

# HOW OPEN INNOVATION AND INFORMATION SYSTEMS AFFECT R&D PERFORMANCE: A KNOWLEDGE SHARING PERSPECTIVE

Ting-Peng Liang, Department of Management Information Systems, National Chengchi University/National Sun Yat-sen University, Taiwan, is.tpliang@gmail.com

Deng-Neng Chen, Department of Management Information Systems, National Pingtung University of Science and Technology, Taiwan, dnchen@mail.npust.edu.tw

Rajiv Kohli, Raymond A. Mason School of Business, College of William & Mary, USA, rajiv.kohli@mason.wm.edu

## Abstract

*Open innovation is a paradigm for knowledge sourcing among organizations. Extant literature argues that organizations should take advantage of both external and internal ideas for innovation in organizations. For open innovation to be effective, however, organizations must be able to source knowledge to partners as well absorb the ideas and knowledge from external parties. It is critical to share the knowledge in the organization, and then both the external and internal knowledge can be applied to help the business. We argue that information systems (IS) play a key role in assimilation of knowledge and are critical to adoption of open innovation. In this research, we investigate how IS can facilitate the adoption of open innovations and knowledge sharing, and whether knowledge sharing affects organizational research and development (R&D) performance. In this Research-in-Progress we will test our research model with a matched-pair response survey involving two respondents from each organization. We expect that IS strategies will have direct effect on the level of open innovation adoption and that knowledge sharing will play a mediating role between open innovation and R&D performance.*

*Keywords: Open innovation, IS strategy, Knowledge sharing, R&D performance.*

# 1 INTRODUCTION

Innovation is like oxygen for modern organizations. Innovation is essential to achieve superior performance and is critical for organizational success. The foundation for innovation is up-to-date knowledge and the ability of an organization to manage incorporate knowledge effectively into its operations. Peter Drucker (1999) stated that knowledge would replace tangible assets, such as equipment, capital, material, or labor and emerge as a key production factor. As knowledge workers replace traditional labor and become creators of organizational value, this theme is echoed once again “... *ideas will be the real scarce inputs -- scarcer than both labor and capital*” (Brynjolfsson et al. 2014). Although academic research has a long tradition of innovation research, recent evidence points to increasing compartmentalization of innovation research in management and economics (Shafique 2013). This calls for greater integration of ideas across academic disciplines.

A recent paradigm, *open innovation*, proposes that organizations should be more ‘open’ in taking advantage of knowledge and innovations from sources outside their organizational boundaries (Chesbrough 2003). This implies that organizations must share their knowledge and learning and be willing to collaborate with other organizations in order to accelerate innovation. In contemporary network based market dynamics, organizations often create innovative products and services when they share their innovation with partners who build upon them. For example, automobile manufacturer BMW sourced its manufacturing knowledge to its partner Magna Steyr to manufacture BMW X3 automobiles. By further innovating in manufacturing, Magna Steyr has developed expertise in the manufacture of electric cars. This serves as a platform for design of electric vehicles<sup>1</sup>, an opportunity that BMW can leverage from an outbound partnership. Thus, knowledge sharing provides a platform for the success of open innovation.

From a theoretical perspective, the resource-based view (RBV) proposes that valuable and inimitable resources are critical to a firm’s competitive advantage (Grant 1991). In modern organizations, both knowledge and information, internal as well as external, are valuable resources to build such advantage. Open innovation is a mechanism through which the access to new knowledge and information becomes more effective. Information technologies provide a platform for more efficient management of information and knowledge. Hence, we can anticipate that both open innovation and the IT capabilities of an organization will affect organizational performance.

There are a number of ways to interpret how open innovation and IT affect performance. One such way is proposed by the knowledge sharing perspective. Previous literature indicates that knowledge sharing among different business units is the key to create superior business strategies and enhance competitive advantage (Kearns & Lederer 2003). As open innovation stresses the exchange of knowledge within and between organizations, better knowledge sharing in the organization enables healthier knowledge ecology formation for enhancing organizational performance.

Information systems serve as an important facilitator in the communication and dissemination of knowledge (Dodgson et al. 2006). Organizations deploy IS to support knowledge sharing and improve performance (Alavi & Leidner 2001). In particular, an increasing number of organizations are taking advantage of Internet-based platforms to expand their knowledge capacity by engaging with external partners, often in ‘open’ innovation settings (for example, Innocentive.com) to solve challenging business problems. With the above propositions on open innovation and IS, it is interesting to empirically testing these hypothetical relationships for a better understanding of the effect of open innovation and IS on organizational performance.

