first stage, the control group represents an immature bank quantity only containing 150 emotional adjectives, while the experimental group, which represents a mature bank quantity, contains sextuple imageries extended from the imageries in the control group. This can simulate the growth and evolution of the imagery bank through numerous co-developing sessions. Second, since there are numerous imagery-creation sessions in our system and each session can contain different kinds of interpreters' compositions, the scopes of the interpreters' compositions can vary. To this end, we model the three network types to follow the possible network evolving situations in our system. Third, we set 4 rounds for each network type and the rounds of the

Table 6 Imagery bank initialization settings

Approach	Imagery bank materials	
Simulation	Control Group	We select 100 adjectives randomly from the color image scale (Kobayashi 1991) as the imagery bank elements.
	Experimental Group	We use color image scale (Kobayashi 1991) and DISCO API to get 900 adjectives randomly as the imagery bank elements.
Field	We gather 60 imageries with at most 8 attributes/adjectives as the vehicles through Google query "as * as the imagery" into the imagery bank. Besides, each imagery obtains one representative adjective for the computing usage.	

Table 7 The profiles of the interviewees

Company code	Service types	Description
SMB1	Merchandise, Experiences	Sell Chinese deserts and provide DIY tutorials for making deserts.
SMB2	Lodging	Provide tourists with bed-and-breakfast with beautiful night scenes.
SMB3	Experiences	Offer pear and guava picking, orchard tour and insect sample DIY.
SMB4	Lodging, Experiences, Merchandises	It's a multifunction-service with country atmosphere, and provides bed-and breakfast, drinking bar, and nature farm for free visit.

experiments are sequentially conducted in order to monitor the evolving situation in the imagery bank. Last, each round contains 1000 times to simulate long term imagery co-developing.

By doing so, we can obtain three indexes (i.e., evolving times, recall rate, precision rate) for three network types in the two groups in order to monitor the impact of the initial materials of the imagery bank and the impact of the network types .

Experiment results The results are shown in Table 10, Figs. 6 and 7. Three indexes are discussed. At the beginning, the average of the three indexes is shown Table 10. We combine the results for the two groups and the three network types in Figs. 6 and 7 for in-depth analysis.

In general, the average recall rates of the control group for the small/medium/large network types are 65.20 %, 17.6 %, and 10.2 % respectively. In the experimental group, the average recall rates for the small/medium/large network types are 68.47 %, 24.6 %, and 20 % respectively. Notice that the average recall rate in the experimental group is slightly higher than that of the control group. Compared to the average precision rate, the experimental group's rate is also higher than the control group's except for in the small network. The average precision rate of the control group is 71.7 %, which is greater than that of the experimental group by 1.65 %. Since the experimental group contains much more imageries in the imagery bank, we can infer that the composition of the imagery bank influences our recommendation mechanism. More imageries in the imagery bank enhance the recall rate. Through the imagery bank evolving mechanism, the selection diversity of the imageries in the co-developing process is also enhanced based on the better performance of the average recall rate. That is, when the elements in the imagery bank increase, the selection diversity of the imagery bank increases. This is because the three indexes in the experimental group are greater than those in the control group. Since the difference between the two groups is the imageries in the imagery bank, the number of imageries is key factor for enhancing the selection diversity of the imagery bank.

Meanwhile, when the elements of imagery bank increase, the evolving rate of the imagery bank decreases. If we only consider the average evolving times for each group, we find that the evolving times actually decrease based on network types. That is, the broader the network is, the greater the decrease in the evolving rate of the imagery bank. However, if we compare each network type by group, we find that the average evolving times in the experimental group are only a little higher than those in the control group. This revels that bank initialization does not influence the evolving rate; however, the network type does so. Table 10 shows how evolving time is driven by the network types.

