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Relationship between knowledge sharing and performance: A survey in Xi'an, China

Rong Du [a,*], Shizhong Ai [a], Yuqing Ren [b]

[a] School of Economics and Management, Xidian University, #2 Taibai Road, Xi'an, Shannxi 710071, China
[b] Department of Social and Decision Sciences, Carnegie Melon University, Pittsburgh, PA 15213, USA

Abstract

This paper explores the quantitative relationship between knowledge sharing and performance, with contextual factors in consideration. First, we argue that both knowledge sharing and its contextual factors should be associated with performance. Then, we analyze the multi-dimensional characteristics of knowledge sharing and propose six measures for it. Next, we model the relationship between knowledge sharing and performance, integrating various contingent factors with the model framework, some of which have significant influences on the relationship between knowledge sharing and performance. After that, we propose four alternative models and corresponding propositions for knowledge sharing-contingent variables relationship, and present a quantitative formulation of the relationship between knowledge sharing and performance. Finally, we conduct a survey of 249 organizations in Xi'an, China, and show the empirical results. Our propositions about the knowledge sharing-performance relationship and contingent factors are supported by the survey. The empirical results suggest that managers have to pay attention to some contingent factors while they commit to knowledge sharing. This study adds to the understanding of the effects of knowledge sharing on performance, and gives implications to the practice of knowledge sharing.

Keywords: Knowledge sharing; Performance; Contingent factors; Survey

1. Introduction

In the knowledge-based economy, it is the ability of firms to create, to transfer and to adopt knowledge rather than their allocating efficiency that determines their long-run performance (Prahalad & Hamel, 1990; Spender, 1994). This reflects the ongoing changes in production systems. These systems are not stereotype converters of standard inputs into standard outputs any more, but dynamic organizations that arrange resources and yield products basing on knowledge creation and sharing (Patchell, 1993).

Research in knowledge creation and knowledge sharing (Argote, McEvily, & Reagans, 2003; Carlile & Rebentisch, 2003; Koh & Kim, 2004; March, 1991; March & Simon, 1958) reveals that innovations process can be regarded as a knowledge create-knowledge retain-knowledge transfer-knowledge adoption cycle, searching for and spreading new technical or organizational knowledge. In the innovations process knowledge sharing has an important bearing on performance (Lee, Lee, & Kang, 2005). Furthermore, properties of the context within which knowledge sharing occurs affect the performance. As a result, organizations rely on their socially constructed practices, routines, and programs to drive knowledge search and sharing (Baum, Li, & Usher, 2000). Organizational culture also affects knowledge sharing and its performance. For example, Moller and Svahn (2004) examine the influence of ethnic culture on knowledge sharing in different types of intercultural business nets. They suggest that the nature of the cultures involved and the type of network both influence the knowledge-sharing barriers. In addition, many other organizational contingent factors, such as trust and conflict (Panteli & Sockalingam, 2005), may have roles on knowledge sharing-performance relationship.

* Corresponding author. Tel.: +86 029 88201944; fax: +86 029 88202794.
E-mail address: durong@mail.xidian.edu.cn (R. Du).

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Other studies in knowledge creation and knowledge sharing (Lee & Cole, 2003; Nelson & Winter, 1982; Nerkar, 2003) show that knowledge creation is a path-dependent evolutionary process that involves the spread of recombining knowledge over time and the innovation process can be effectively organized as an evolutionary process of knowledge sharing. Therefore, the basis of a firm's competitive edge has gradually shifted from static price competition towards dynamic improvement, and the global market is favoring firms that are able to create and share knowledge a little faster than their competitors (Porter, 1990).

Hence, knowledge sharing is one of the most important processes of knowledge management, which gradually evolves and improves the production system and its constituting elements. As a result, knowledge sharing is closely related to long-run performance and the competitiveness of a firm.

Researchers have developed numerous theories describing alternate perspectives of knowledge sharing (e.g., Kanter, 1989). Most of them depict the necessities, benefits and contents of knowledge sharing. Although these efforts have served to link knowledge sharing to performance to some extent, they seldom point out the various dimensions of knowledge sharing and the relevant factors influencing the relationship between knowledge sharing and performance. This lack of dimensions has impeded progress for researchers toward building and testing a quantitative theory of knowledge sharing, and has made it especially difficult for them to investigate the relationship between knowledge sharing and performance.

