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Readiness Analysis of Open Innovation - A Self-assessment Method

Mei Na Cheng, The Hong Kong Polytechnic University, Hung Hom, Hong Kong
https://orcid.org/0000-0002-1223-5363

Chi Fai Cheung, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

Eric Tsui, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

Kit Ling Wan, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

ABSTRACT

Nowadays, many companies are increasingly turning to open innovation (OI) to generate new business opportunities through the utilization of knowledge, and technology with the external parties. Various researchers and practitioners are paying attention to the development of OI readiness evaluation tools for assessing innovation capabilities in their business activities. However, methods of these evaluation tool are capability-oriented and relatively little attention has been paid to considering mindset and behavior intersect in OI activities at organizational level. In this article, attempts to fill this gap are made by examining organizations' readiness for OI adoption. Particular attention is given to what thinking toward OI, what behavior toward OI, and how mindset affects their behavior for OI adoption in the market and technology activities. The goal is to understand how these understanding can enhance effectiveness for implementing OI activities in the organizations, especially technology-intensive enterprises.

KEYWORDS

Mindset Toward Thinking And Behavior, Open Innovation, Readiness Analysis, Self-Assessment, Technology-Intensive Enterprises

INTRODUCTION

Open innovation (OI) is one of business concepts used in the innovation and technology management process across organizations for innovation that can share knowledge, increase choices and quality of ideas, lower trading risks as well as improve successful commercialization of ideas (Wei et al., 2018; Huggins and Thompson, 2015; Tsimiklis et al., 2015; Messeni Petruzzelli et al., 2009). Chesbrough (2003) defined that "Open innovation is a paradigm that assumes that enterprises can and should use external ideas as well as internal ideas, and internal and external paths to market, as the enterprises is look for advancing their technology". In other words, OI is also a strategy in which enterprises allow a flow of knowledge across their boundaries as they look for the ways to enhance their innovation capabilities (Martinez-Conesa et al., 2017; Cheng and Shiu, 2015; Chesbrough and Crowther, 2006). In the globe, there is a marked trend to take very different ways for the adoption of OI in corporations which offers various benefits to different industries, such as shortening time-to-market, gaining access to new technologies and enhancing innovation competencies (Castellano et al., 2016; Wirtz et al., 2015). However, relatively little attention has been paid to the way of understanding of the

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mindset and behavior intersect in open innovation. In this paper, a self-assessment method has been designed and developed for technology-intensive enterprises to better understand their readiness for open innovation adoption. The results of this study provide insights from how they are getting ready to implementation of open innovation and preliminary understanding on how mindset affects their behaviors for open innovation adoption.

Factors Affecting the Adoption of Open Innovation (OI)

Many factors which vary in different industries and countries are necessary to take into account of the implementation of OI, and they are also affecting the adoption of OI. Mortara et al. (2009) mentioned that permanent employment model and partner selection are two of major considerations in a global OI perspective which should be kept in mind, these considerations include employment models, partner selection for collaboration, patterns of knowledge transfer and interaction models. Laursen and Salter (2006) proposed the measurement of openness with different levels of research and development (R&D) intensity so as to examine the relationship between the openness to external search activities and their innovative performance (i.e. internal R&D). van de Vrande et al. (2009) investigated the market-related motivation (i.e. innovation needs, timing of implementation, keeping up with competitors) to action toward OI in small and medium-sized enterprises (SMEs), instead of large technology-intensive multinational enterprises (MNEs). Hackler (2011) articulated that regional factors (i.e. regional economic, social and cultural dynamics) have an effect on innovation strategy using nine-hypothesis analysis, particularly in technology-intensive enterprises (TIEs). Spithoven et al. (2012) reclassified the factors identified by Chesbrough (2003, 2006) in three main categories, which are supply side factors (i.e. increased availability of intellectual property rights (IPRs)), technical factors (i.e. adoption of technical standards to facilitate an exchange of resources between enterprises) and geographical factors (i.e. globalization and internalization to extend a firm's commercialization markets). In general, capability, culture, knowledge and experience, motivation as well as networking are some of significant factors affecting the adoption of OI in organizations.

Capability

Capability refers to one of organization's significant capabilities of managing internal and external knowledge in OI processes (Lichtenthaler and Lichtenthaler, 2009). Katila and Ahuja (2002) stated that exploratory tasks (i.e. innovation) are typically associated with the need for skills that transcend the current capabilities of the organization. Gassmann and Enkel (2004) demonstrated the impact of outside-in process on the integration of internal knowledge capability with new and complementary knowledge of external parties (i.e. suppliers, customers). Motzek (2007) stated that OI may enhance the enterprise's capability for the generation of new solutions by leveraging external resources of knowledge and creativity from third parties. Spithoven et al. (2011) demonstrated that technology intermediaries assist enterprises in the traditional industries building absorptive capacity to engage in inbound OI activities, which may take advantage of innovation and technology management. With regard to the organizational capability in OI practices, Spithoven et al. (2012) examined that both the qualification and occupation of the internal R&D personnel and the availability and qualification of the R&D experts and managers are important factors affecting the enterprise-level decisions relating to OI practices. Hung and Chou (2013) conducted a survey for high-tech manufacturing companies in Taiwan to investigate the effect of internal R&D and environmental turbulence on company performance for adoption of OI in dimensions of external technology acquisition and exploitation. Kim and Kim (2018) studied how Intellectual Property (IP) management capability affecting OI process in Korean new Information and Communications Technology (ICT) Industry. They highly encouraged that the new companies in Korean ICT industry should enhance their IP management capability for increasing their technological innovation performance in OI activities. The study of Naqshbandi and Tabche (2018) indicated that absorptive capacity is one of significant factors interacting with organizational leadership that affects OI outcomes.

Knowledge

In the knowledge-based economy, knowledge of users is one of the major resources in OI process which can be used in the generation of new solution information (Terhorst et al., 2018; Motzek, 2007; von Hippel, 2005; Prahalad and Ramaswamy, 2004). Grimsdottir and Edvardsson (2018) mentioned that knowledge creation is a critical learning process of innovation activities in companies. In a common practice of implementing innovation, most enterprises strive for gaining knowledge and experience (i.e. implicit and tacit knowledge) by testing different approaches of OI (i.e. ideation contests, co-creation toolkits, developer communities, or tournament-based crowdsourcing) based on the level of pilot projects at the beginning rather than within the entire enterprise (Terhorst et al., 2018; Diener and Piller, 2013; Lüttgens et al., 2012; Lechner and Floyd, 2007; Turner, 2005). Many small and medium-sized enterprises (SMEs) cause apprehension about innovation, OI and Intellectual Property (IP) for lack of awareness and education (Bevis and Cole, 2010). Porter and Newman (2011) proposed a five-stage framework to capture external R&D knowledge and generate new knowledge possibilities from research literature by technology mining. One of the insights from OI literature emphasizes the need for companies to access external knowledge in order to perform research and innovation (Spithoven et al., 2012; Enkel et al., 2009). de Araújo Burcharth et al. (2014) conducted a survey for manufacturing companies in Denmark to investigate the two significant attitudes (i.e. the negative attitude towards the utilization of external knowledge and negative attitude against the external exploitation of knowledge assets) for adoption of OI practices. The result indicated that both of attitudes have negative impacts on the adoption of the inbound and outbound approaches to OI. Terhorst et al. (2018) applied exponential random graph modeling to investigate both tacit and explicit knowledge sharing in two early stage OI projects and they found that tacit knowledge sharing is one of the most significant criteria to the success of OI projects.

Network

External networking is one of the significant elements associated with OI consistently (van de Vrande et al., 2009; Chesbrough and Crowther, 2006). Laursen and Salter (2006) suggested that the network of relationships between an enterprise and its external environment can interact to shape the enterprise's innovative performance. They also defined OI as "cooperation for innovation within wide horizontal and vertical networks of universities, start-ups, suppliers, customers, and competitors". Brown and Hagel III (2006) proposed to choose an appropriate way of coordination of the network, and then create a new network where a number of participants collaborate to create new knowledge, learn from each other and build on each other's contribution. Fichter (2009) mentioned that the development of an innovation community and of community interaction quality is a key concern in the management of OI projects. van de Vrande et al. (2009) mentioned that the external networking to acquire new knowledge and fill in specific knowledge needs are important and effective OI activities among SMEs. Saur-Amaral and Rego (2010) observed that enterprises can take the unaware knowledge from the huge knowledge base by leveraging the free contribution of social networks. Bianchi et al. (2011) investigated different organizational modes to embark on relationship with different types of partners for acquiring and exploiting technologies and knowledge through OI approach. Kim and Kim (2018) studied how two factors (i.e. Intellectual Property (IP) Management Capability and Network Strategy) affecting OI activities in Korean new Information and Communications Technology (ICT) Industry. They highly recommended that the new companies in Korean ICT industry should build up their own technological innovation network in order to enhance their competitive advantage.

Motivation

Motivation is one of key issues with aim to implement OI activities in the organization (Antikainen, 2010). Mortara et al. (2009) mentioned that top management rarely inclines to accept the new approach to innovation by demonstrating commitment and support. Lüttgens et al. (2012) mentioned that lack of motivation is one of major barriers to OI adoption in bottom-up and top-down approaches. In

the bottom-up management, people in R&D may be lacking internal commitment for OI adoption, and then resulted in a rather slow commitment to identify potential opportunity for OI adoption (Lüttgens et al., 2012; Chesbrough and Crowther, 2006; van de Vrande et al., 2006). In the top-down management, insufficient top management support and insufficient resources had great influences on motivation for OI adoption, such as inadequate personnel were allocated to identify the problem and to determine the appropriate solution (Lüttgens et al., 2012; van de Vrande et al., 2009). It is interesting to note that Mortara et al. (2009) mentioned that top-down approaches are generally short-lived since they tend to produce over-compliance rather than acceptance. Tsinopoulos et al. (2018) developed a conceptual model using survey data which were collected from the U.K. government to investigate how motivation affecting the OI and process innovation.

