IT Innovativeness, Exploration and Organizational Knowledge Transfer

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Abstract

This paper investigates the relationships between organizational IT innovativeness and tacit and explicit knowledge transfers. It also examines the impact of firm's strategy of exploit or explore on those two kinds of knowledge transfers. Using survey data from U.S. biochemistry and biomedical industries with sample size of 206, I run the structural equation modeling techniques and find positive and significant relationship between IT innovativeness and tacit knowledge transfer, but marginally significant and positive association between IT innovativeness and explicit knowledge transfer. I also find that the more firms exploit, the less knowledge transfers occur, both for explicit and tacit knowledge. The paper concludes with the managerial implications and future research directions.

Keyword: It Innovativeness, Knowledge Transfer, Tacit Knowledge, Explicit Knowledge, Exploration, Exploitation, Competitiveness

1. Introduction

The knowledge in the organization is examined for a long time and is categorized into two major types: explicit and tacit (Foss and Mahnke 2003). Organizational knowledge transfer has also been studied by different literatures such as innovation, and information systems among others. In innovation literatures, knowledge transfer has been found to have positive effect on firms' innovation capability (Calantone *et al.* 2003). In IS literature, Alavi and Leidner (2001) and Griffith *et al.* (2003) conceptualized the role of IT in organizational knowledge creation, storage and transfer. This paper examines the impact of IT innovativeness on organizational knowledge transfer, both explicit and tacit. It also examines the effect of firm's exploitation-exploration (E-E) strategy on knowledge transfers. The remaining parts of the paper are organized as follows: first current literature of knowledge transfer, IT capabilities and E-E will be examined and used to develop hypotheses about how firms' IT innovativeness, E-E strategy will affect tacit and organizational knowledge transfer. Then, methodology and result of data analysis will be discussed. The paper concludes with discussion and implications for future research and practitioners.

Theoretical Background and Hypotheses Development

2.1 Knowledge Transfer

Foss and Mahnke (2003) conceptualized knowledge into tacit and explicit. Tacit knowledge relates to intuition, actions, values, and ideals and tacit knowledge is difficult to communicate (Nonaka, Toyama, and Konno 2000). However, explicit knowledge is highly codified and is transmittable in formal, systematic language (Polanyi, 1966; Nonaka and Takeuchi, 1995). Whereas explicit knowledge provides the building blocks, tacit knowledge provides the glue and integrating mechanism in learning (Dhanaraj *et al.* 2004). Nonaka (1994) conceptualized the mode of knowledge creation that tacit knowledge of individual transfers to firm's tacit knowledge through socialization, and transfers to firm's explicit knowledge through process of externalization, while individual's explicit knowledge transfers to organization's tacit and explicit knowledge through internalization and combination, respectively. Knowledge transfers have been treated as independent variable in innovation literatures. Calantone *et al.* (2002) found that intra-organizational knowledge sharing positively affects the firm innovation capability.

Tamer *et al. (*2003) found the relationship between extent of tacit knowledge transfer and innovation capability. However, there has been little work that examines the antecedents of knowledge transfer. In this paper, it is argued that Information Technology innovativeness of the firm and the degree to which it explores versus exploits current resources or capabilities will impact the degree of knowledge transfers in the organizations, for both explicit and tacit knowledge.

2.2 IT and Knowledge Transfer

In the IS literature, IT has been studied for its effect on knowledge creating and transfer. In Alavi and Leidner (2001), the role of IT is conceptualized as the tool to provide access to knowledge, to involve gathering, storing and transferring the knowledge, to provide a link among knowledge sources to create wider and deeper knowledge flows and to support the development of individual and organizational competencies. Griffith *et al.* (2003) argues that IT can facilitate the dissemination of knowledge across the organization even for virtual teams. This paper tries to examine the IT innovativeness of a firm on its different impact on tacit knowledge and explicit knowledge transfers. For example, social networking services allows co-workers to be connected more closely, and company's intranet or knowledge base gives employees easier access to the knowledge from their peers without direct verbal communication. The role of IT in knowledge transfer may be even more salient if the knowledge is tacit or hard to be codified because when some knowledge is hard to express such as experience of doing some work, IT may help it more by using multimedia or allowing easy, fast and effective coding, storage and transfer throughout the organization (e.g. watching YouTube video may help employees better understand how to finish some work from other employees). Therefore, the more innovative a firm is in their IT, it is easier for them to facilitate the knowledge transfers, especially for tacit knowledge transfer. Knowledge workers in the workplace will find it more useful to transfer their tacit knowledge with the help of new IT tools, compared with explicit knowledge, which was not hard to transfer with traditional verbal communication or non-innovative IT before the innovations. Hence, the tacit knowledge transfers are more likely to happen when a firm has high IT innovativeness. Though explicit knowledge is also likely to happen with IT innovation, the magnitude of the impact is expected to be lower than that of tacit knowledge transfer.