The purpose of this paper is to develop some dimensions of knowledge sharing and to provide an integrative framework for exploring the relationship between knowledge sharing and performance. On the basis of the framework, we pose some propositions describing the sophisticated impacts of some contingent factors on the relationship between knowledge sharing and performance. The results of our survey of 249 organizations verify empirically these propositions. Thus, this paper can help to frame research questions and further researchers' understanding of the relationships between knowledge sharing and performance. Furthermore, the empirical results derived from our survey provide a strong support to our idea about knowledge sharing. It gives insightful implications to knowledge sharing practice.

The remainder of the paper is divided into five sections. In Section 2, we address knowledge sharing and its contextual factors, and their relevance to performance by reviewing some knowledge sharing literature briefly. In Section 3, we propose and discuss some basic measures for knowledge sharing. In Section 4, we present alternate contingency models for investigating the performance implications of knowledge sharing, and propose several qualitative propositions of contingent relationships. Then, in Section 5, we depict our survey in Xi'an, China, and present the results of our survey. In the final section, we explain how our proposed framework can be applied in interpreting the differences in knowledge sharing behavior and performance across firms, and point out some directions to further research.

2. Knowledge sharing, contextual factors, and performance

In a concluding article, Argote et al. (2003) provide an integrative framework for organizing the literature on knowledge management. In the framework, the knowledge management outcomes of knowledge creation, retention, and transfer are represented along one dimension. Properties of the context within which knowledge management occurs are represented on the other dimension. The framework is used to identify where research findings about knowledge management converge and where gaps in our understanding exist. With the help of the framework, knowledge sharing and the contexts with which knowledge sharing actions are performed can be found to be hot concerns in knowledge management. Moreover, they affect a firm's ability to create, retain and transfer knowledge. Therefore, knowledge sharing has attracted more attentions then before.

Knowledge sharing is the common thread in knowledge integration. By framing the task of knowledge integration as a cycle (Carlile & Rebentisch, 2003), we can find the ability of knowledge sharing to explain the consequences that arise from the path-dependent nature of knowledge. The three stages of the "knowledge transformation cycle" show the core role of knowledge sharing in knowledge management. Usually, knowledge is shared in organizations through the transformation of occupational communities' situated understandings of their work. As a result, the communities' knowledge-sharing is underlined in the whole organization's knowledge integration (Bechky, 2003).

There are some contextual factors that affect knowledge sharing. Organizational factors and inter-personal factors should be considered first. After examining the conditions for successful knowledge sharing and learning in inter-organizational alliances, Soekijad and Andriessen (2003) presented several factors that are important for knowledge sharing in alliances, suggesting that attention should be paid to conditions both in inter-organization level and inter-personal level. In addition, trust and conflict are inherent issues of any organizational arrangement and central for knowledge sharing. Panteli and Sockalingam (2005) undertook an investigation of both phenomena within the context of virtual alliances. A generic framework for understanding the dynamics of trust and conflict within the context of virtual inter-organizational arrangements was presented.

Group values, attitudes, and norms, and organizational climate should also be considered. In a recent study, Bock, Zmud, Kim, and Lee (2005) developed an integrative understanding of the factors supporting or inhibiting individuals' knowledge-sharing intentions. They employed the theory of reasoned action, and augmented it with extrinsic motivators, social-psychological forces and organizational

climate factors that are believed to influence individuals' knowledge sharing intentions. The results of a field survey suggest that attitudes toward and subjective norms with regard to knowledge sharing as well as organizational climate affect individuals' intentions to share knowledge.

From the above literature it follows that both knowledge sharing and its contextual factors should be studied simultaneously. Moreover, they should be associated with performance. For knowledge sharing has a subtle effect on organizational performance.

In firms, knowledge can be created by an intentional and resource-consuming effort. However, a lot of knowledge is created as a by-product of other activities, such as knowledge sharing. Knowledge is a resource, which differs from other resources in its frugality. The application and transfer of knowledge in knowledge sharing activity not only do not consume it, but also help to promote knowledge creation due to the improvement of firms' absorptive capacity (Cohen & Levinthal, 1990). Therefore, the process of knowledge sharing has no limit.