Culture

Although culture is an important element for supporting change on OI adoption (Naqshbandi and Tabche, 2018; Naqshbandi et al., 2015; Felício et al., 2013; Lichtenthaler, 2011; van de Vrande et al., 2009; Dodgson et al., 2006; Witzeman et al., 2006; Boschma, 2005), the firms mentioned that cultural and practical background are also challenges to motivate the employees to be completely open (Mortara et al., 2009). van de Vrande et al. (2009) also examined the significant challenges to adopt OI practices in SMEs which relate to organizational and cultural issues. Savitskaya et al. (2010) stated that organizational culture is one of common barriers affecting OI implementation, in terms of IP issue, no matter which types of OI is carried out. Mortara and Minshall (2011) demonstrated that the way for OI adoption is found to vary according to the firm's innovation requirements, timing of the implementation and organizational culture. Mortara et al. (2009) conducted an analysis of enablers and obstacles that companies have to tackle when implementing OI. The result identified four critical factors that companies had experienced including OI culture, OI procedures, OI skills and OI motivation. Chiaroni et al. (2011) identified four key managerial levers including networks, organizational structures, evaluation processes and KM systems which may have impacts on the implementation of open innovation. Mattes (2011) suggested a series of questions to be checked on the readiness of an organization before starting its OI implementation in terms of innovation performance, innovation approach, innovation network and organizational actions supporting OI. Lazzarotti et al. (2012) studied the relationship between OI models and a set of firm-specific factors (i.e. innovation approach, R&D intensity, company collaboration objectives, as well as organizational and managerial actions supporting OI) in Italian manufacturing industries. Spithoven et al. (2012) studied four major factors affecting the adoption of OI from theoretical and empirical perspectives, these factors includes firm heterogeneity in innovation performance, the relationship between public funding (i.e. funding from government) and a firm's innovation networking behavior, the implications for R&D outsourcing on internal R&D activities, and the role of internal R&D personnel in a firm's decision to engage in OI practices. Companies that have been implementing OI successfully pinpointed that the development of an OI culture is a powerful motivating factor, while internal cultural barriers and lack of motivation are the greatest obstacles for OI adoption (Wagner and Piller, 2012). Naqshbandi et al. (2015) conducted a survey to investigate how culture affecting OI in organizations and they found that organizational culture is one of significant predictors of open innovation. Naqshbandi and Tabche (2018) further investigated how organizational leadership interacts with absorptive capacity and learning culture to affect OI outcomes.

In summary, the literature shows that capability, culture, knowledge, motivation and network turn out to be important. These views are shared by an extensive literature on firm strategies and their relation to OI strategies that has developed over the past decade. The roles of capability, knowledge and experience, network, motivation as well as culture have come to the fore in the investigation of facilitating factors affecting the adoption of OI.

Evaluation Tools of Open Innovation (OI) Readiness

Over the years, companies have generally based on the evaluation of innovation and knowledge capabilities in order to achieve the best innovation performance. Many researchers and practitioners proposed various methods that can help the companies to measure the OI readiness or openness in terms of their innovation capability and innovation performance for OI adaption as shown in Table 1. Laursen and Salter (2006) examined that the openness of firm's external search strategies has a close relationship with firm's innovative performance by developing the concept of two components (i.e. external search breadth' and external search 'depth' strategies). Applying measures on the 'breadth' and 'depth' of OI proposed by Laursen and Salter (2006) and the importance of impediments, Keupp and Gassmann (2009) identified four OI archetypes users (i.e. "Isolationists", "Scouts", "Explorers" and "Professionals") of Swiss firms which differ significantly regarding the number of sources they used for OI activities (i.e. customers, other firms, research institutions) and the intensity of collaboration with each source. Bevis and Cole (2010) introduced the concept of an OI readiness tool to assist SMEs who might be apprehensive about innovation, OI and IP to understand their position regarding capability to innovate. Mattes (2011) proposed an Applied Innovation Management™ tool to provide the knowledge required to conduct a critical assessment of existing OI approaches, to identify new opportunities as well as to plan for professional implementation. The framework of the tool consists of (a) a well-organized thought process with 4 main steps which is used to determine the best OI approaches for the firm and (b) a series of suggestions and advice which provide guidance to reflect on and find the solutions to questions that the enterprise need to work with when implementing the knowledge in the enterprise.

Various researchers proposed different evaluation tools to measure the OI readiness or openness which have to take the other factors into account, such as innovation practices, network collaboration, organizational structure and culture. Focusing on the motivations and perceived challenges when SMEs adopt OI practices, van de Vrande et al. (2009) conducted survey to measure the OI with eight innovation practices reflecting technology exploration and exploitation in SMEs. NineSigma (2010) developed a diagnostic tool for the companies to measure their OI capabilities and the result ranks the companies in terms of collaborative innovation such as internal collaboration, existing network collaboration and global innovation community collaboration. Another evaluation tool of OI readiness audit is designed and developed for companies to self-evaluate their position (Wagner and Piller, 2012; Piller, 2011) using a questionnaire which consists of four main components, including absorptive capacity, culture, organizational structures and strategy. Waiyawuththanapoom et al. (2013) proposed an integrated framework as a general guide to evaluate readiness of organizational OI implementation in term of six dimensions, including knowledge management (KM), strategic management, change management, external network management, intellectual property right management (IPRM) and environmental moderators. Lamberti et al. (2017) developed OI scorecard for senior management staff (i.e. innovation managers) as a practical tool for monitoring the OI implementation in the company.

Summary

In the literature, importance of the factors affecting the adoption of OI (i.e. capability, culture, knowledge, motivation as well as network) is reviewed and discussed. The existing OI readiness evaluation tools are also studied and discussed. The characteristics of these methods are summarized in Tables 1 and 2. On the whole, the existing OI readiness evaluation methods help considerably for management executives (i.e. solution seekers) in the company which is implementing OI strategy. However, there are three major limitations found in the literature of the evaluation tools for OI readiness which include: -

- **Less awareness of various facilitating factors and their interaction affecting OI adoption**

Table 1. Chronological overview of evaluation tools of OI readiness

Researcher (Year)	Methods	Detail
Keupp and Gassmann (2009); Laursen and Salter (2006)	Hypotheses testing	To measure the openness of the firm's innovatory activities in two dimensions of OI (Laursen and Salter, 2006), such as • External search breadth' strategy • External search 'depth' strategy
van de Vrande et al. (2009)	Survey	Eight innovation practices • Technology exploration • Venturing • Outward IP licensing • Employee involvement • Technology exploitation • Customer involvement • External networking • External participation • Outsourcing R&D • Inward IP licensing
Bevis and Cole (2010)	Open Innovation Readiness Tool	Five main stages • Learning • Preparing • Initiating ideas • Managing • Maturing
NineSigma (2010)	Survey	Three tiers of OI capabilities • Internal collaboration • Existing network collaboration • Global innovation community collaboration
Mattes (2011)	Well-organized thought process	Four main steps • Make an inventory of all OI approaches that your firm already is pursuing • Analyze the fields where OI potentially could add value to your firm • Look for OI benchmarks in the fields identified in step 2 and add these approaches to the list made in step 1 • Filter out the most appropriate approaches by applying four testing questions
	A series of suggestions and advices	Six main steps • Judge whether your existing innovation approach is good enough • Be clear about where the firm should innovate openly – and where it should not • Assess the firm's existing open approaches to innovation • Be inspired – look for proven OI approaches and exchange experiences • Select the most appropriate approaches • Plan for a professional implementation
Wagner and Piller (2012), Piller (2011)	Questionnaire	Four main components • Absorptive capacity • Culture • Organizational structures • Strategy
Waiyawuththanapoom et al. (2013)	General guide	Six dimensions • Internal dimensions • Knowledge Management • Strategic Management • Change management • External dimensions • External network management • Intellectual property right management (IPRM) • Environmental moderators
Lamberti et al. (2017)	A series of indicators	Five dimensions • Outer environment • Inner environment • Collaboration • Importing • Exporting mechanisms

The evidence in the literature that most of the companies are pursuing OI approaches is very compelling, but only few of them have logical mindset to implement OI approaches fully and have a well-architected, integrated and managed OI profile in place. As shown in Table 2, the existing

approaches do not fulfill the requirements needed for the facilitating factors of OI adoption. In particular, the effect of other facilitating factors (i.e. culture, knowledge and experience, motivation as well as network) and their interaction has been overlooked in most of the studies of OI adoption.

- **Capability-oriented measurement for innovation performance**

As shown in Table 2, most of the researchers and practitioners have studied different methods and techniques to focus on the measurement of company's innovation performance (i.e. OI readiness or openness) for OI adoption in terms of their innovation capability. The outputs are always being transformed into capability-oriented result, even though the inputs are non-capability criteria. In other words, all are about the company capability-oriented performance evaluation for OI implementation.

- **Less awareness of how mindsets can affect the company's innovation**

Most of the existing methods and techniques have been restricted to the companies to measure the OI readiness or openness after or during the implementation of OI, as shown in Table 2. There is a lack of investigation into the area of how mindset can affect the company's innovation behaviors before OI adoption. The study in the area of the effect of facilitating factors for OI adoption has also been quite limited. A better understanding of consistency between mindset and behavior to adopt and evolve ways of working within OI is much needed.

In order to address the key issues found in the existing methods, this paper aims to design and develop a self-assessment tool which provides companies with fresh insights from how they are getting ready to implement OI and preliminary understanding on how mindset affect their behavior for OI adoption. Firstly, a better understanding of the effect of various facilitating factors and their interactions on innovation openness is of prime importance for the further development of OI. A survey is designed for companies to conduct the assessment of the openness which takes five facilitating factors (i.e. capability, culture, knowledge and experience, motivation as well as network) into consideration. Secondly, an educative and proactive assessment tool is designed and developed for the companies in assessing their OI mindset toward thinking, their OI mindset toward behavior, and how mindset affect their behavior for OI adoption, respectively. Last but not least, a comparative case study is conducted to verify the performance of the assessment tool through a trial implementation in the selected reference site.