Hence, the goal of this research is to investigate propositions grounded in the literature of open innovations, knowledge sharing, and IS strategies through a firm-level research model. We will evaluate this research model with empirical data collected from companies in Taiwan.

---

<sup>1</sup> <http://green.autoblog.com/2008/03/31/magna-steyr-talking-evs-with-bmw-mercedes/>

The remainder of this paper is organized as follows. The theoretical background and research hypotheses are described in the next section. This is followed by our research model and Methodology. Measurements and data collection are discussed afterward.

## **2 THEORETICAL BACKGROUND AND HYPOTHESES**

As a new organizational innovation paradigm for focusing on acquiring and applying external knowledge, open innovation is expected to have a positive effect on organizational performance. A key reason for such a belief is that “two heads are better than one” and because the best ideas may not be developed internally due to an organization’s inadequate personnel or environmental opportunities. It is also likely that good ideas or innovations exist outside an organization, therefore, open innovation gives an organization a better chance of availing those opportunities. However, the mechanism through which open innovation influences firm performance, and the role the information systems play, needs to be further examined. In this research, we argue that the open innovation and information systems play a pivotal role in the development of knowledge sharing capacity of an organization that results in superior performance. Below we examine the extant literature in support of our research hypotheses.

### **2.1 Open Innovation**

Open innovation benefits from external resources for innovation, including user innovation, cumulative innovation, know-how trading, mass innovation and distributed innovation. Open innovation recognizes that organizations can, and should, use external knowledge in conjunction with internal ideas in seeking paths to improved performance. Under this paradigm the boundaries between a firm and its environment have become permeable because innovations can easily transfer inward or outward. In a widely distributed knowledge environment, organizations cannot afford to rely entirely on their own research and development and should be open to buying or licensing processes or inventions (e.g., patents) from others (Chesbrough 2003). In addition, internal R&D inventions that are not being exploited should be taken outside the company through licensing, joint ventures, and spin-offs to partners who can better exploit such innovations. In a recent survey of business executives, 80% of the respondents believed that their organization would benefit from collaborating in a network of R&D organizations (Capozzi et al. 2013).

The adoption of open innovation is boosted by recent developments in information and communication technologies that enable social networking and wisdom of crowds to promote the use of virtually unlimited knowledge sources and to capture valuable ideas in product design, research and development and customer service. A rich body of literature in open innovation focuses upon aspects such as conceptual descriptions (e.g., Chesbrough & Crowther 2006; Dodgson et al. 2006), potential theories (e.g., Gassmann et al. 2010), research frameworks (e.g., West et al. 2006), and effectiveness of open innovation (e.g., Laursen & Salter 2006).

Despite the anticipated benefits, adopting open innovation is not without challenges. A key issue is the cost involved in a large number of potentially low-quality ideas. In an open innovation platform, ideas may come from participants with varying levels of expertise and hence it is hard to assure the quality. Another key issue is the protection of intellectual property rights of innovations. Ideas and knowledge obtained from open platforms may not belong exclusively to the organization. They are usually not copyrighted, nor patented. This issue is particularly challenging when open innovation involves two or more commercial organizations. For organizations to sustain their competitive advantage, it would be better if the knowledge were scarce and inimitable. Too much openness can be harmful to an organization’s innovation (Laursen & Salter 2006). Knowledge obtained from open sources does not meet these guidelines. Whether the adoption of open innovation can really create a competitive advantage, and if so, how can organizations take advantage of open innovation are critical issues that need empirical examination. By acquiring external sources of knowledge to enhance organizational innovations, open innovation adoption is assumed to affect organizational performance (Chesbrough 2003).

## 2.2 Knowledge Sharing

As a knowledge management paradigm, open innovation highlights the importance of acquiring and applying external knowledge. Given that innovation activities are knowledge intensive, a critical success factor of open innovation in an organization is its knowledge management capabilities (Alavi & Leidner 2001; Chesbrough 2003). In order to succeed in open innovation a firm must have adequate absorptive capacity to identify, assimilate, transform, and apply external valuable knowledge (Roberts et al. 2012). Therefore, the alignment between external and internal knowledge is critical to the success of knowledge management and open innovation. In the alignment process, knowledge sharing plays a crucial mediating role between open innovation and organizational performance (Kearns & Lederer 2003).

Knowledge sharing is a core element of an organization's knowledge management activities. The better knowledge sharing would result in better knowledge transferring, reusing, and application, and lead to higher performance of teams or organizations (Alavi & Leidner 2001; Lin et al. 2005; Majchrzak et al. 2013). Knowledge sharing is considered as the activities of information/knowledge exchanging between knowledge sender and receiver. Knowledge sender is responsive to the source of contributing knowledge, and receiver is the entity that receives the knowledge. By different communication channels, such as face-to-face or information systems, the knowledge transfers from the sender to receiver (Lin et al. 2005; Pee et al. 2010).