However, knowledge sharing is an activity with uncertainty. The information required to facilitate intentional decision-making in knowledge sharing is either hard or impossible to obtain. This complicates intentional knowledge sharing, and the consequences of all actions become uncertain (Dosi & Orsengio, 1988). Firms usually handle such situations by developing internal procedures and routines, which can be used to search for possible solutions. These procedures and routines are formed on the base of a firm's successful behavior in the past, and will continually be reproduced and reinforced if they seem efficacious (Nelson & Winter, 1982). In practice, some ways of doing things are rejected and then eliminated from the internal routines while others function well and are embedded as part of the internal routines if they are not included in them. These internal procedures and routines will determine the arrangements of the firm's specific knowledge sharing actions, and have impacts on knowledge sharing and its performance. These internal procedures and routines can be regarded as contextual factors, which may influence the effectiveness of knowledge sharing, especially tacit knowledge sharing. The only feasible way for a firm to obtain and transfer tacit knowledge is to learn from and share experiences. Thus, a helpful context is a crucial part of knowledge sharing, and is then closely related to organizational performance. In other words, effective knowledge-sharing systems are needed to improve performance.

Knowledge-sharing systems have been implemented in various companies during the last few years. However, many of them have failed because they were limited to technical solutions and did not consider the organizational and environmental factors that are necessary to make a knowledge-sharing platform successful (Voelpel, Dous, & Davenport, 2005).

To successfully establish an effective knowledge-sharing system, one must identify knowledge sharing activity, its contextual factors, and their relations to performance. Therefore, when studying and implementing knowledge sharing strategies, the most important things we think are that (1) knowledge sharing activities should be measured quantitatively, (2) some contextual factors should be considered, and (3) both of them should be linked to performance properly.

3. Measures for knowledge sharing

When carrying out knowledge sharing, firms are assumed to have always been oriented toward accumulating and adopting knowledge to create economic value and competitive advantage. We, therefore, suggest the need for creating knowledge sharing measures (KSM).

With regard to KSM, we would like to mention a metric, knowledge management performance index (KMPI) for assessing the performance of a firm in its knowledge management (Lee et al., 2005). KMPI was defined as a logistic function, having five components that can be used to determine the knowledge circulation process: knowledge creation, knowledge accumulation, knowledge sharing, knowledge utilization, and knowledge internalization. However, there were few special measures for knowledge sharing maybe because it is not easy to formulate knowledge sharing activities. Here we try to explore the formulation of knowledge sharing and then provide some basic measures for it.

In the reminder of this part, we begin with the goal of knowledge sharing, and develop along the ways in which to attain the goal.

The fundamental goal of knowledge sharing in a firm is to facilitate knowledge transfer among different persons and different units in the firm, to absorb knowledge from other firms, and to speed the knowledge adoption. To this end, first, it is necessary for employees to learn from knowledge and experiences (Madsen, Mosakowski, & Zaheer, 2003) accumulated by the co-workers in their team and other departments, internal processes and routines accumulated by the organization, and even knowledge accumulated by other organizations outside. As a result, a firm needs to perform inter-units training and participate in inter-organizational training. Hence, the expenditure on such trainings is deserved to be a measure for knowledge sharing.

Secondly, knowledge sharing often occurs unexpectedly during the process of the trials and experiments (Carrillo & Gaimon, 2000) performed by a team or several teams collaboratively. By this means the new knowledge of doing a job is accumulated and shared increasingly, resulting the improved or innovative way of doing that job, and leading to a better performance. For this reason, it is believed that collaborative trials and experiments are crucial necessary conditions for knowledge sharing although they are not sufficient ones. Thus, the expenditure on such trials and experiments should be considered as a measure for knowledge sharing.

Thirdly, the intentional activities for communicating and transferring conceptual and operational knowledge,

experiences, and skills in a company can accelerate the process of knowledge sharing (Ingram & Simons, 2002). Suppose that a worker finds a new better way to operate a machine. The company can not benefit from this worker's operational knowledge, unless each worker operating the same machine in the company can obtain and master this new knowledge. Hence, intentional activities for communicating and transferring such knowledge may be performed. Furthermore, much better ways may be found after the activities. Thus, the expenditure on intentional activities for communicating and transferring knowledge is taken into account as a measure for knowledge sharing.