SELF-ASSESSMENT METHOD FOR READINESS ANALYSIS OF OPEN INNOVATION

Open innovation (OI) is a construct which is not measurable by quantity directly. In this study, a series of indicators were designed and developed to measure the degree of openness (i.e. OI readiness) in terms of consistency of both the organizational mind (i.e. corporate policy) and organizational behavior (i.e. action/ outcome) connected to OI. Five significant facilitating factors for OI adoption are selected based on the existing literature including capability, culture, knowledge and experience, motivation as well as network. To assess the openness of companies (i.e. OI readiness) with regards to these five significant facilitating factors, a survey was conducted for company to perform a self-assessment of how mindset affecting their behavior for OI adoption using a quick test. A survey questionnaire is designed which contains 20 statements that is illustrated in Appendix I. They are divided into five dimensions which include capability, culture, knowledge and experience, motivation as well as network. Each dimension is composed of four statements, especially the one attempts to address their OI mindset toward thinking while the other three aim at addressing their OI mindset toward behavior. By Likert-type scale, the respondent is offered a choice of five responses (i.e.

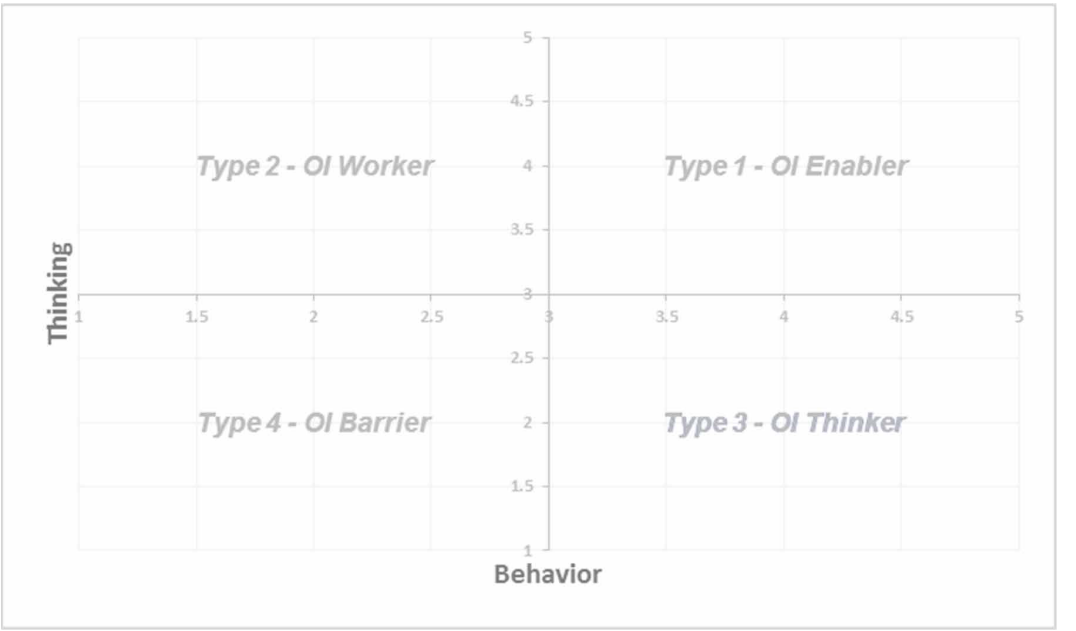
Table 2. Comparison of the existing OI readiness evaluation tools

Author (Year)	van de Vrande et al. (2009)	NineSigma (2010)	Wagner and Piller (2012); Piller (2011)	Proposed Method
Purpose	To explore the incidence of and trends towards OI in SMEs	To evaluate the innovation capabilities across 'engage' and 'enable'	To determine organization's readiness for OI	To assess the consistency of mindset and behavior in OI adoption
Level	Organizational level	Organizational level	Organizational level	Organizational level
Factors	• Venturing • Outward IP licensing • Employee involvement • Customer involvement • External networking • External participation • Outsourcing R&D • Inward IP licensing	• Internal collaboration • Existing network collaboration • Global innovation community collaboration	• Absorptive capacity • Culture • Organization • Strategy	• Capability • Culture • Knowledge • Motivation • Network
Tool	Questionnaire	Questionnaire	Questionnaire	Questionnaire
Focus on	Capability-oriented measurement	Capability-oriented measurement	Capability-oriented measurement	Mindset and behavior-oriented measurement
Output	• Incidence of and apparent trend towards open innovation	• Extent to which they are able to engage with innovation partners internally and externally • How well enabled they are to assimilate knowledge and solutions into their organization	• Aggregated total value for all dimensions • Breakdown of figures for the individual dimensions • Breakdown of figures within the respective dimensions	• OI mindset toward thinking • OI mindset toward behavior • How mindset affect their behavior for OI adoption

strongly agree, somewhat agree, neutral, somewhat disagree, strongly disagree) to express how they agree or disagree with a particular statement. The questionnaire was designed to elicit three types of information: (a) the state of their OI mindset toward thinking, (b) the state of their OI mindset toward behavior, and (c) the state of how mindset affects their behavior for OI adoption. To visualize the result of the questionnaire, the responses were grouped into a 2 x 2 matrix based on the extent of their OI mindset toward thinking and behavior as shown in Figure 1.

As shown in Figure 1, the company is classified according to the OI mindset. Type 1 refers to the "OI enabler" which is characterized by the highest degree of OI adoption. This type of companies has positive attitude to OI adoption which shows in the way they think and behave. In the other words, these companies open up their approaches to innovation which are willing to advance their technology leveraging external and internal ideas as well as the external and internal paths to markets towards mind (i.e. thought) and behavior (i.e. action) in OI adoption. Type 2 refers to the "OI worker". This type of companies has the attitude towards they behave in OI adoption that behave quite differently than what they think. In the other words, these companies prefer to innovate in a closed way, but they innovate openly. Type 3 refers to the "OI thinker" which mindset is opposite to type 2's. This type of companies has the attitude towards what they think in OI adoption, but their thought is quite

Figure 1. Illustration of result in 2 x 2 matrix based on the extent of their OI mindset toward thinking and behavior



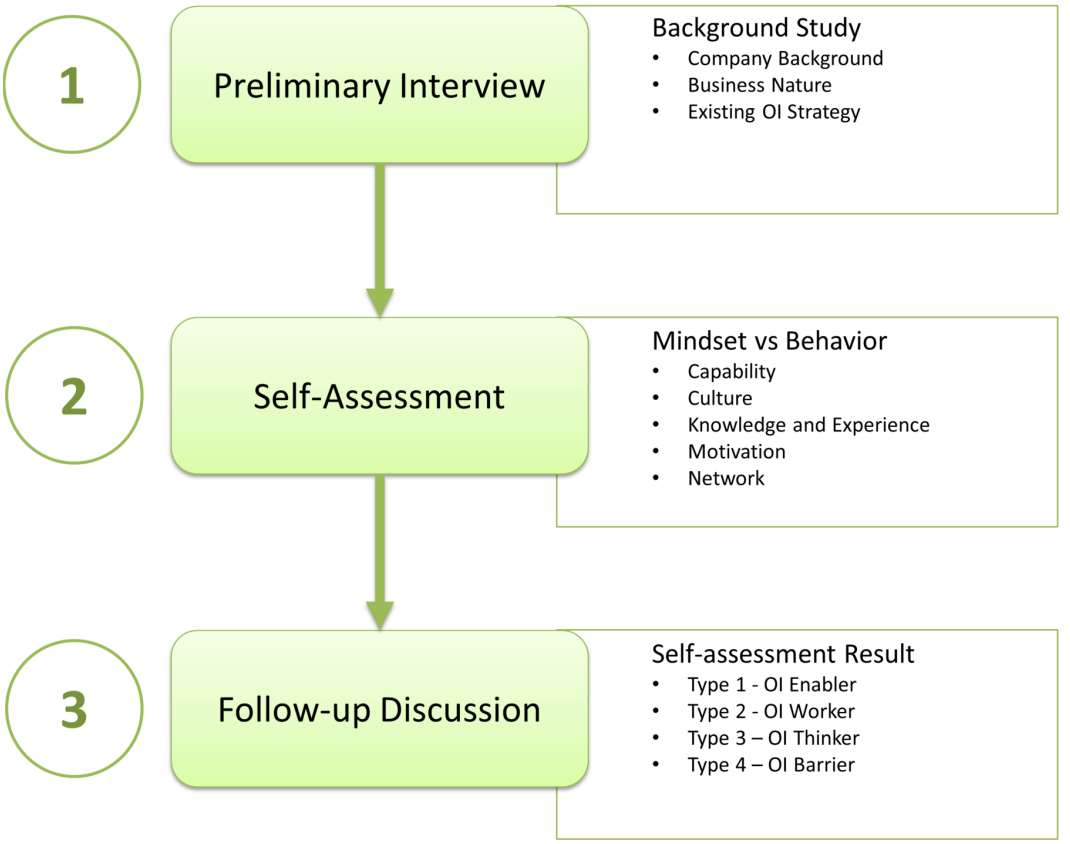
differently from what they behave. In the other words, these companies prefer to innovate openly, but the mindset is still kept in a closed way. Type 4 refers to the "OI barrier" which is characterized by the lowest degree of OI adoption and mindset is opposite to type 1's. This type of companies has the positive attitude to closed innovation adoption which shows in the way they think and behave, but not in OI adoption. In the other words, these companies still pursue closed innovation in order to generate internal ideas and be responsible for developing, producing, distributing, and marketing their own products, technologies and applications in closed environment (i.e. in-house R&D).