We further break down the details to see the different changes in network types. Throughout the co-developing process, the recall and the precision rate increases gradually. Small networks have higher recall and precision rates because of the homogeneous of the interpreters. Medium and large network types have lower recall and precision rates since the imageries from the interpreters are less similar. At the same time, less similarity between the proposed imageries in the medium and large network reveals a complex pattern resulting in difficulty for the system's imagery recommendation (i.e., our system cannot recommend imageries precisely). Although the recommendation mechanism in the medium and large network types cannot reach high recall and precision rates by recommending similar imageries to the SMB, this mechanism

Table 8 Information of the interviews

Type	Number of participants	Participants information	Topic in interview or focus group
Focus group	7	3 SMBs 4 Customers	- To demonstrate our system design - To understand the pitfalls of our system and to get the positive feedbacks, suggestion of our system
Interviews	4	4 SMBs	- To understand the situations of the leisure agriculture innovation resources - To understand how SMBs do product and service innovation in the past. - To understand the needs and advantages of the our system's co-developing process design

Table 9 Experiment settings

	Bank initialization	Network types	Round	Times in each round
Control group	150 imageries	Small	4	1000
		Medium	4	1000
		Large	4	1000
Experimental group	900 imageries	Small	4	1000
		Medium	4	1000
		Large	4	1000

is relatively useful from the facilitation perspective. This is because the conflict management module can deal with problem of interpreters having totally different proposed imageries in the medium and large network. In addition, for each network type, our system's mechanism is triggered effectively with the evolving of the imagery bank given that the recall rate increases round by round. As for the precision rate, it is influenced by network type rather than the imagery bank.

The imagery bank might eventually contain all the possible imageries through bank evolution. This evolving can improve the selection diversity and content richness of the imageries in the imagery bank. We found that a mature imagery bank (i.e., the experimental group) still continues growing and the evolving times did not decrease (if compared with the control group in average). This could be the result of two possible reasons. One is that the imageries in the experimental group are still not numerous enough to represent a mature imagery bank, as we assume that a mature imagery bank does not have the high evolving times and it should coverage to zero. The other is that there is no saturation of the imagery bank. It just keeps evolving session by session. In sum, the imagery bank and its imagery recommendations can help facilitate the interpreters of different cognitive demand levels on the imagery co-developing process along the dynamic evolutions of the imagery bank.

5.3.2 Experiment 2 - evaluation of the generative network

Experiment 2 includes a set of field interviews to evaluate whether the composition of the crowd members influences the crowdsourcing outcome, implying the importance of proper management of generative networks of crowd members. This is relevant to examine the relationship between Factor 2 of generative network and the impact of crowdsourcing intermediary. It is done by assessing the qualitative analogy (A is like B in a relevant respect; i.e., finding out the ways A and B are alike) when used for the exploratory and explanatory purposes (Bermejo-Luque 2014), after the interviewees see our system's demonstrations (the novelty A) and reflect their real-world experiences (the phenomenon B). The findings are that including suitable experienced experts in the co-developing process is important for SMBs in regard to businesses improvement and innovation. This evaluation is conducted to check if our system can resonate with the phenomenon of the interpreters' compositions and interactions shown in successful SMBs in Zhen-Shan village.

Some exemplar raw data from field interviews are shown Table 11. Taking SMB3 — [4]EXPERT-FACILITATION as an example, this SMB encountered a pear cultivation problem that was solved by classes and discussions offered by pear experts. By doing so, the SMB saved lots of cost and time. Once SMBs encountered problems, they always try to find the appropriate solutions to enhance their products and indirectly increase the value of their service. SMBs might ask domain experts for help. However, while some experts facilitate problem solving, others might concentrate on his/her own benefits (like the insecticides'shop — [10]*Benefit contradiction*). In contrast, we can look at the example of SMB1 (see [7]CO-CREATION), who is an expert in Chinese desert. Other partners ask him about the problems involved in making Chinese desert. He is willing to share his experiences and discuss problems. If we attempt to propose an assessment guideline for interpreters' selections, the experts with a sharing mindset are invited to participate in the co-developing process.