Fourthly, knowledge sharing often occurs automatically in both job rotation (Ortega, 2001) within an organization and workers' mobility (Rosenkopf & Almeida, 2003; Song, Almeida, & Wu, 2003) among different organizations and different districts, for the mobile worker may take their knowledge originated from the former jobs in the new jobs. Moreover, the blend and crossover of different knowledge available in different positions or different fields may lead to new knowledge's creation. It is well known that most organizations, which emphasize knowledge sharing, frequently import workers outside and implement job rotation to stimulate the blend and crossover of different knowledge in different fields and different units. Hence, the frequency of importing workers and the frequency of job rotation should be incorporated into the measure system for knowledge sharing.

Finally, R&D projects have been also used to illuminate knowledge transfer. For example, using the case of the Linux kernel development project, Lee and Cole (2003) suggested that the product development project can be organized effectively as an evolutionary process of knowledge sharing and they can be performed by members from different subunits or even different organizations in an alliance. Therefore, the expenditure on R&D may be regarded as an important dimension measuring knowledge sharing in a company. The process of R&D performed by a team or several teams collaboratively not only creates knowledge but also impels the communications among different workers and units, and then facilitate knowledge transfer and knowledge share. Without doubt, an emphasis on collaborative R&D can result in an encouragement to knowledge sharing. Thus, the expenditure on collaborative R&D should be considered as a measure for knowledge sharing.

The multi-ways to attain knowledge sharing determine the multi-measures of knowledge sharing. On the basis of above discussion, we propose six basic variables measuring knowledge sharing, which are shown in Table 1. We will use them to measure knowledge sharing later in our empirical survey.

Table 1
Variables for knowledge sharing and description

Variables	Description
x_1	The expenditure on inter-units and inter-organizational trainings
x_2	The expenditure on collaborative trials and experiments of non-R&D departments
x_3	The expenditure on intentional activities for communicating and transferring knowledge
x_4	The frequency of importing workers
x_5	The frequency of job rotation
x_6	The expenditure on collaborative R&D

4. Knowledge sharing-performance relationship: exploring key contingencies and alternative models

Before studying the knowledge sharing-performance relationship, it is essential to recognize the multi-dimensional nature of the performance construct (Zahra, 1993). For example, Lewis (2004) identified four items for performance measure when examining the relationship between knowledge and performance in knowledge-worker teams.

In this study, however, in order to put our emphasis on the measuring of knowledge sharing, we consider only a comprehensive performance measure, which we called "added value per labor", AVPL in short. It is the average outcome per worker in term of money, which we suppose can reflect multi-dimensions of performance.

The importance of knowledge sharing to the organizational strategic management has been widely acknowledged. As we know, knowledge sharing influences the organizational performance from various aspects, such as management, decision, and production processes. Therefore, we are concerned with the relationship between key contingent variables and performance. In order to effectively model the knowledge sharing-performance relationship, the role of these contingent variables should also be considered. Contingency theory suggests that congruence or fit among key variables, such as environment, structure, and strategy, is critical for obtaining optimal performance (Miller, 1988). Hence, the congruence or fit among knowledge sharing and these contingent variables may have a significant effect on organizational performance. Thus, we present an integrative framework, introducing some factors that may affect the relationship between knowledge sharing and performance. The integrative framework is shown in Fig. 1.

In the above framework, given that knowledge sharing is characterized quantitatively by a vector, $X(x_1, x_2, x_3, x_4, x_5, x_6)$, which is determined by six measures, and performance is characterized quantitatively by a variable, Y, which is a quantity, we formulate the basic relationship between knowledge sharing and an organization's performance in the following function:

$$Y = F(X). \tag{1}$$

The goal of the organization is to pursue the best performance, here maximizing Y. Therefore, the objective function is shown as follows:

$$\text{Max}\, Y = F(X). \tag{2}$$

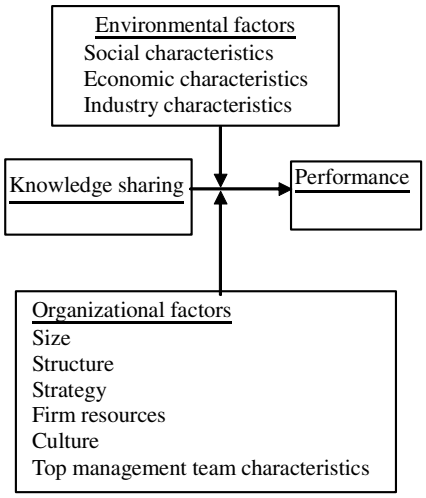

Fig. 1. Integrative framework on knowledge sharing-performance relationship.