From the perspective of RBV, information or knowledge is a valuable resource in a knowledge economy and firms should use knowledge sharing to enhance organizational competitive advantage (Kearns & Lederer 2003). In open innovation, the innovative ideas within an organization that can be more valuable by sharing with partnering organizations, and the innovative ideas brought from outside should be shared in the organization. The alignment process among external and internal ideas should be implemented well by knowledge sharing, and the innovative ideas could really play a role in the organization. Based on the above discussion we can assume that the effect of open innovation on organizational performance is through the knowledge sharing of the organization. In other words, knowledge sharing will mediate the effect between open innovation and organizational R&D performance. We choose R&D performance because R&D is closely related to organizational performance resulting from management of knowledge. Hence, we propose the following two related hypotheses:

*H1: Higher level of open innovation will lead to greater knowledge sharing.*

*H2: Greater knowledge sharing will lead to higher organizational R&D performance.*

## 2.3 Information Systems as Facilitator of Open Innovation and Knowledge Sharing

Information systems (IS) are a key enabler of knowledge management (Alavi & Leidner 2001) and play a critical role in open innovation (Dodgson et al. 2006) because communication with external entities is crucial for information sharing. IS are viewed as the enabler and trigger for organizational innovation (Nambisan 2013). Previous literature has established that the alignment between IS strategy and business strategy is critical for higher business performance (e.g., Sabherwal & Chan 2001). Rai and Tang (2010) examined the organizational IT capabilities by measuring IT integration and IT reconfiguration and the corresponding organizational process capabilities by measuring alignment and flexibility. They found that IT capabilities could enhance the organizational process capabilities and lead to higher performance. In particular, investments in IT were found to facilitate reconfiguration of resources and modification of processes in collaboration-intensive alliances (Tafti et al. 2013). Lu and Ramamurthy (2011) proposed that IT capability enhances organizational agility and innovativeness. A meta-analysis of previous findings about the resource-based view in IT/IS and firm performance has shown significant effects of IT/IS on organizational capabilities, which in turn improves firm performance (Liang et al. 2010). Therefore, it is reasonable to expect that strategies to deploy information systems will have an effect on the adoption of open innovation.

In viewing the relationship among IS strategies, open innovation, knowledge sharing, and firm's R&D performance, knowledge sharing can be viewed as a capability that emerges from open innovation and

complementary IS strategies, both of which are rare and inimitable resource. When aligned, the knowledge sharing leads to competitive advantage that will be reflected in the R&D performance. Organizational capabilities derived from valuable resources that are at the firm's disposal are known to create organizational competitive advantage (Bharadwaj 2000).

Previous research has deployed various approaches to analyze IS strategies. For instance, Sabherwal and Chan (2001) examined IS strategies based upon four categories of IS: operational support systems, market information systems, strategic decision support systems, and inter-organizational systems. They found that each type of IS strategy has distinct impacts on organizational processes and performance. In fact, these four types can be viewed in terms of our classification of knowledge management -- internal orientation (operational support systems and strategic decision support systems) and external orientation (market information systems and inter-organizational systems). The above discussion suggests that IS strategy is critical to organizational innovation and success. IS enable knowledge management, innovation, and organizational performance. Hence, we posit the following hypotheses:

*H3: Superior information systems strategies will lead to greater open innovation adoption.*

*H4: Superior information systems strategies will lead to higher knowledge sharing.*

### 3 RESEARCH MODEL AND METHODOLOGY

#### 3.1 Research Model

Based on our literature review in the previous section, our research model includes four major constructs, including open innovation, IS strategies, knowledge sharing, and organizational R&D performance (Figure 1).