Figure 2 shows a framework for the Self-assessment Method for Readiness Analysis of Open Innovation. For better understanding of their openness for OI adoption, three main steps (i.e. preliminary interview, self-assessment and follow-up discussion) were conducted, respectively. The preliminary interview is conducted to elicit three types of information initially, such as company background, business nature and the existing OI strategy of target organization before completion of the self-assessment. Self-assessment of how mindset affecting their behavior for OI adoption is then conducted using a quick test. The result of the self-assessment clearly shows that the target organization belongs to which type of OI mindset (i.e. Type 1, 2, 3, or 4). Regarding the result, the state of their OI mindset toward thinking, the state of their OI mindset toward behavior, and the state of how mindset affect their behavior for OI adoption is also enclosed. The follow-up discussion is subsequently conducted with the respondent to provide advice and suggestions on how mindset affects their behavior for OI adoption according to the results of the self-assessment.

TRIAL IMPLEMENTATION

To realize the capability of the Self-assessment Method for Readiness Analysis of Open Innovation, a trial implementation of the proposed method for analyzing how mindset affecting their behavior for OI adoption was conducted for various companies so as to assess their openness with regards to these five significant facilitating factors using a quick test. A total of 29 companies were invited to participate in the preliminary study which consists of 11 in the Service Industry, 8 in Engineering Industry, 3

Figure 2. Framework of self-assessment method for readiness analysis of open innovation



in Education, 4 from Departments from Government as well as 3 Non-government Organization (NGO) (see Table 3). A representative from the companies who are working in management level was selected to conduct the self-assessment method for readiness analysis of open innovation using the questionnaire.

After the completion of the questionnaire, self-assessment results of each organization is calculated in terms of thinking and behavior according to five factors (i.e. motivation, network, culture knowledge and capability). In this study, actual scores of each question completed by the 29 participating companies were collected and shown in Table 4. In Figure 4, item (a) of each factor is the scores of OI toward thinking in particular factors. Items (b), (c) and (d) are the scores of OI toward behavior in particular factors, respectively.

As shown in Table 5, T_n is score of OI toward thinking in each factor, as same as the score of item (a) illustrated in Table 4 and $Av(T_n)$ is average scores of each item (a) in five factors which also represents final scores of OI toward thinking. B_n is average score of items (b), (c) and (d) as shown in Table 4 that represents scores of OI toward behavior in particular factors, respectively. Afterward, $Av(B_n)$ is average scores of each B_n in five factors which also represents final scores of OI toward behavior. According to the final scores of OI toward thinking and behavior, the organization can be classified in types of OI mindset.

After the completion of the trial implementation, the companies were classified into four particular types according to the OI mindset, i.e. OI enabler, OI worker, OI thinker, OI barrier. As shown in Figure 3, the results of the self-assessment clearly show that 10 participating companies belong to

Table 3. Information of 29 participating companies

Industry	Company No.	Quantity
• Service Industry	Company #1, #3, #4, #5, #6, #11, #13, #18, #20, #23 and #27	11
• Engineering Industry	Company #9, #10, #15, #21, #24, #25, #26 and #28	8
• Education	Company #14, #17 and #29	3
• Government	Company #2, #8, #16 and #22	4
• NGO	Company #7, #12 and #19	3
Total		29

OI enabler (i.e. type 1 of OI mindset) and another 10 belong to OI thinker (i.e. type 3 of OI mindset). Only one participating company belongs to OI worker (i.e. type 2 of OI mindset) while the rest of the participating companies belong to the OI barrier (i.e. type 4 of OI mindset).

COMPARATIVE CASE STUDY

To illustrate how the above assessment framework is applied in technology-intensive company, a comparative case study research was conducted in Hong Kong. In order to make the assessment more comparative, two target organizations of 29 participating organizations were selected in the study according to similar core competency in terms of (a) the nature of business, (b) the qualification of staff, (c) research areas, (d) variety of the customers, and (e) research achievement (i.e. projects, patents and awards). The empirical study has focused on technology-intensive organizations which mainly provide R&D services and are looking for the adoption of OI. The background information of two target organizations is tabulated in Table 6.

Reference Case 1: Target Company A

Since its foundation in 2004, Target Company A ("The company") is a leading Radio Frequency Identification (RFID) solution provider with headquarter in Hong Kong which provides RFID solutions and consultancy services according to customer requirements. Experienced staff with strong technical background from different industries such as computing, electronic, engineering, and manufacturing contributes to R&D of the company. Several strategic alliances have been formed with other research institutes and corporations to benefit from synergy and technology transfer. The company invests a lot of high-grade equipment for R&D and creates their own products and at the same time also builds up their honor images. The remarkable achievements of the company are reflected by their outstanding performance in obtaining R&D as well as marketing. For instance, various RFID products have been placed onto the market and were very well received. For the group of end users, it comprises RFID end users companies and RFID technology suppliers. In this case study, the company is a hardware solution provider so that they have to consider their potential customer's needs and also to consider the software company alliance providing the feasible technical support for their complete solution. Over the years, the company is also honored with several patents and various awards in area of RFID technology.

Reference Case 2: Target Company B

Target Company B ("The laboratory") engages in applied research, technology transfer, and provision of consultancy services for the development of RFID Technology, Internet of Things (IoT) Technology, Wireless Sensor Network (WSN) Technology, Mobile Technology and Cloud Computing in the

Table 4. Actual scores of each question completed by the 29 participating companies

Company Number	(1) Motivation				(2) Network				(3) Culture				(4) Knowledge				(5) Capability			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
#1	3	4	4	3	5	4	3	2	4	4	5	3	4	4	2	4	3	4	4	4
#2	2	3	3	3	3	2	5	4	3	3	3	3	3	2	4	1	2	1	2	3
#3	4	2	4	2	5	2	2	2	2	3	4	4	2	2	2	1	2	2	1	1
#4	4	4	3	3	4	2	2	1	4	4	4	2	1	1	2	1	2	1	2	2
#5	4	2	2	2	3	2	5	4	3	3	4	3	3	1	1	2	3	2	1	1
#6	4	4	2	2	5	4	4	4	4	3	3	4	2	2	4	2	3	1	2	1
#7	4	3	4	2	4	3	4	2	3	3	3	2	2	2	2	2	2	2	2	3
#8	3	4	4	1	4	2	3	2	2	2	4	2	2	1	1	1	2	1	2	1
#9	2	2	2	3	4	3	4	3	1	2	3	2	2	1	2	3	3	2	3	4
#10	4	2	2	2	4	3	3	4	4	4	2	2	3	3	3	3	3	2	2	2
#11	4	4	3	4	4	4	4	4	4	4	3	3	4	4	5	4	4	4	4	4
#12	4	4	4	4	4	4	3	3	4	4	5	4	4	4	4	4	4	4	4	4
#13	3	4	4	4	3	3	2	3	4	3	3	3	3	3	5	3	4	3	4	3
##14	2	1	2	1	3	3	4	4	2	1	3	3	3	1	3	2	4	4	3	3
#15	5	2	2	1	4	1	1	2	3	2	4	2	1	1	3	2	3	1	2	2
#16	1	2	2	3	3	4	2	2	2	2	3	4	3	3	3	2	2	2	3	3
#17	3	3	4	2	3	2	2	3	4	3	3	3	2	2	4	3	3	3	3	2
#18	4	5	4	2	4	4	3	2	4	4	4	3	3	3	3	3	3	3	3	3
#19	3	1	4	4	4	2	5	5	5	5	5	5	5	5	5	5	4	4	4	4
#20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1
#21	2	2	4	3	4	3	4	2	4	3	4	5	2	2	5	2	4	2	2	4
#22	4	4	3	2	4	2	2	2	3	3	2	2	2	2	3	2	3	2	3	2
#23	5	4	4	3	3	4	2	3	4	3	4	3	2	3	3	2	3	3	4	3
#24	5	4	5	3	4	3	3	2	5	5	3	4	5	4	5	4	4	5	5	4
#25	5	4	3	3	5	2	3	3	4	4	4	3	3	2	5	3	4	4	3	4
#26	5	5	5	5	5	5	3	2	4	4	4	4	5	3	5	3	5	5	5	5
#27	3	1	1	1	3	1	3	1	3	3	1	1	1	1	1	1	1	1	1	1
#28	4	4	3	2	4	3	3	3	5	5	2	3	3	3	4	2	2	1	2	2
#29	3	3	3	3	3	4	4	4	3	3	3	4	3	3	3	2	3	2	4	3

various industries since its establishment in 2000. The research team in the laboratory positions itself in industry-based and applied research. The significance of contributions made by the research activities undertaken by the research team is indicated by its achievement in securing research grants and soliciting industrial donations. The high degree of success has been achieved through involvement of the research team in industry-based and consultancy projects. The team has successfully obtained over HK$18 million research funding over the last few years including external research funds (i.e. Innovation and Technology Fund (ITF), internal research funds, collaborative research, and consultancy projects. The remarkable achievements of the team in research are reflected by their outstanding performance in obtaining external research funding, high quality research output, and industrial applications to companies in Hong Kong and on Mainland China. Always mindful of