Venkatraman (1989) proposed alternative models for investigating the impact of third variable as a means of exploring contingency relationship. Levin and Cross (2004) studied the mediating role of trust in effective knowledge transfer. Utilizing the essence ideas behind the two studies, we propose the contingency models for knowledge sharing-performance relationship in Figs. 2–5, which provide a useful framework for obtaining additional insight into the knowledge sharing-performance relationship and the effects of some contingencies.

We believe that our understanding of the knowledge sharing-performance relationship can be further improved by testing the proposed contingency models. The models here serve as the examples of possible relationships and

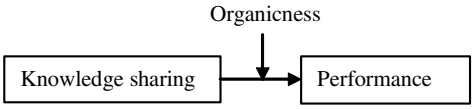

Fig. 2. Moderating-effects model.

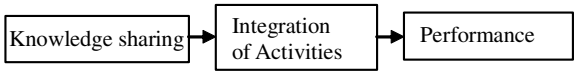

Fig. 3. Mediating-effects model.

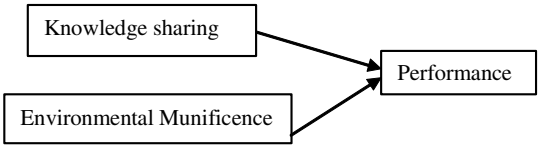

Fig. 4. Independent-effects model.

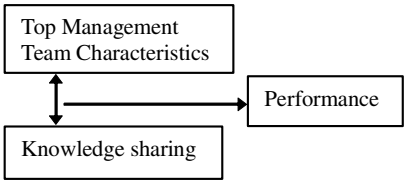

Fig. 5. Interaction-effects model.

provide a framework for introducing a series of propositions that we acknowledge are tentative. They are for illustrative purpose and provide a context in which to study real-world examples.

In the moderating-effects model (shown in Fig. 2), we consider only the impact of organizational structure on the knowledge sharing-performance relationship. In this condition, the form or strength of the knowledge sharing-performance relationship varies as a function of organizational structure. The organicness variable, z_1, moderates the relationship in the following way:

$$Y = f_1(z_1)F(X), \tag{3}$$

where $f_1(z_1)$ is a function of z_1, which represents the moderating effect of organicness on the basic knowledge sharing-performance relationship. On the basis of this model, we propose

Proposition 1. *The relationship between knowledge sharing and firm performance is moderated by the use of an organic structure. Firms that emphasize knowledge sharing and use an organic structure are more likely to have higher performance than those that do not use an organic structure.*

In the mediating-effects model (shown in Fig. 3), we consider only the impact of integration of activities on the knowledge sharing-performance relationship. Here knowledge sharing, X, is treated as an antecedent variable. Firm performance, Y, is the outcome variable, and the integration of organizational activities, z_2 is the mediating variable. We think that effective integrating activities intervene in the relationship between knowledge sharing and performance. Firms emphasizing knowledge sharing require a greater use of integrating activities and processes in order to obtain superior performance, and what is more, integrative thinking is vital when firms carry out knowledge sharing. Hence, the relationship between knowledge sharing and performance happens through the mediating variable in the following way:

$$Y = f_2(z_2), \quad \text{with } z_2 = G_1(X). \tag{4}$$

Here $f_2(z_2)$ represents the mediating effects of integrative activities on performance, and the function $G_1(X)$ characterizes the impact of integrative activities on the effectiveness of knowledge sharing. On the basis of this model, we propose

Proposition 2. *The relationship between knowledge sharing and firm performance is mediated by the use of integrating activities. Firms emphasizing knowledge sharing require the*

use of integrating activities, and integrating activities give rise to superior performance. So firms that use integrating activities are more likely to have higher performance relative to those that do not use integrating activities.