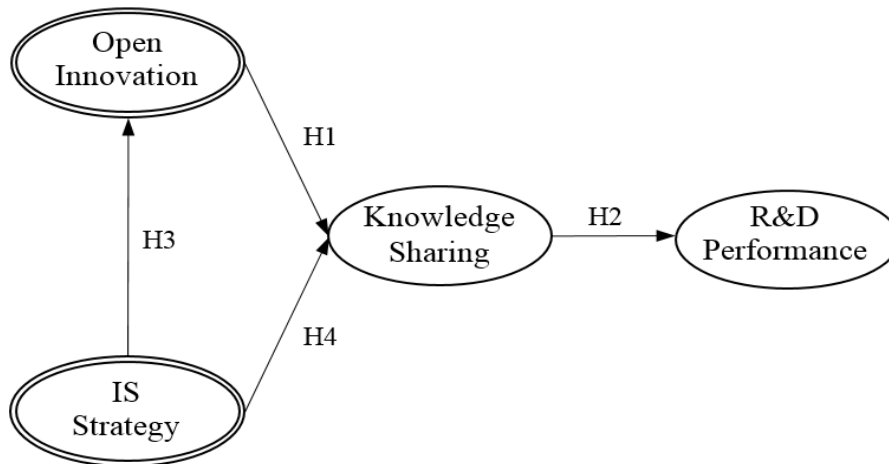


Figure 1. Research Model.

#### 3.2 Operational Definitions of Research Constructs

We adapted measurement items from existing literature when available, while others were developed for this research. For measurement items that we developed, we evaluated each item in a pilot test and conducted reliability and validity tests on the complete dataset to ensure data quality. All items were measured using a 7-point Likert scale with 1 anchored as "strongly disagree" and 7 anchored as "strongly agree." In Table 1 we summarize the sources and a brief description that informed our measurement items.

Construct	Source References	Summary of findings
Open Innovation	Developed from Gassmann and Enkel (2004), Herstad et al. (2008)	In the two papers, the outside-in and inside-out processes of open innovation were proposed and discussed. The definitions and concepts are referred to develop our measurement of inbound and outbound open innovation.
Knowledge Sharing	Developed from Alavi and Leidner (2001)	The research of knowledge sharing was reviewed in this paper. Knowledge sharing is defined as the capability that the members would share their knowledge to others in the organization, and the effectiveness of knowledge sharing.
IS Strategy	Adopted from Sabherwal and Chan (2001)	The measurements of IS strategy are adopted from Sabherwal and Chan (2001). The authors proposed a model to investigate the alignment between IS strategy and business strategy, and impacts of the alignment on business performance. The measurements of IS strategy are composed of four types of information systems, including operational support systems, interorganizational systems, market information systems, and strategic decision support systems. These four types of information systems have covered all the business functions in an organization
R&D Performance	Developed from Kusunoki et al. (1998)	Explored the effects of organizational capabilities on product development performance. Three organizational capabilities were defined, including local, architectural, and process capabilities. The organizational performance was measured by productivity, product quality, and innovativeness. The measurements of innovativeness performance are used to develop R&D performance instruments in our research.

Table 1. Sources of Measurements.

### 3.3 Survey

#### 3.3.1 Instrument Evaluation

In order to ensure accuracy and reliability of our survey instruments, we undertook the following two steps. First, we invited two experts with doctoral degrees in business to verify content validity of the research model and the survey items in the questionnaire. Unclear and inappropriate words were revised for ease of respondents' understanding. Second, we conducted a pilot study to check for appropriateness of survey design. The results of the pilot survey analysis indicate that the measurement instruments did not contain confusing questions.

#### 3.3.2 Data Collection

Our surveys were conducted in Taiwan. To avoid the issue of common method bias, two respondents questionnaires were obtained administered in each organization, one for the IT division and another for the R&D division of the same organization. Following evaluation of our research model (Figure 1) our next step will be to test the model.

## 4 DISCUSSION

The purpose of this research-in-progress was to theorize how open innovation influences R&D performance and to examine the mediating role of knowledge sharing through information systems strategies. In understanding this relationship, we have developed a research model and will analyze the collected data to evaluate the hypotheses, and contrast it with other models we have previously tested

(Liang et al. 2013). As open innovation becomes more prevalent, the findings of this research will shed much light on how organizational adoption of open innovation affects its R&D performance. Our proposal of viewing the effect of open innovation from the knowledge sharing perspective is also innovative. The empirical confirmation of our hypotheses will provide a better interpretation of the effect and possible directions for further strengthening the contribution from open innovation.