In addition to the views of experts, there has also a trend of shifting from product-orientation to service-orientation in

Table 10 The average performance of the three indexes

Group	Network types	Recall average	Precision average	Evolving times average
Control group	Small	65.20 %	71.7 %	672.25 times
	Medium	17.6 %	34.08 %	391.25 times
	Large	10.2 %	18.70 %	191.5 times
Experimental group	Small	68.47 %	70.05 %	678.5 times
	Medium	24.6 %	37.71 %	390 times
	Large	20.00 %	19.14 %	210 times

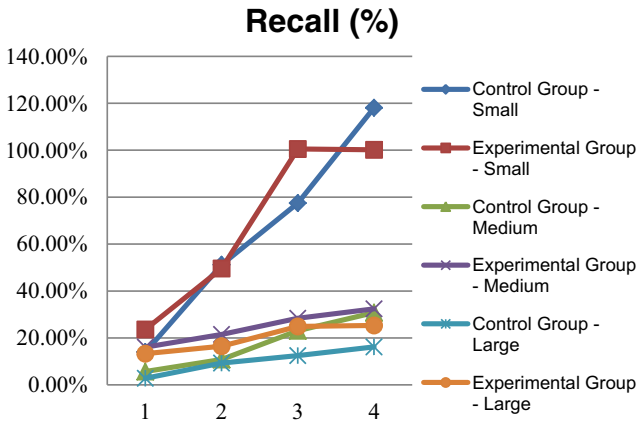


Fig. 6 Recall rate

recent years. According to the interviews, SMBs understand the trends in the market but they lack clear direction (see [5]CUSTOMER-DRIVEN). This trend from product-driven to service-driven approaches accelerates the triggering of innovation. SMBs tend to pay more attention to customers' advices. The suggestions or needs of customers influence the design of SMBs' businesses and services. Therefore, customers are also invited to participate in the co-developing process.

In sum, the findings in the interviews reveal the possible result of interactions between different kinds of interpreters. As we expected, the composition of the interpreters directly influences the outcome of the imagery creation process. Moreover, we found that the interpreters can be business partners, experts and customers. There are also certain common traits in the co-developing process, such as sharing mindset or experience. If someone has good domain-knowledge but exhibits benefit contradiction, he will not be invited to participate in the co-creation process.

Based on the previous discussion, we conclude that different kinds of experts and customers influence the co-developing process and outcome. Sharing, self-benefit and unreasonable customer demand can result in totally different co-developing processes. That is, the composition of

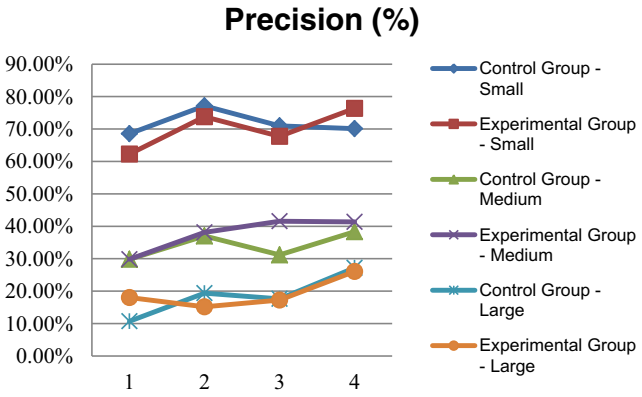


Fig. 7 Precision rate

interpreters influences interactions with the SMB, and the outcome of imagery creation is also impacted. This resonates with our system's mechanism, enabling the separation of different network boundaries. To better manage the inclusion of suitable interpreters in the co-developing process, this system's mechanism can delimit the various network boundaries of interpreters, allowing the central SMB to dynamically decide an appropriate network boundary of interpreters to be engaged in the current co-developing context.

5.3.3 Experiment 3 - evaluation of empowerment of crowd members

Experiment 3 includes a set of field interviews and simulated experiments to evaluate if the perceptions of the intermediary's empowerment supports for competence, autonomy and relatedness can make the crowd members' value co-creation journey effective (i.e., our third argument). According to self-determination theory (Deci and Ryan 2000), the perceptions of support for competence, autonomy and relatedness drive individuals' actions. To evaluate whether or not the greater empowerment of crowd members would make the value co-creation of the crowdsourcing process more effective, field interviews and experiments are conducted with respect to the intermediary's support of competence, autonomy and relatedness, as elaborated in the arguments shown below together with their justifications. This is relevant to examine the relationship between Factor 3 of empowerment of crowd members and the impact of crowdsourcing intermediary. It is done by assessing the qualitative analogy (A is like B in a relevant respect; i.e., finding out the ways A and B are alike) when used for the exploratory and explanatory purposes (Bermejo-Luque 2014), after the interviewees see our system's demonstrations (the novelty A) and reflect their real-world experiences (the phenomenon B).