Table 5. Final assessment results of 29 participating companies

Company Number	(1) Motivation		(2) Network		(3) Culture		(4) Knowledge		(5) Capability		OI toward Thinking	OI toward Behavior	Type
	T_n	B_n	T_n	B_n	T_n	B_n	T_n	B_n	T_n	B_n	Av(T_n)	Av(B_n)	
#1	3	3.67	5	3.00	4	4.00	4	3.33	3	4.00	3.8	3.6	OI Enabler
#2	2	3.00	3	3.67	3	3.00	3	2.33	2	2.00	2.6	2.8	OI Barrier
#3	4	2.67	5	2.00	2	3.67	2	1.67	2	1.33	3	2.27	OI Thinker
#4	4	3.33	4	1.67	4	3.33	1	1.33	2	1.67	3	2.27	OI Thinker
#5	4	2.00	3	3.67	3	3.33	3	1.33	3	1.33	3.2	2.33	OI Thinker
#6	4	2.67	5	4.00	4	3.33	2	2.67	3	1.33	3.6	2.8	OI Thinker
#7	4	3.00	4	3.00	3	2.67	2	2.00	2	2.33	3	2.6	OI Thinker
#8	3	3.00	4	2.33	2	2.67	2	1.00	2	1.33	2.6	2.07	OI Barrier
#9	2	2.33	4	3.33	1	2.33	2	2.00	3	3.00	2.4	2.6	OI Barrier
#10	4	2.00	4	3.33	4	2.67	3	3.00	3	2.00	3.6	2.6	OI Thinker
#11	4	3.67	4	4.00	4	3.33	4	4.33	4	4.00	4	3.87	OI Enabler
#12	4	1.33	4	2.00	4	3.33	4	1.00	4	2.00	2.6	1.93	OI Barrier
#13	3	4.00	3	2.67	4	3.00	3	3.67	4	3.33	3.4	3.33	OI Enabler
##14	2	1.33	3	3.67	2	2.33	3	2.00	4	3.33	2.8	2.53	OI Barrier
#15	5	1.67	4	1.33	3	2.67	1	2.00	3	1.67	3.2	1.87	OI Thinker
#16	1	2.33	3	2.67	2	3.00	3	2.67	2	2.67	2.2	2.67	OI Barrier
#17	3	3.00	3	2.33	4	3.00	2	3.00	3	2.67	3	2.8	OI Thinker
#18	4	3.67	4	3.00	4	3.67	3	3.00	3	3.00	3.6	3.27	OI Enabler
#19	3	3.00	4	4.00	5	5.00	5	5.00	4	4.00	4.2	4.2	OI Enabler
#20	1	1.00	1	1.00	1	1.00	1	1.67	1	1.00	1	1.13	OI Barrier
#21	2	3.00	4	3.00	4	4.00	2	3.00	4	2.67	3.2	3.13	OI Enabler
#22	4	3.00	4	2.00	3	2.33	2	2.33	3	2.33	3.2	2.4	OI Thinker
#23	5	3.67	3	3.00	4	3.33	2	2.67	3	3.33	3.4	3.2	OI Enabler
#24	5	4.00	4	2.67	5	4.00	5	4.33	4	4.67	4.6	3.93	OI Enabler
#25	5	3.33	5	2.67	4	3.67	3	3.33	4	3.67	4.2	3.33	OI Enabler
#26	5	5.00	5	3.33	4	4.00	5	3.67	5	5.00	4.8	4.2	OI Enabler
#27	3	1.00	3	1.67	3	1.67	1	1.00	1	1.00	2.2	1.27	OI Barrier
#28	4	3.00	4	3.00	5	3.33	3	3.00	2	1.67	3.6	2.8	OI Thinker
#29	3	3.00	3	4.00	3	3.33	3	2.67	3	3.00	3	3.2	OI Worker

keeping close collaboration with industry, various collaborative projects are being undertaken by the laboratory. The team members contributed to this success in various aspects from idea generation, implementation, to industrial liaison activities. The academic pursuit in RFID applied research also has a strong applications orientation which has led to high-level consultancy and technology transfer activities to industry. In addition, the laboratory is also honored with several US, China and Hong Kong patents, and various awards over the years.

RESULTS AND DISCUSSION

Background description of two target organizations presented in the above section provides a clear illustration of their core competency in terms of (a) the nature of business, (b) the qualification of staff, (c) research areas, (d) variety of the customers, and (e) research achievement (i.e. projects, patents and awards). In the section, self-assessment results of how mindset affecting their behavior for OI adoption are presented and discussed.

Figure 3. Illustration of self-assessment results of 29 participating companies in term of type of OI mindset

Table 6. Background of target organizations

Target Organizations	Target Company A	Target Company B
Company Number (Refer to Tables 4 and 5)	Company #28	Company #29
Technology	RFID Technology	RFID Technology
Year of Establishment	Since 2004	Since 2000
Location	Hong Kong	Hong Kong
Nature of Business	Service Provider	Service Provider

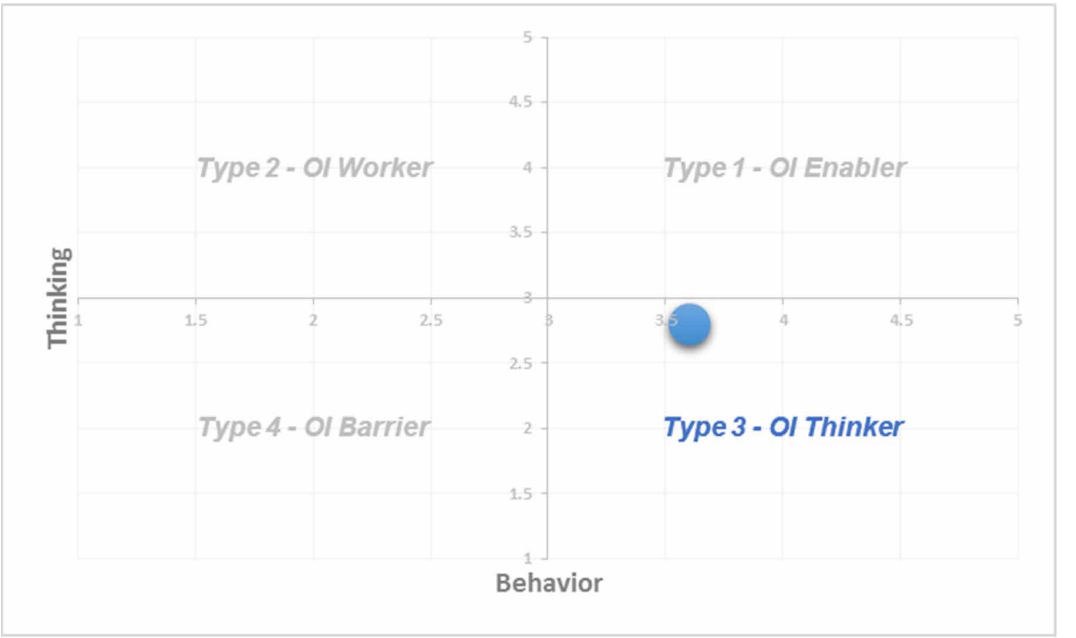
Case Study 1 - Target Company A

As shown in Table 5 and Figure 4, the results of the self-assessment clearly show that the company belongs to OI thinker (i.e. type 3 of OI mindset). This type of companies has partly opened up their innovation mindset which has the attitude towards what they think in OI adoption that think quite differently than they behave. In the other words, these companies prefer to innovate openly, but the mindset is still kept in a closed way. For better understanding of OI mindset of the company, the state of their OI mindset toward thinking, the state of their OI mindset toward behavior, and the state of how mindset affect their behavior for OI adoption is also shown in Figures 5(a), 5(b) and 5(c), respectively.

State of Their OI Mindset Toward Thinking

The findings in Figure 5 indicate that the company had strongly positive responses on statements of culture, motivation and network which addressed their OI mindset toward thinking. Especially, the interviewee strongly agreed with the statement on culture that is "Employee have an open-minded toward open innovation". Furthermore, the interviewee had neutral and slightly negative responses on statements of knowledge and experience as well as capability respectively.

Figure 4. Illustration of self-assessment result of Target Company A in term of type of OI mindset



State of Their OI Mindset Toward Behavior

The findings in Figure 6 indicate that the company had slightly positive and slightly negative responses on statements of culture and capability which addressed their OI mindset toward behavior, respectively. Besides, the interviewee had neutral responses on statements of motivation, network as well as knowledge and experience.

State of How Mindset Affect Their Behavior for OI Adoption

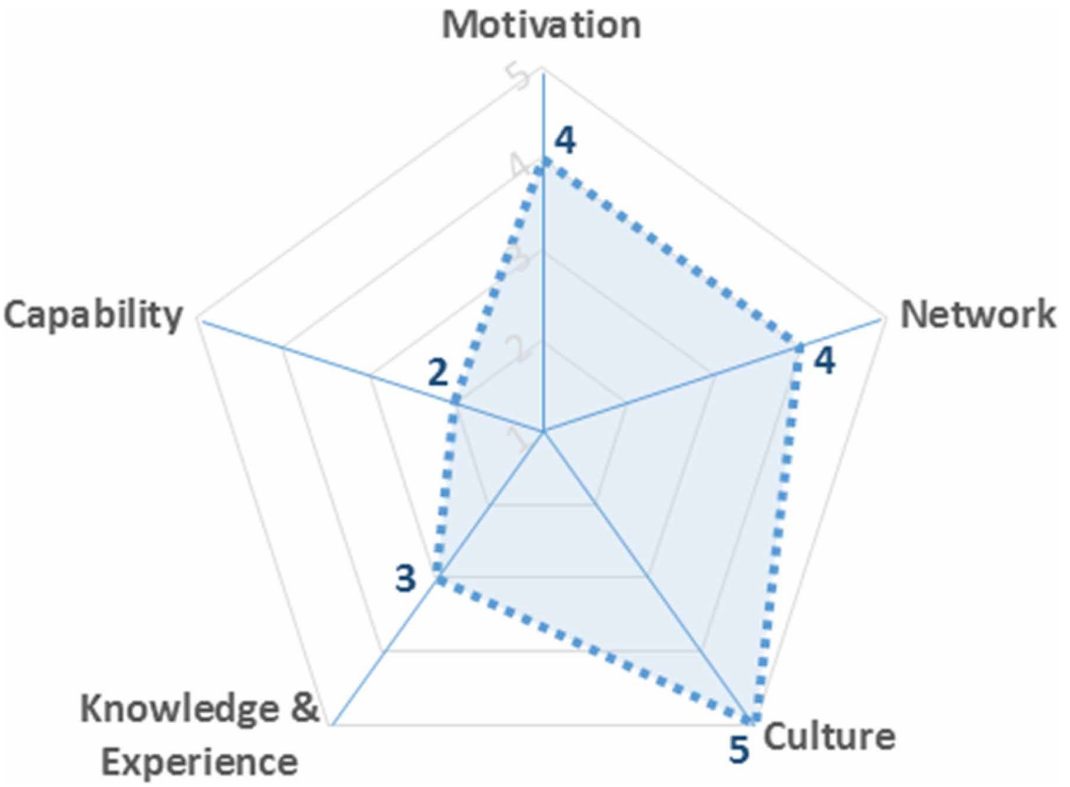
In the case of the company, an idea of OI adoption is beginning to take shape in the mind towards thinking, rather than behavior, as shown in Figure 7. The state of their OI mindset toward thinking could be attributed to the existing OI strategy of the company, since the interviewee mentioned during the preliminary interview that the active efforts are being made to adopt OI in the company.