## References

- Alavi, M. and Leidner, D.E. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly*, 25 (1), 107-136.
- Bharadwaj, A.S. (2000). A Resource-based Perspective on Information Capability and Firm Performance: An Empirical Investigation. *MIS Quarterly*, 24 (1), 169-196.
- Brynjolfsson, E., McAfee, A. and Spence, M. (2014). New World Order: Labor, Capital, and Ideas in the Power Law Economy. *Foreign Affairs*, 93 (4), 44-53.
- Capozzi, M., Biljon, P. and Williams, J. (2013). Organizing R&D for the Future. *MIT Sloan Management Review*, 54 (3), 19-20.
- Chesbrough, H.W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press, Boston.
- Chesbrough, H.W. and Crowther, A.K. (2006). Beyond high tech: Early adopters of open innovation in other industries. *R&D Management*, 36 (3), 229-236.
- Dodgson, M., Gann, D. and Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management*, 36 (3), 333-346.
- Drucker, P.F. (1999). Knowledge Worker Productivity: The Biggest Challenge. *California Management Review*, 41 (2), 79-94.
- Gassmann, O. and Enkel, E. (2004). Towards a Theory of Open Innovation: Three Core Process Archetypes. in *Proceedings of R&D Management Conference (RADMA)*. Lisbon, Portugal.
- Gassmann, O., Enkel, E. and Chesbrough, H. (2010). The Future of Open Innovation. *R&D Management*, 40 (3), 213-221.
- Grant, R.M. (1991). The resource-based theory of competitive advantage: Implication for strategy formulation. *California Management Review*, 33 (3), 114-135.
- Herstad, S., Bloch, C.W., Ebersberger, B. and Velde E. (2008). Open Innovation and Globalisation: Theory, Evidence and Implications. *Vision Eranet*, [http://www.aksjonsprogrammet.no/vedlegg/openING\\_report\\_final.pdf](http://www.aksjonsprogrammet.no/vedlegg/openING_report_final.pdf)
- Kearns, G.S. and Lederer A.L. (2003). A resource-based view of strategic IT alignment: How knowledge sharing creates competitive advantage. *Decision Sciences*, 34 (1), 1-29.
- Kusunoki, K., Nonaka I. and Nagata A. (1998). Organizational Capabilities in Product Development of Japanese Firms: A Conceptual Framework and Empirical Findings. *Organization Science*, 9 (6), 699-718
- Laursen, K. and Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27 (2), 131-150.
- Liang, T.P., You, J.J. and Liu, C.C. (2010). A Resource-based Perspective on Information Technology and Firm Performance: A Meta Analysis. *Industrial Management & Data Systems*, 110 (8), 1138-1158.
- Liang, T.P., Chen, D.N. and Pee, L.G. (2013). The Impacts of Open Innovations on Organizational Performance: A Perspective based on Information Technology and Knowledge Ecology. In *Proceedings of the 2013 International Conference on Information Systems (ICIS 2013)*, Milan, Italy.
- Lin, L., Geng, X. and Whinston, A.B. (2005). A Sender-Receiver Framework for Knowledge Transfer. *MIS Quarterly*, 29 (2), 197-219.
- Lu, Y. and Ramamurthy, K. (2011). Understanding the Link between Information Technology Capability and Organizational Agility: An Empirical Examination. *MIS Quarterly*, 35 (4), 931-954.

- Majchrzak, A., Wagner, C. and Yates, D. (2013). The Impact of Shaping on Knowledge Reuse for Organizational Improvement with Wikis. *MIS Quarterly*, 37 (2), 455-469.
- Nambisan, S. (2013). Information Technology and Product/Service Innovation: A Brief Assessment and Some Suggestions for Future Research. *Journal of the Association for Information Systems*, 14 (4), Article 1.
- Pee, L.G., Kankanhalli, A. and Kim, H.W. (2010). Knowledge Sharing in Information Systems Development: A Social Interdependence Perspective. *Journal of the Association for Information Systems*, 11 (10), Article 1.
- Rai, A. and Tang, X. (2010). Leveraging IT Capabilities and Competitive Process Capabilities for the Management of IR Portfolios. *Information Systems Research*, 21 (3), 516-42.
- Roberts, N., Galluch, P.S., Dinger, M. and Grover, V. (2012). Absorptive Capacity and Information Systems Research: Review, Synthesis, and Directions for Future Research. *MIS Quarterly*, 36 (2), 625-648.
- Sabherwal, R. and Chan, Y.E. (2001). Alignment between Business and IS Strategies: A Study of Prospectors, Analyzers, and Defenders. *Information Systems Research*, 12 (1), 11-33.
- Shafique, M. (2013). Thinking inside the box: Intellectual structure of the knowledge base of innovation research (1988-2008). *Strategic Management Journal*, 34 (1), 62-93.
- Tafti, A., Mithas, S., Krishnan, M. (2013). The Importance of IT-Enabled Flexibility in Alliances. *MIT Sloan Management Review*, 54 (3), 13-14.
- West, J., Vanhaverbeke, W. and Chesbrough, H. (2006). Open Innovation: A Research Agenda. in H. Chesbrough, W. Vanhaverbeke, and J. West, eds. *Open Innovation: Researching a New Paradigm*. Oxford University Press, Oxford, 285-307.