Competency The understanding of SMBs' background can enhance the competence of interpreters in proposing suitable imageries in the co-developing process.

It is often the case that not every suggestion or institutional visit can inspire the innovation of SMBs. For example, in Table 12, the SMB seeks experiences related to their businesses operations (see [20]*Needs deep visiting*). However, some classes offered by the area committee do not directly give SMBs new ideas and lead to little improvement (see [8]DEEP-UNDERSTANDING). In this situation, we can infer that the innovation from a product-orientated to service-orientated approach is not easy. If an SMB want to adjust their business operation to focus on service experience, they still need other support to enhance the possibility of creating unique and special service innovation imagery. Based on the previous experiences from SMBs, they prefer to be inspired by similar businesses. For

Table 11 Field data encoding about the evaluation of the generative network

Questions	Raw data	Preliminary code	Final code	Interviewee
Who will you interact with to develop your businesses mostly? Why?	[8]In Taichung, there's a pear cultivation class. That's very good. We take approximately one week lessons. In all lessons, there was a lot of things needed to learn and we were almost overloaded.	[8]Take professional classes to solve difficulties	[4]EXPERT-FACILITATION	SMB3
	[9]However, in that week, if you had any agricultural problems, such as manure and blight…, etc., you could find teachers' phone number and other related information. The teachers were willing to share all the knowledge and experiences. We didn't have any interest relationship …… One of the best ways to learn new things are to learn from others, like blight. Just tell me which insecticides are useful, cheap, and fast.	[9]Experiences' suggestion		
	[10]If we ask insecticides' shop, the owner won't sell you the most effective insecticides. Do you know why? He will sell you the most profitable one instead of the most effective one. His mindset is to make you come back to buy his products again and again ……	[10]Benefit contradiction		
	[11]These kinds of problems can't be found in the Internet easily since there are few agriculturist interaction platforms.	[11]Less interaction platform		
How do you improve your product?	[12]Food hygiene is an important thing. In the past, the customer didn't take this seriously. However, our diet habit changes gradually.	[12]Food Hygiene issue	[5]CUSTOMER-DRIVEND	SMB1
	[13]Thus, there are still a few outside catering in Taiwan. But in summer, customers will go to the indoors restaurant. Food ecosystem is changing, the same as my next business stage DIY.	[13]Lessoutside catering		
	[14]Besides, we also contact with Agricultural Leisure Area, taking some classes to see the change of the outside market.	[14]Monitor market trend		
How do you get new ideas for your businesses?	[15]I used to reference ideas from others, discuss with other partners, and visit other companies. If I get something good, it is learned from them.	[15]References	[6]CO-DEVELOPMENT	SMB3
How do you improve your product? Have you ever discussed with others or learned from books?	[16]I always utilize my past experiences. Actually, I also read many books; however, it often can't work.	[16]Experiences- driven	[7]CO-CREATION	SMB1
	[17]Other business partners often discuss with me because I have numerous related experiences in Chinese deserts.	[17]Experts discussion		

Table 12 Field data encoding about the evaluation of empowerment of crowd members on competence