Interestingly, the state of their OI mindset toward behavior may be slightly different as compared with the state of their OI mindset toward thinking. The results implied that the company take slightly passive actions to adopt OI, especially in the dimensions of culture, motivation and network.

According to the result of dimension "culture", the top management of the company strongly supports to adopt OI and they are aggressive to find external partners for creating and profiting from technology, especially business-to-consumer (B2C) services. Meanwhile, employees are hesitant to value idea and technology that are generated from outside company and remain neutral when they scout and scan the external technology consciously. The company makes more effort on motivation for searching external technology and information about OI and remains neutral when identifying potential partners, but the company may make relatively less effort to improve employee's motivation for engaging with external innovation partners.

The interviewee explained that the company placed extensive manpower and capital on R&D, only the top management of the company is responsible for engaging OI and find external innovation partners for collaboration. That's why the company takes slightly passive actions on statements of culture and motivation which addressed their OI mindset toward behavior.

Figure 5. Self-assessment results of the state of Target Company A's OI mindset toward thinking

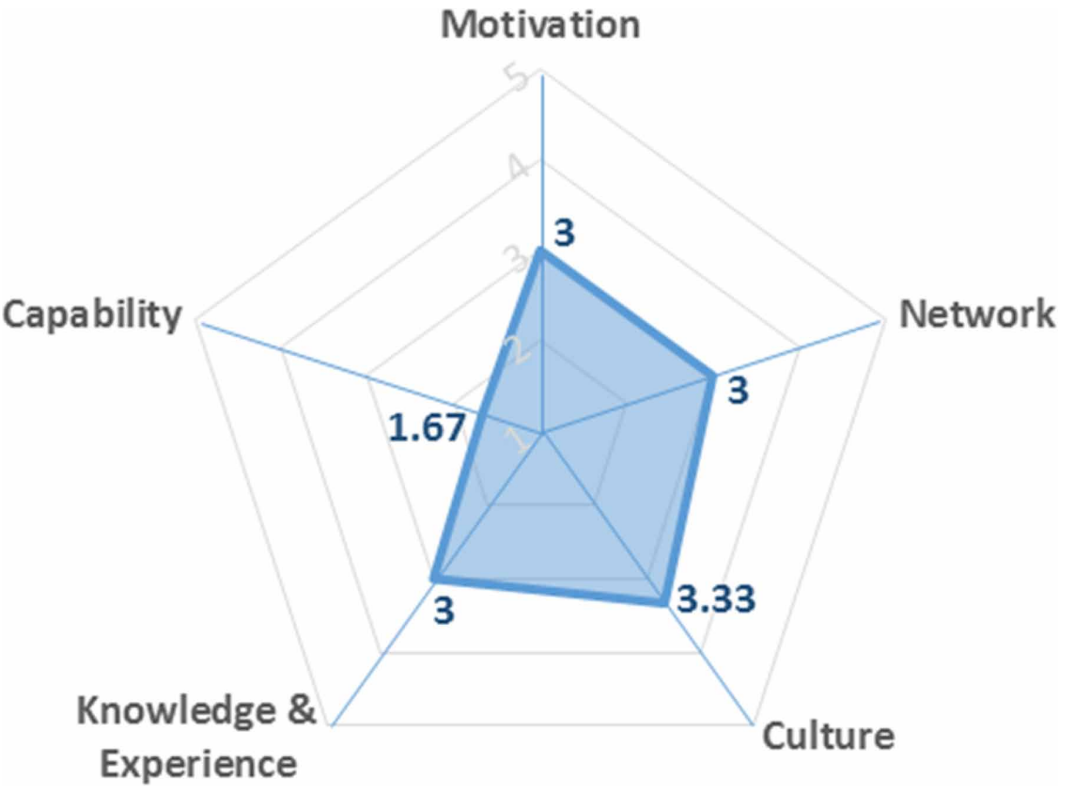


The company adopts a neutral position on all statements of network which addressed their OI mindset toward behavior. The interviewee mentioned that the company is strict about building a network for engaging OI, so the top management will take different criteria into consideration when deciding to add the new partners. Access to the expertise in the existing network is restricted to top management only. In addition to the strategic alliance cooperation with other research institutions and corporations, not only the company can improve the RFID technology fabulously, they are also able to promote the advantages of the use of RFID to future lives with wide coverage.

The company had slightly negative response on statements of capability which addressed their OI mindset toward behavior. The result expressed that the company may not undertake to establish their OI capability. Especially, the company rarely put effort (i.e. assign staff or project team) into management of OI projects. The interviewee mentioned that the company mainly focuses on the hardware development of their products and take out several patents on their hardware products. Software of their products is non-core development in their business which is outsourced and developed by the external parties.

In the dimension "experience", the result implied that the company has plenty of experience on building collaboration partnership with other companies through OI practices, and some experience on finding partner when participating OI activities, respectively. Relatively, the company may have less experience to design and develop products via OI approaches. The interviewee expressed that the company devoted the effort in the confirmation of base source with assistance from many experts including RF Engineers, Product Designers, Information System Experts so as to ensure the uniformity, uniqueness and differentiation of the product and service quality.

Figure 6. Target Company A's OI mindset toward behavior



Case Study 2 - Target Company B

As shown in Table 5 and Figure 8, the results of the self-assessment clearly show that the laboratory belongs to OI worker (i.e. type 2 of OI mindset) which is opposite to the results of Target Company A. This type of companies has also partly opened up their innovation mindset but in the different way. The laboratory has the attitude towards what they behave in OI adoption that behaves quite differently from what they think. In the other words, the laboratory prefers to innovate in a closed way, but they innovate openly.

For better understanding of OI mindset of the laboratory, the state of their OI mindset toward thinking, the state of their OI mindset toward behavior, and the state of how mindset affect their behavior for OI adoption is shown in Figures 9, 10 and 11, respectively.

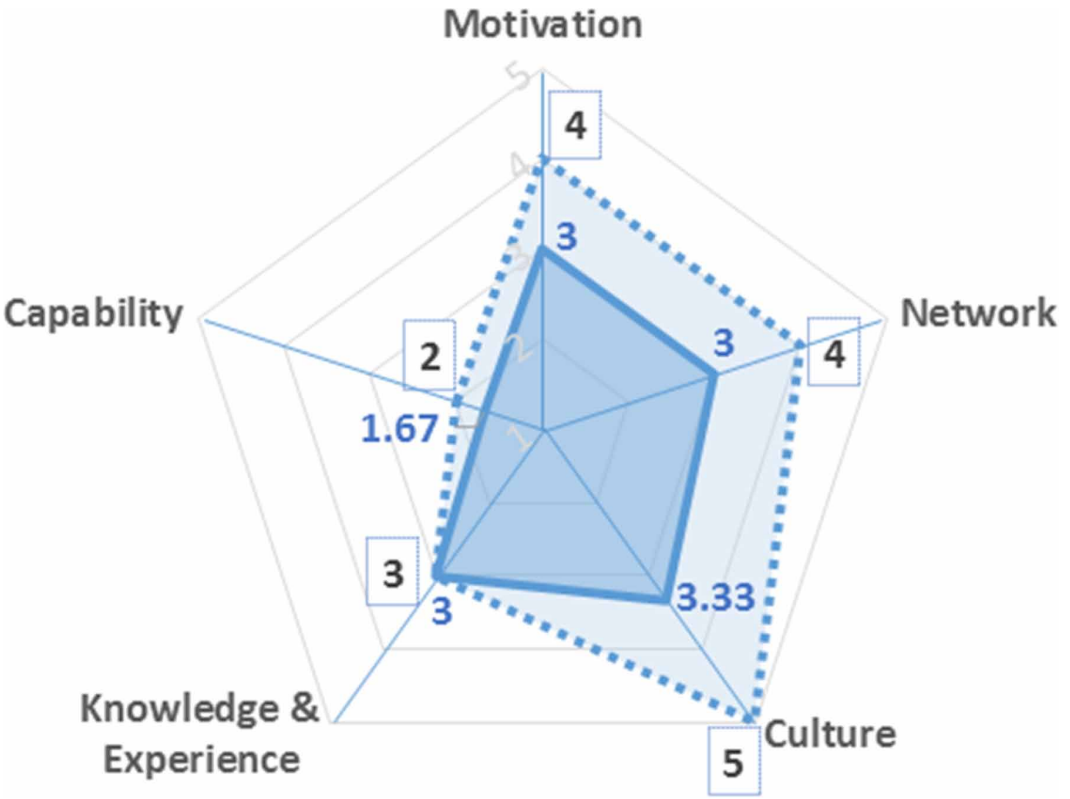
State of Their OI Mindset Toward Thinking

According to the result shown in Figure 9, it is revealed that the laboratory remained neutral on all the statements in five dimensions which addressed their OI mindset toward thinking.

State of Their OI Mindset Toward Behavior

As shown in Figure 10, the laboratory had slightly positive responses on the statements of network and culture which addressed their OI mindset toward behavior. Furthermore, the interviewee had neutral responses on the statements of capability and motivation and provided slightly negative responses on the statements of knowledge and experience.

Figure 7. State of how mindset affects their behavior for OI adoption



State of How Mindset Affects Their Behavior for OI Adoption

In the case of the laboratory, an idea of OI adoption is beginning to take shape in the mind towards behavior, rather than thinking, as shown in Figure 11. The state of their OI mindset toward thinking could be attributed to the existing OI strategy of the laboratory, since the interviewee mentioned during the preliminary interview that the laboratory tried to remain neutral when they started OI adoption.