In the independent-effects model (shown in Fig. 4), we consider only the impact of environmental munificence on knowledge sharing-performance. Here, environmental munificence is referred to as the profitability or growth rates of the industry in which a firm competes. The industry within which a firm competes has a critical impact on its performance. A firm's environmental munificence is a significant predictor of performance. Even though knowledge sharing may have a critical effect on performance, it does not interact with the environmental munificence-performance relationship. Therefore, knowledge sharing variable, X, and environmental munificence variable, z_3, are described as having independent effects on firm performance, Y, as shown in the following equation:

$$Y = F(X) + f_3(z_3), \tag{5}$$

where X is independent on z_3. On the basis of this model, we propose

Proposition 3. *Both environmental munificence and knowledge sharing have independent effect on organizational performance.*

Top management team characteristics have an important bearing on group values, attitudes, norms and organizational culture, which influence both knowledge sharing and performance significantly. Hence, in the interaction-effects model (shown in Fig. 5), we consider only the impact of top management team's characteristics, z_4, on the knowledge sharing-performance relationship. Characteristics of the top management team, such as learning, sharing, innovation, collectivism, consciousness, and proactiveness, are believed to interact with knowledge sharing to influence firm performance. Favoring learning, sharing, innovation, and collectivism is likely to be congruent with the requirement suggested by knowledge sharing. Therefore, the relationship between knowledge sharing and performance is influenced by the characteristics of top management team in the following way:

$$Y = f_4(X, z_4) \tag{6}$$

with

$$z_4 = G_2(X), \tag{7}$$

where $f_4(X, z_4)$ reflects the interactive function of knowledge sharing and top management team characteristics, and $z_4 = G_2(X)$ represents the relationship between knowledge sharing, X, and top management team characteristics, z_4. On the basis of this model, we propose

Proposition 4. *Top management team characteristics, which include learning, sharing, innovation, collectivism, consciousness, proactiveness, etc., and knowledge sharing influence organizational performance through their interaction effects. Firms emphasizing knowledge sharing, in which managers favor learning, sharing, innovation, and collectivism, are more likely to have higher performance compared to firms with managers who do not favor learning, sharing, innovation, and collectivism.*

Considering the comprehensive impacts of the four contingencies depicted previously, we can obtain formulation (8), which presents the complicated relationships among knowledge sharing, organizational contingencies, and performance.

$$Y = F(X) + f_1(z_1)F(X) + f_2(z_2) + f_3(z_3) + f_4(X, z_4). \tag{8}$$

Under this formulation, the implementation of knowledge sharing becomes a program with the objective function and constraints as follows:

$$\begin{aligned} \text{Max} \quad & Y = F(X) + f_1(z_1)F(X) \\ & \quad + f_2(z_2) + f_3(z_3) + f_4(X, z_4) \\ \text{s.t.} \quad & z_2 = G_1(X), \\ & z_4 = G_2(X). \end{aligned} \tag{9}$$

Here, X is independent on z_3, environmental munificence variable.

In the framework of the model proposed here, $F(X)$ is the very basis function which must be estimated. We suggest a simple linear estimated equation as follows:

$$Y = F(X) = c_0 + \sum_i c_i x_i, \quad i = 1, 2, 3, \ldots, 6. \tag{10}$$

In above estimated equation, c_0 and c_i are parameters to be estimated. This estimated equation can be used to determine the quantitative relationship between knowledge sharing measures and performance on the basis of empirical investigation. We will do it in next section.

5. Survey and empirical results

5.1. Survey

Because our purpose was to explore the relationship between knowledge sharing and performance, and to reveal the influences of some contingent factors on the relationship, we attempt to cover all types of organizations in our survey. Thus, we conducted a survey of 249 organizations, including a variety of firms and institutes, which were registered in District Yanta, Xi'an, China. District Yanta is famous for its great scientific and technological resources, and is a representative of western regions in China. So we choose District Yanta as our target in survey.

To carry out the survey, we submitted a project proposal to Yanta Science and Technology Bureau. The project was approved. Then we got a financial support from the bureau to undertake the survey.

In our project team, there were 9 members from School of Economics and Management, Xidian University, who

were responsible for the design of survey, the necessary training of the staff participating in the survey, and the analysis of collected data. There were another 9 members from Yanta Science and Technology Bureau, who were responsible for the recruitment and selection of survey staff, the coordination with the surveyed firms and institutes, and the preservation of survey data. The selected part-time investigators are government officials working for the communities belonging to District Yanta. They were responsible for visiting the chosen organizations, collecting data and the answered questionnaires. And they rendered the collected data and questionnaires to Yanta Science and Technology Bureau after the data and questionnaires were sealed by the surveyed organizations. The 50 part-time workers came from different communities and were responsible for different respondents, respectively.