Questions	Raw data	Preliminary code	Final code	Interviewee
Have you ever visited others' leisure agricultural area to inspire your new businesses ideas? How about that?	[18]In recent years' institution visits, I can't see anything special because they always arrange lots of places.	[18] No inspiration	[8]DEEP-UNDERSTANDING	SMB3
	[19]"To give only a passing glance at things." …… like woodcarvings, we went there for three times. That was so strange. They loved to arrange these kinds of useless visits …… I found that these kinds of institution visits couldn't get the deep inspiration since there are so many different types of SMBs in our Agricultural Leisure Area. When we want to fulfill each type, it is equal to "give only a passing glance at things."	[19]"To give only a passing glance at things."		
	[20]That is, we are tourism orchard so we can find some same successful tourism orchards and interact with them. That will be deep.	[20] Needs deep visiting		
What do you think about service innovation?	[21]I don't do innovation now. That's an over-fashion thing and it will pass over time. We only do what we should do. No innovation is innovation.	[21] No innovation	[9]SELF-POSITION	SMB4
	[22]Since we are the first B&B in Ilan, there's a tight relationship with economics. If we only do innovation and didn't do great breakthrough, we can't succeed.	[22] Self-Breakthrough		
	[23]Customers' needs are complex now. Sometimes, their needs are temporary and interminable……	[23]"Complex, temporary, interminable needs"		
	[24]In our green B&B, we only do what we want to do to make the environment natural. Customers will come.	[24] Niche market		

example, MB3 suggested that similar cases of successful businesses are more inspirational (see [20]*Needs deep visiting*).

Moreover, SMBs have their own perspectives. Taking [9]SELF-POSITION as an example, SMB4 attempts to focus on improving its own positioning value (i.e., natural, comfortable, etc.). All of the improvement drawn from others' suggestions should fit into their own imagery. The aforementioned result resonates with our system's design. That is, a co-developing environment for SMBs and other interpreters and SMBs' information (such as their basic information, abilities, and willingness) is included in the co-creation process to let other interpreters better understand the needs of SMBs. Since the final decision about imagery creation depends on SMBs' decisions, the disclosure of the SMBs' information can facilitate more in the co-developing process, and interpreters can recommend more suitable imageries.

Autonomy and relatedness Conflict detecting and conflict dealing can prevent the default imageries from being too diverse in order to allow SMBs to effectively derive coherent meanings of the default imageries.

In this experiment, we attempt to observe which network type is the most effective in the conflict management module in order to see whether the module can resolve the problem of diverse imageries and then provide a new hint to effectuate the co-developing process. First, we define the control group and the experimental group. The control group exerts no manipulation. The interpreters' behavior in the control group is assumed to be random. That is, the proposed imageries and the agreement about the imagery are randomly selected. In the experimental group, we test three network types. The two groups are designed to compare which interpreters' pattern (i.e., network type) triggers the most the effective facilitation in the conflict management module. In addition, the conflict solving index can reveal the possible contributions to the final coherent imagery in the co-developing process.

The experiment data are twofold:

- Default imagery: Each round starts from a default imagery. We select the default imagery randomly from the imagery bank as a starting point for the co-developing process.
- Proposed imagery: In the experimental group, the proposed imageries depend on the similarity scores computed by DISCO similarity API according to different network types. As for the control group, we use randomly generated imageries attained from the imagery bank.

In the experiment, we monitor the results of different network types. Hence, we set each experiment to run 5000 times to simulate the overall trend of the conflict management module. The experiment results are then shown in Table 13. The results show the detecting times and the solving times of the

Table 13 Conflict management simulation results

		Detecting times	Solving times	Detecting rate (%)	Solving rate (%)
Control group		4528 times	2268 times	90.05 %	50.08 %
Experimental group	Small	2043 times	1460 times	40.86 %	71.46 %
	Medium	4381 times	1741 times	87.62 %	39.73 %
	Large	4562 times	871 times	91.24 %	19.09 %

conflict management module. For conflict detection times, we can obviously observe that the large network type detects the highest conflict times. In the experimental group, the conflict detecting rate is 40.86 % in the small network type, 87.62 % in the medium network type and 91.24 % in the large network type. This infers that once the number of interpreters in the network is increased, more ideas are attained in the co-developing process. This also implies that the conflict management module's mechanism is useful for facilitating the imagery co-developing process among more heterogeneous interpreters. When the network expands (i.e. more heterogeneous interpreters), the effectiveness of our conflict detecting mechanism also improves.