Interestingly, the state of the laboratory's OI mindset toward behavior may be slightly different as compared with the state of their OI mindset toward thinking. The results implied that the laboratory take slightly aggressive actions to adopt OI, especially in the dimensions of network and culture.

According to the result of dimension "network", there are slightly positive responses on the existing and new network of searching partnership for OI adoption. Moreover, the network is easily accessed by the team members of the laboratory. The interviewee explained that the team members of the laboratory frequently participate in various local and international activities (i.e. seminars, workshops, conferences, exhibitions, site visits and competitions) to create network for promoting the laboratory and seeking for further collaboration opportunities. In addition, various workshops, seminars and exhibitions have been organized to disseminate the knowledge gained from the industry.

In the dimension "culture", top management of the laboratory adopts a neutral position on supporting to OI and the employees of the laboratory remain neutral when they value idea and technology from outside. Interestingly, the employees are going to scout and scan the external technology consciously. The interviewees mentioned that the research team of the laboratory plays a research-oriented role which mainly engages in investigating various new and potential technologies. As a result, the team members of the laboratory consciously participate in various activities to obtain

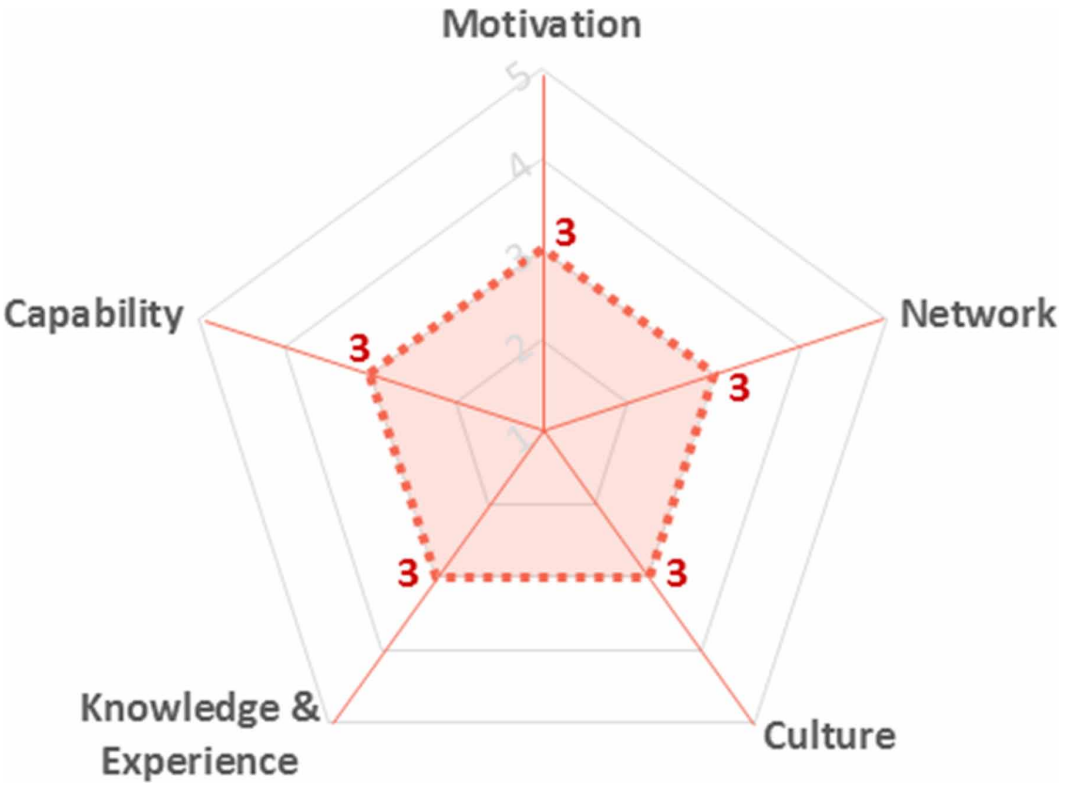
Figure 8. Illustration of self-assessment result of Target Company B in terms of type of OI mindset

information of the latest technology, learn more different emerging technologies and also understand the latest technology development which could be taken into consideration on the research and project enhancement. Moreover, most of the team members graduated in Industrial Engineering and Computing Engineering disciplines. Similar background of the employees is one of the major forces in the culture.

The laboratory has strong intellectual Property (IP) mechanisms (i.e. patents, memorandum of understanding (MoU), non-disclosure agreement (NDA)) to secure the technology. By virtue of the mechanism, the laboratory is also honored with several United Stated (US), China and Hong Kong patents in areas of supply chain management, logistics management, physical asset management, manufacturing, counterfeit prevention, and healthcare management in the decade. The interviewee mentioned that most of industrial and research partners may perceive patent portfolios as a conclusive evidence of the high level of expertise, specialization and technological capacity with the laboratory. The remarkable achievements of the team in research are reflected by their outstanding performance in obtaining external research funding, high quality research output, and industrial applications to companies in Hong Kong and on Mainland China. Furthermore, some OI tools may be used to support OI adoption. No staff or project team is designated to manage OI project, but search external technology.

The laboratory had neutral responses on the statements of motivation which addressed their OI mindset toward thinking and behavior. The laboratory keeps scanning and monitoring external technologies, but not only for OI adoption. The team members also regularly participate in activities to identify potential partners for collaboration, but not for OI only. Moreover, the interviewee mentioned that it is rare to find OI activities in Hong Kong. The laboratory establishes a reward system to encourage team members for collaborating with external partners. The interviewee pinpointed that the excellent services provided by the team have made a significant impact and created goodwill among local industries which also helps to foster a "high-tech" image for the Department in particular and the University in general.

Figure 9. State of Target Company B's OI mindset toward thinking



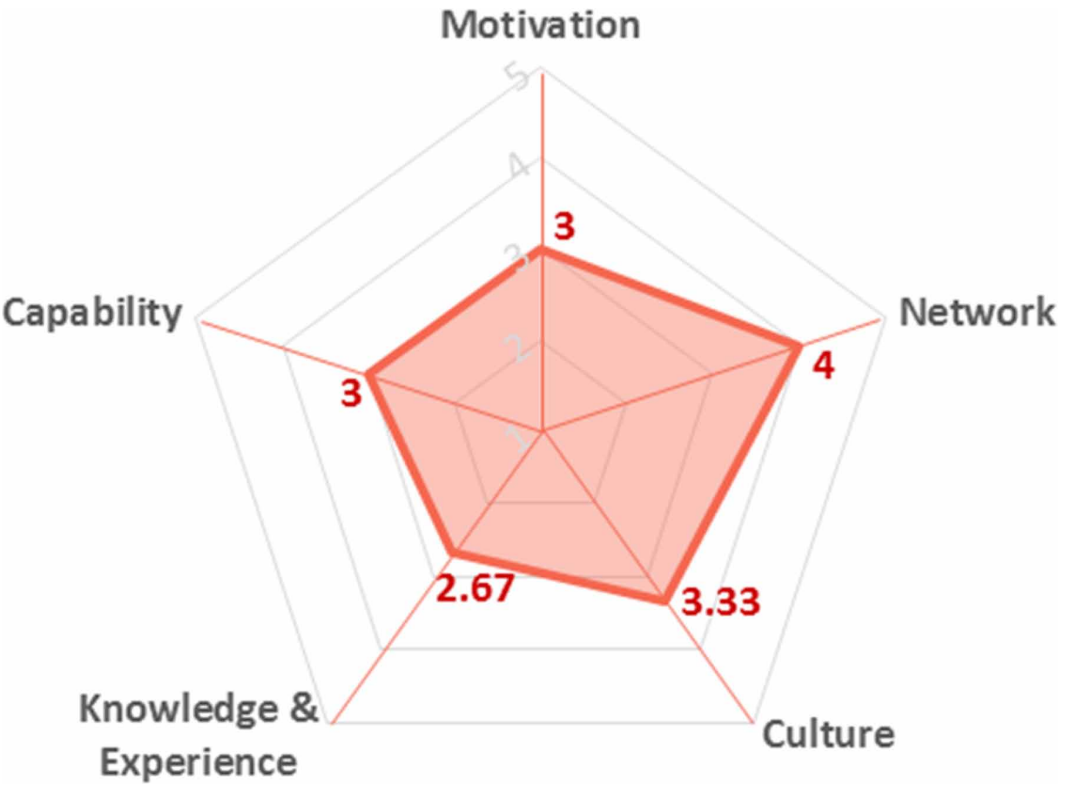
The laboratory has some experience to search partners when participating in various activities and collaborates with them via OI practices, such as licensing, spin-off, etc. To address such industrial needs, the team is collaborating with different international and local universities and companies (i.e. Intelligent Maintenance Systems (IMS) of University of Cincinnati in USA, University of Toronto in Canada, HARTING Technology Group in Germany, Leo Paper Group in Hong Kong, Sino Parking Services Limited in Hong Kong, Pok Oi Hospital in Hong Kong) in joint research and development of methodology, systems, and standards on innovative and advanced RFID technologies and Internet of Things (IoT) solutions for various areas, such as infotronics, logistics, healthcare management, counterfeit prevention and physical asset management (PAM), etc.

The outputs of the team's work are highly regarded by the industries and the team has successfully solicited sponsorships and donations from industries in acquiring software and hardware in RFID equipment and accessories. However, the products of the laboratory are rarely designed and developed using OI approach. The interviewee explained that the core products are mainly designed and developed by the team members and the supporting parts of product development are conducted by outsourcing approach. It is convenient to apply for patent on their products and methodologies.