In order to collect enough data, we chose all state-owned firms and research institutes (including institutes in universities), and parts of private firms and institutes in District Yanta.

The surveyed 249 organizations include 182 firms and 67 institutes. These firms engage in a wide variety of lines, ranging from manufacturing industry to services industry. And the surveyed institutes specialize in a wide variety of technological territories, ranging from high technologies to traditional technologies.

The heterogeneous firms and institutes that our survey covers provide a rich setting to investigate the relationship between knowledge sharing and performance and the impacts of contingent factors.

In the survey, we collected the data of our knowledge sharing variables, x_1 through x_6, and performance, added value per labor (AVPL), from each organization of our sample. In addition, we designed 4 additional "Yes or No" questions in the questionnaire, measuring four contingent factors: organicness, integration of activities, environmental munificence, and top management team characteristics. $z_1 = 1$ if the surveyed organization has an organic structure; $z_1 = 0$ if not. Similarly, $z_2 = 1$ if the organization supports integrated activities; $z_2 = 0$ if not. $z_3 = 1$ if the organization's environment is munificent; $z_3 = 0$ if not. $z_4 = 1$ if the top management team emphasize on innovation; $z_4 = 0$ if not. Thus, the survey provided us with a systematic record of knowledge sharing, performance, and contingent factors.

5.2. Method and results

First, to test our basic model (formulated by Eq. (1)), we made a regression analysis by using our surveyed data.

With the help of SPSS software, we computed the intercept and the regression coefficients, and we obtained the regression equation as below:

$$\widehat{Y} = 1.0238 + 0.7841x_1 + 0.4814x_2 + 0.6573x_3 + 0.3021x_4 + 0.2214x_5 + 0.6985x_6. \quad (11)$$

From the regression equation we can see that: (1) x_1, the expenditure on inter-units and inter-organizational trainings contributes more than other variables to performance; (2) x_3, the expenditure on intentional activities for communicating and transferring knowledge, and x_6, the expenditure on collaborative R&D, have similar contributions to performance, but the contributions are slightly less than that of organizational trainings; (3) x_2, the expenditure on collaborative trials and experiments of non-R&D departments contributes moderately to performance relative to the other variables and (4) x_4, the frequency of importing workers, and x_5, the frequency of job rotation, have relatively a little contribution to performance.

Our regression equation suggests that some knowledge sharing variables have significant impacts on performance, and the emphasis on them may improve the effectiveness of knowledge sharing greatly.

Then we tested the four propositions with the help of collected answers to additional questions in questionnaire. We made association analyses of the 4 contingent variables, respectively, with the relationship between knowledge sharing and performance by using cross (two-way) table technique. We put the knowledge sharing-performance relationships into two categories, and coded them as $z_5 = 1$ or 0. Here, we set $z_5 = 1$ if the surveyed organization's observed performance, Y, i.e. the added value per labor (AVPL) is no less than the estimated performance $\widehat{Y}$ that is calculated from the regression Eq. (11), which may represent a strong knowledge sharing-performance relationship; otherwise, we set $z_5 = 0$, which may represent a weak relationship.

Table 2 summarizes the results of our association analysis, which characterize the effects of four contingencies on the relationship between knowledge sharing and performance.

In Table 2, index of predictive association, $\lambda_{A\cdot B}$, depicts the degree to which a predictor variable, B, can predict a criterion variable, A. The value of $\lambda_{A\cdot B}$ falls in $[0,1]$, with $\lambda_{A\cdot B} = 1$ standing for the greatest capability of predictor variable B to predict criterion variable A, and $\lambda_{A\cdot B} = 0$ standing for the least capability of predictor variable B to predict criterion variable A. The greater the index is, the stronger the predicting capability is, which, to some extent,

Table 2
Index of predictive association

Predictor variables (contingent variables)	Index of predictive association with knowledge sharing-performance relationship variable, z_5 (criterion variable)
Organicness of an organization, z_1	$\lambda_{z_5\cdot z_1} = 0.6512$
Integration of activities, z_2	$\lambda_{z_5\cdot z_2} = 0.8896$
Environmental munificence, z_3	$\lambda_{z_5\cdot z_3} = 0.1033$
Top management characteristics, z_4	$\lambda_{z_5\cdot z_4} = 0.3891$

can describe the effects of contingencies (predictors) on the relationship between knowledge sharing and performance (criterion variable).