As for the control group, the conflict detecting rate is 90.05 %. Since the proposed imagery behavior in the control group is random, the resulting conflict detecting rate is relatively high. The detection mechanism of our system is based on the similarity distances between the imageries. If the interpreters mostly propose imageries with low similarity distances, we can infer the interpreters are heterogeneous given there is a high conflict detecting rate. That is, we can apply the results of the control group as a benchmark to observe the results of the three network types in the experiment group. The solving rate is 71.46 % in the small network type, 39.73 % in the medium network type, and 19.09 % in the large network type; this indicates that an extended network does not improve the solving rate. The reason is that the heterogeneous interpreters cannot get the consensus easily. However, this index does not decrease the effectiveness of the conflict management mechanism. The system can still inspire some new ideas in the interpreters through the conflict detecting function. The detected conflicts can still give the interpreters hints for creating new imageries in the co-developing process.

Relatedness The design of the co-developing concept evolutionarily facilitates the imagery building process.

In the field interviews, we investigated how the system impacts innovation, how to decide the market position, and the reason why SMBs decided to trigger business transformation. The detailed interview excerpts are shown in Table 14. In the first interview of the focus group, the perspective proposed by the SMB1 can be classified as "[1]ADVICE-TAKING". He considered the experience of obtaining domain knowledge from others as essential for his business and also believed in the influences of collective intelligence. Moreover, the interview result from SMB2 shows that any decision-making (such as brand image, market position or service type) is influenced by other business stakeholders in the regional area (see [2]CASE-REFERENCE in Table 14). Like SMB2, she decided her B&B name by referencing the most popular B&B business in the Zhenshan Agricultural Leisure Area. We can infer that there is certain power in a local region and it might give rise to some new insights about possibilities of business transformation. The example of "[3]CO-DEVELOPING" in SMB1 reveals the influences in the regional area are likely to contribute to business transformation. From a series of classes taken by SMBs, SMB1 figured out their business transformation through discussion with experts and through help from teachers in classes.

When SMBs attempt to break through new in businesses, they are willing to take others advice. They agree that the opinions from experienced people can reduce their trial-and-error time and also improve their businesses. To shift from traditional agriculture to leisure agriculture, the committee in Zhenshan Agricultural Leisure Area designed a series of classes to help them, in areas such as product improvement and service process improvement. Some of the SMBs found new directions based on these classes. We find that the behavior of the SMBs can be classified as [1]ADVICE-TAKING, [2]CASE-REFERENCE and [3]CO-DEVELOPING in service innovation. That is, suggestions from others should play an important role in their decisions.

The aforementioned findings resonates with our proposed system on the aspect of crowdsourcing impact, which facilitates SMBs to find unique service innovation imagery by drawing on a wider pool of interpreters who give SMBs advice or suggestion which are useful in the imagery building process. This concept of co-developing imagery is in line with SMBs desire to obtain advice from interpreters.

6 Discussion

6.1 Results discussion

The evaluation results in the previous section have some important implications:

- Academic Implications

In response to the challenges of developing amenable crowdsourcing information system as addressed by Doan et al. (2011) and the importance of developing dedicated crowdsourcing intermediaries to create values and impacts especially for resource-lacking SMBs as addressed by Agafonovas and Alonderienė (2013), this study identifies three important factors (including crowdsourcing knowledge base, generative network and crowd member empowerment) and presents a novel design of crowdsourcing intermediaries. This design takes into account the different cognitive demand levels of solution providers' contributions and facilitates the combination and evaluation of contributions as addressed by Doan et al. (2011). The design includes Factor 1 of crowdsourcing intermediary knowledge base (imagery bank), Factor 2 of generative network (network boundary module) and Factor 3 of empowerment of crowd members (default imagery module and co-developing module). This study provides a case to demonstrate how the design facilitates achieving a higher chance of attaining creative solutions for users' innovation problems when these three factors are well incorporated and managed within the crowdsourcing intermediary.