Summary

By conducting a comparative case study research on how their mindset affects their behavior for OI adoption, two technology-intensive organizations were selected and assessed. They mainly provide R&D services and are looking for the adoption of OI in Hong Kong. According to the results of the self-assessment, The Target Company A belongs to OI thinker (i.e. type 3 of OI mindset) which is opposite to the result of the Target Company B (i.e. OI worker, type 2 of OI mindset). The state of

Figure 10. State of their OI mindset toward behavior



their OI mindset toward thinking could be attributed to their existing OI strategy mentioned during the preliminary interview for both cases. In contrast, the state of their OI mindset toward behavior may not attributed to their existing OI strategy for both cases. This is reflected in the fact that the companies may be overestimated or underestimated their OI mindset towards behavior in terms of five dimensions (i.e. capability, culture, knowledge and experience, motivation as well as network).

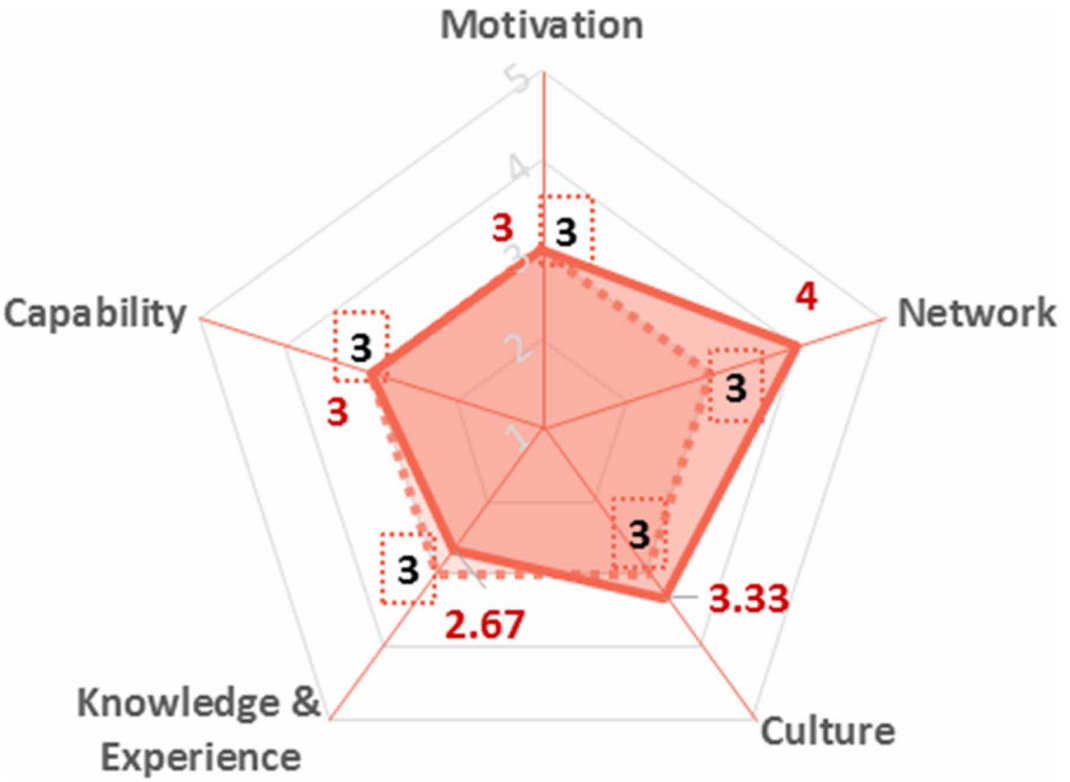
In the case of the company, the status of their OI mindset toward behavior may be overestimated in the dimensions of capability, culture, motivation and network, as shown in Figure 11. As the findings in Figure 11, they indicate that the status of the laboratory's OI mindset toward behavior may be underestimated in the dimensions of network and culture.

The representatives of the target organizations expressed that the results of the study are useful and practical for both the target companies to have a better understanding on how mindset affect their behavior for OI adoption in terms of five dimensions. Especially, the state of their OI mindset toward behavior provide a quick view on what they are already done and vice versa for OI adoption and they may initiate the follow up actions effectively after the completion of the assessment.

CONCLUSION

Various companies are increasingly paying attention to external sources (i.e. knowledge and technologies) in their innovation activities. Shortening time-to-market for product, gaining access to new technologies and enhancing innovation competencies are important for the adoption of OI. The exploration of OI is the evolution of decades of research. The literature provides evidence that the existing OI readiness evaluation tools are used mainly to measure and analyze their innovation

Figure 11. State of how mindset affects their behavior for OI adoption



capability for OI adoption in organizational level. However, there is a gap regarding how mindset affect behavior for OI adoption in the organization. In order to address the key issues found in the literature, this paper presents a self-assessment tool which provides companies with fresh insights from how they are getting ready to implement OI and understanding on how mindset affect their behavior for OI adoption.

In this study, a comprehensive investigation into factors affecting the adoption of OI has been conducted. The literature provides evidence that five facilitating factors (i.e. capability, culture, knowledge and experience, motivation as well as network) are significant facilitating factors affecting the adoption of OI. A better understanding of consistency between mindset and behavior to adopt and evolve ways of working within OI is much needed. A survey was conducted to find out what type of OI mindset (i.e. OI enabler, OI worker, OI thinker, OI barrier) they belong to and how mindset affect their behavior for OI adoption which takes five facilitating factors mentioned before into account. An educative and proactive assessment tool has been designed and developed in questionnaire format for the companies to perform self-assessment. The questionnaire was managed to elicit information from the interviewee, including the state of their OI mindset toward thinking, the state of their OI mindset toward behavior as well as the state of how mindset affect their behavior for OI adoption. A total of 29 companies were invited to join the study so as to realize the capability of the Self-assessment Method for Readiness Analysis of Open Innovation. A trial implementation of how mindset affecting their behavior for OI adoption was conducted to access their openness via the quick test. The results show that most companies belong to OI enabler (i.e. 10 out of 29) and OI thinker (i.e. 10 out of 29). A comparative case study has been conducted to illustrate the performance of the assessment tool in two target organizations. It is interesting to note that the state of their OI mindset toward thinking

could be attributed to their existing OI strategy for two cases, but it is quite different from the state of their OI mindset toward behavior.

With the successful development and trial implementation of the self-assessment tool for Readiness Analysis of Open Innovation, the interviewees made positive comment about the assessment results. It also allows the companies to have fresh insights on how mindset affects their behavior for OI adoption before they start to adopt OI. Comparing to the existing innovation openness assessment methods, the proposed method addresses the key concepts of OI mindset and discovers the relations between the mindset and five facilitating factors for OI adoption, not only the OI capability. This approach is capable of analyzing the state of their OI mindset toward thinking or behavior as well as the state of how mindset affects their behavior for OI adoption. For future work, more factors may be also taken into consideration for assessment of openness, such as resource limitation, the capacity restriction, the competencies, the tasks undertaking, the corporate/ national policy, contract research, leadership, and so on. Future studies may focus on searching potential partners for collaboration by leveraging the results generated by the assessment tool. This helps the companies to explore business opportunities for innovating technology via OI approach.

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APPENDIX I

Table 7. Survey

Dimension		Statement	Score
Motivation	1(a)	Open Innovation is a business strategy that benefit to our company create innovative product	
	1(b)	Our company is ongoing searching external technology and information about open innovation	
	1(c)	Regularly searching some open innovation activities to participate or join the activities by invitation in order to identify potential partner(s)	
	1(d)	Establishing a reward/incentive system for employees that supports engaging with external innovation partners	
Network	2(a)	Building a network is necessary for our company engaging open innovation	
	2(b)	Our company has an existing network for accessing the technology	
	2(c)	It is easy to add new partners to our network	
	2(d)	Our network partners' expertise is easily accessed by all company employees	
Culture	3(a)	Employee have an open-mind toward open innovation	
	3(b)	The top management has a direct support to open innovation and give a positive effect	
	3(c)	Employee value idea and technology that are generated from outside company	
	3(d)	Employee scout and scan the external technology consciously	
Knowledge and Experience	4(a)	Our company has experience in serving open innovation practitioner	
	4(b)	Company has experience in participating open innovation activities to find partner	
	4(c)	Our company has form a collaboration partnership with other company through open innovation practices, such as licensing, joint venture, etc.	
	4(d)	Our company product is/are regularly come from open innovation	
Capability	5(a)	Our company strive to build up an open innovation capability	
	5(b)	Staff or open innovation team are designated to search external technology and manage open innovation project	
	5(c)	Strong IP protection mechanisms, such as patent and legal contract to secure the technology	
	5(d)	Some open innovation tools and infrastructure, such as intelligence systems, have established to support open innovation	

Meina Cheng is a Postdoctoral Fellow of the Department of Industrial and Systems Engineering at The Hong Kong Polytechnic University and she is working on several research and education projects in areas of Strategic Planning, Technology Forecasting, Product-Service System (PSS), Learning Analytics and Learning Pedagogies. Her research interests are also on Knowledge Management, Technology Management, Innovation Management, Supply Chain Management and Logistics, Industrial Engineering, and Ultra-precision Engineering.

Benny C.F. Cheung is Professor and Associate Director of the Knowledge Management and Innovation Research Centre at the Department of Industrial and Systems Engineering in The Hong Kong Polytechnic University. His research in Knowledge and Technology Management encompasses a broad-based research of methods and tools built on a basis of Information Processing and Artificial Intelligence Technologies for supporting the management of knowledge and technology for enterprises from various industries such as Manufacturing, Public Utility, Social Service, etc. He has authored and co-authored more than 150 Science Citation Indexed (SCI)/Social Science Citation Indexed (SSCI) refereed journal papers.

Eric Tsui is Professor and Director of the Knowledge Management and Innovation Research Centre (KMIRC) at The Hong Kong Polytechnic University. Previously, he was the Chief Research Officer, Asia Pacific of Computer Sciences Corporation (CSC). His research interests are on Knowledge Management technologies, Personal Knowledge Management, Cloud Services, and Learning pedagogies. His qualifications include B.Sc. (Hons.), PhD, and MBA.

Kit Ling Wan is a graduate of the Department of Industrial and Systems Engineering of The Hong Kong Polytechnic University. She obtained her Bachelor of Engineering (Honours) in Logistics Engineering with Management from The Hong Kong Polytechnic University.