From Table 2 we can see that the effect of integrative activities on knowledge sharing-performance relationship is relatively stronger than that of other contingencies. While the effect of environmental munificence on knowledge sharing-performance relationship is very little, revealing the independent effect of environmental munificence on knowledge sharing-performance relationship. The effect of organic organization structure is moderate, and that of top management characteristics is slight. These results prove our contingent models presented in Section 4.

Our empirical results suggest that some contingent factors have significant effects on knowledge sharing-performance relationship, and appropriate contingencies facilitate the functioning of knowledge sharing.

6. Conclusion

In a knowledge-based society, the ability of a firm to create, sustain, and transfer knowledge has a very great impact on its performance. Knowledge sharing is a good way to effectively and efficiently create, sustain, and transfer knowledge. Therefore, it has been broadly studied and applied in many contexts, and the exploration of the relationships between knowledge sharing and performance becomes very crucial. However, researchers investigating knowledge sharing and organizational performance are still struggling with many hot issues. Underlying these issues are the basic questions, "What kind of relationship exists between knowledge sharing and performance and what factors influence the relationship?"

Our goal in this paper is to suggest a fundamental quantitative model that we believe will provide a basis on which the further quantitative models can be established easily. So, first we have conducted a short review of literature, identified some contextual factors in knowledge sharing, and linked knowledge sharing and its contextual factors with performance. Second, we have proposed some basic dimensions of knowledge sharing and developed some measures for it, on the basis of which we have provided an integrative model framework for empirically exploring the relationship among knowledge sharing, organizational contingencies, and performance. Then we have depicted our empirical survey in Xi'an, China, and the method we used. Finally, we have made an aggression analysis and determined the linear estimated equation for the unknown function in the model, and tested the propositions that are provided in our model framework.

The empirical findings support the idea that knowledge sharing is related to performance, and different dimensions of knowledge sharing contribute to performance differently. The resulted regression equation shows that: (1) the expenditure on inter-units and inter-organizational trainings contributes more than other variables to performance; (2) the expenditure on intentional activities for communicating and transferring knowledge and the expenditure on collaborative R&D have similar contributions to performance, but the contributions are slightly less than that of organizational trainings; (3) the expenditure on collaborative trials and experiments of non-R&D departments contributes moderately to performance relative to the other variables and (4) the frequency of importing workers and the frequency of job rotation have relatively a little contribution to performance.

Our empirical findings also support the idea that some contingent factors influence the relationship between knowledge sharing and performance. First, integration of activities is the most important factor, which mediates the knowledge sharing-performance relationship. Second, organicness of structure is another important contingency, which moderates the relationship between knowledge sharing and performance. Third, characteristic of top management team is a contingent factor that interacts with knowledge sharing. While, environmental munificence is independent on knowledge sharing when influencing performance.

This study suggests that managers have to focus on the important dimensions of knowledge sharing and care the contingent factors when they perform knowledge sharing. For (1) some knowledge sharing dimensions have significant impacts on performance, and the emphasis on them may improve the effectiveness of knowledge sharing greatly and (2) if the contingent factors that have significant effects on knowledge sharing-performance relationship are suitable, higher performance can be obtained; otherwise, the effectiveness of knowledge sharing may be influenced negatively, and the performance goal of knowledge sharing cannot be attained. These two points can provide a meaningful implication to the practice of knowledge sharing.

Several limitations in this study must be acknowledged. First, our reliance on the "Yes or No" answers to the additional questions in our questionnaire makes our measures glancing for contingent variables. While it may be reasonable if one adopts better methods to describe them more exactly. Second, the survey we conducted is not a random one, with our sample restricted in one district. It may be more reasonable if one undertakes a similar survey in a more wide area. However, we believe that our study will contribute to the quantitative research of knowledge sharing, and will further the understanding of the relationships between knowledge sharing and performance.

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