In addition, these three factors can also help inspire how to mobilize knowledge to design the intermediary's value-added services that can better engage the participants and facilitate the crowdsourcing process as advocated by Simula and Ahola (2014). For instance, this idea can be applied to an existing example of crowdsourcing technology under development by SagivTech (a part of the future emerging technologies EU funding scheme). The technology uses the collected efforts of the crowd members to generate 3D scenes. The crowd members take the videos with their smartphones from a variety of viewing angles, and the technology then synchronizes the uploaded videos to obtain a 3D reconstruction of the scenes. This technology currently requires a very heavy computing power to process the graphic mathematics of videos (good or bad qualities). To further improve its current intermediary focusing on only storing and synchronizing the uploaded videos in order to effectively attain a higher quality of 3D scene reconstructions, the intermediary can be enhanced by considering the three factors of crowdsourcing knowledge base, generative network and crowd member empowerment. Exemplars are like that the intermediary can have a knowledge base (similar to our case's imagery bank) and the generative network (as demonstrated in our case that dynamically identifies suitable boundaries of crowd members) to facilitate the whole co-developing journey of 3D scene reconstructions. In addition, the intermediary can provide some additional value-added services that can better engage and empower the crowd members (supports for competence, autonomy and relatedness to drive individuals' actions as demonstrated in our case) within the co-developing journey. In other words, our crowdsourcing intermediary factor framework and our case system are believed to point to a slew of new research opportunities for digital technologies to advance the current state of art on open innovation initiatives.

- Practical Implications

To better facilitate service imagery creation for SMBs, this study presents a crowdsourcing approach based on the concept of value co-creation as addressed by service dominant logic (Vargo and Lusch 2008). According to Table 10, the utility (i.e., precision, recall) of the recommendation module is over 60 % in the small network. According to Table 13, the utility (i.e., detecting rate) of the conflict management module is over 90 % in the large network. Although the recommendation mechanism in the medium and large network types cannot reach high recall and precision rates, the conflict management module can deal with problem of interpreters having totally different proposed imageries in the medium and large network. In addition, according to Figs. 6 and 7, the evolving can also improve the selection diversity and content richness of the imageries in the imagery bank. That is, the results are able to show that these system's modules can effectively play the role of mediator.

Associating these results with the scope of service innovation, we can infer that the outcome of the imagery co-developing process leads to a small innovation in the small network type and radical innovation in the large network type. This is because the interpreters and the system usually propose similar imagery for SMBs. They consider the default imagery to be the foundation of service innovation. However, when the proposed imageries are more heterogeneous, the diversity of the imageries increase the possibility of radical innovation. Though radical innovation can shape a new niche market for SMBs, there might be certain constraints for applying service imagery to a certain product or service, such as costs, funds, time or space. For service innovation in the small network type, the uniqueness required for reinforcing the difference between competitors and SMBs may be lacking. Therefore, if an SMB pursues a certain level of innovation and can also make it realizable, the SMB should develop a medium network type in the co-developing process.

6.2 Other recent works

There are other recent works investigating crowdsourcing intermediaries. For example, Zogaj et al. (2014) used a case of German start-up intermediary called testCloud (offering software testing services for companies to outsource their testing tasks to a certain crowd) to exemplify the challenges of managing the crowdsourcing process, managing the crowd and managing the technology for crowdsourcing intermediaries. testCloud copes with the challenges in terms of implementing a structured registration process that could help the crowdsourcer to be connected with appropriate crowd

Table 14 Field data encoding about the evaluation of empowerment of crowd members on relatedness

Questions	Raw data	Preliminary code	Final code	Interviewee
What do you think about this idea, to get other's suggestions in service innovation?	[1]We are willing to accept others good suggestions. However, we still need to try our best by ourselves. Some people give the advices in their goodness, but their ideas might …...	[1]Self-Breakthrough	[1]ADVICE-TAKING	SMB1
	[2]My basic thinking is, take Paw's boss as an example, he wants to make pizza. Thus, he does pizza-related research by himself and also asks someone else. He also asks me about the tips of noodle skin and materials. He does the great job. If he didn't ask any others, he might succeed. However, comparing with asking someone else, he himself will take more time to explore.	[2]Paw's success from other's advices		
	[3]Back to the question of the importance of taking others' suggestions, general people will absolutely take others advices, except for un-general people …... Two heads are better than one.	[3]"Two heads are better than one"		
Why called "Top-Mountain-Side"?	[4]Because underneath there's "Countryside" B&B in Ilan, we are located in the peak of the mountain. Therefore, we called "Top-Mountain-Side" and we also live in the peak of the mountain.	[4]Brand reference from successful case	[2]CASE-REFERENCE	SMB2
Why do you decide to develop tourism factory?	[5]We joined the classes from Leisure Agricultural Area. There are college professors and other experts. They teach us about marketing, packaging and Internet for adding our value.	[5]Experts teaching	[3]CO-DEVELOPING	SMB1
	[6]Besides, they will tell us many successful cases.	[6]Successful Cases		
	[7]My ideas mainly are to cooperate with teachers. Teachers gave me the advice that my factory can transform to tourism factory in teaching DIY and also selling Chinese deserts.	[7]"Cooperate"		

members (i.e., testers) and acquiring the crowdsourcer's requirements via a five-step survey procedure. However, the issue of how to implement functions that can support the work of the crowd members is yet to be explored.

Zogaj and Bretschneider (2014) uses multiple cases to identify the governance mechanisms of crowdsourcing intermediaries, such as task definition, task allocation mechanism, effective rating mechanism, crowd qualification, and precise set of regulations/agreements. However, moving beyond the trial and error approaches, it is yet to explore systematic approaches to develop and manage crowdsourcing intermediaries.

Thuan et al. (2015) used the systematic literature review to identify the issues that would influence the decision to crowdsourcing adoption, including task to crowdsource, people to perform the task, management to plan and coordinate the task, and crowdsourcing environment to surround these managerial decisions. Choy and Schlagwein (2016) used cases to advocate that people in the charity space should consider taking advantage of IT-enabled charitable crowdfunding for donors because of the assistance of cognitive affordance (knowing, thinking), action affordance (doing, acting) and different forms of motivation affordance (individual-extrinsic, social-intrinsic, social-extrinsic motivation). That is, good design of crowdsourcing intermediaries would affect a business' decision to crowdsourcing adoption or business performance.

In light of the aforementioned recent works, this study aims to explore a systematic approach to the development of crowdsourcing intermediaries, considering the management of crowdsourcing process and crowd members with various IT-enabled affordances on the cognitive, action and motivation. Accordingly, our design includes Factor 1 of crowdsourcing intermediary knowledge base (imagery bank) in response to the cognitive/action/motivation affordance, Factor 2 of generative network (network boundary module) in response to crowd member management, and Factor 3 of empowerment of crowd members (default imagery module and co-developing module) in response to crowdsourcing process management, which can better engage the participants and facilitate the crowdsourcing process.

7 Conclusion

This paper investigates the case of an IT-based crowdsourcing intermediary design to solve the problem of how to assist in service imagery creation for SMBs to promote service innovation. This crowdsourcing intermediary for service imagery creation can facilitate the imagery co-developing process among a central SMB and its networks of interpreters, deriving more meaningful and customer-centric service imagery. In addition, this crowdsourcing intermediary develops an imagery bank to facilitate the imagery co-creation emphasized by the service-dominant logic. The crowdsourcing intermediary is able to

assist the SMB in identifying suitable boundaries of crowd members for them to interact with one in the co-developing process. Meanwhile, the crowdsourcing intermediary can empower the crowd members in terms of the supports for competence, autonomy and relatedness to drive their actions.

This case provides us with an exploratory vehicle for verifying the impact of the proposed crowdsourcing factors, including the crowdsourcing intermediary's knowledge base, generative networks and empowerment of crowd members. These factors also signify the future possible directions for advancing the development of crowdsourcing intermediaries. This paper's contribution mainly rests on exploring a systematic approach to the development of crowdsourcing intermediaries, that integrates the management of crowdsourcing process and crowd members considering various IT-enabled affordances on the cognitive, action and motivation.

The limitations of this study include the use of only a single crowdsourcing intermediary system for an exploratory and explanatory investigation. The future works include empirical studies to validate the proposed approach in the real world context, classifications of crowdsourcing intermediary's knowledge bases, generative network boundaries and crowd member empowerment strategies. In addition, theoretical model development in relation to our proposed factors can also be conducted.

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