Hypothesis 1: *IT innovativeness is positively correlated with explicit knowledge transfer*
Hypothesis 2: *IT innovativeness is positively correlated with tacit knowledge transfer*

2.3 Exploitation-Exploration and Organizational Learning

Exploitation and exploration are two strategies that many firms find hard to balance. The reason is that when a firm explores more, it has more chances to have competitive advantage among the competitors, whereas it is also more likely to fail. However, it is more secure for a company to exploit more its current resources, capabilities and know-how to generate rent, but this makes it less competitive for long run. The choice of those two strategies may change over time determined by different factors such as market competitiveness. Here I want to investigate the relationship between choice of E-E and organizational knowledge transfer. March (1991) finds that exploitation has short run effect on organizational learning, while exploration has long run effect. The underlying rationale is that if a company explores more, they need to learn more new things and more knowledge will be created, and then transferred. However, when company deploys an exploitation strategy for its current capability, in a long run, there might not be enough new knowledge to be created and transferred because everyone is following the usual routine of doing work and as time goes by, the more employees exploit current resources and capability, the less knowledge (neither explicit nor tacit) transfers will occur. Hence, I hypothesize that if a company exploits more rather than explores more, there will be less explicit and tacit knowledge transfers.

Hypothesis 3: *Exploitation is negatively correlated with explicit knowledge transfer*
Hypothesis 4: *Exploitation is negatively correlated with tacit knowledge transfer*

2.4 Market Competitiveness

Competitiveness is the degree to which companies in an industry compete with each other. When an industry is competitive, firms are argued to exploit more and invest less on innovative projects like non-routine IT, communications and innovative managerial practices because they want to focus on their main job and do not have extra budget and cannot afford failing them. Competitiveness is used as control variable to predict the IT innovativeness, E-E, explicit and tacit knowledge transfers.

Methodology

3.1 Sample and Scales

This study uses survey to collect data from firms. The sample consists 206 firms in biochemistry or biomedical industry participated in the survey about their knowledge transfers, IT innovativeness, exploitation and exploration (E-E) strategies, competiveness and environmental dynamisms, new product development performance among others. Originally E-E has four items each of which represents one aspect of the strategy: internal, supplier, alliance and acquire. Those four items are on a scale of 1 to 7, with 1 means the company does the most exploration and least exploitation, while 7 means the company does most exploitation and least exploration in one of the units. There are three items for explicit knowledge transfer and four items for tacit knowledge transfer. IT innovativeness is measured by four items, on a 7-scale measurement representing the degree to which the company has the non-routine IT innovations in functional units like communications, information systems, managerial practices and so forth.

3.2 Measurement Model

This section describes the measurement model after the purification process of the constructs and items. In this study, environmental dynamisms and new product performance are not relevant thus are excluded from the model. One of the items in E-E and one in Tacit Knowledge Transfer are excluded due to poor performance in the measurement model. All assessments are conducted with the help of SPSS 15 and EQS 6. Prior to hypothesis testing, I conduct the confirmatory factor analysis (CFA) and assessed the measurement model by examining construct correlations, items reliability, factor loadings, convergent and discriminant validity. Table 1 shows the descriptive statistics and correlations between the constructs.

Table 1. Descriptive Statistics and Correlation Matrix (N = 206)

	Mean	**Std. Dev.**	IT Innov.	E-E	Ex. KN	Tacit KN	Compet.
IT Innovativeness	5.05	0.74	1.00				
Exploitation-Exploration	4.54	1.62	-0.047	1.00			
Explicit Knowledge Transfer	4.23	1.42	0.125**	-0.188***	1.00		
Tacit Knowledge Transfer	4.13	1.01	0.42***	-0.203***	0.17***	1.00	
Competitiveness	3.14	1.18	-0.09*	0.196***	-0.033	-0.027	1.00

**p < 0.10, ** p < 0.05, *** p< 0.01*

Table 2 shows the measurement results with composite reliability, average extracted variance (AVE), standardized factor loading and fit statistics of measurement model. Table 3 provides the results of the discriminant validity assessments. Overall, the 15 purified and perception-based reflective items (of 18 original items) and their corresponding five latent constructs were found to be reliable and valid in the context of this research. The remainder of this section discusses the measurement testing in detail.

Table 2. Measurement Results and Fit Statistics (N = 206)

Construct	E-E	IT Innov.	Ex. KN.	Tacit KN.	Compt.
# of Items	3	4	3	3	2
Composite Reliability	0.82	0.69	0.76	0.69	0.89
Cronbach's Alpha	0.9	0.75	0.84	0.77	0.94
Average Variance Extracted (AVE)	77%	41%	52%	43%	80%
Highest Shared Variance	4%	18%	3%	18%	4%
Standardized Factor Loading	0.81 - 0.91	0.64 - 0.75	0.76 - 0.86	0.60 - 0.86	0.90 - 1.00
Fit Statistics	$\chi 2 = 287.982$, d.f. = 80, CFI = 0.868, RMSEA = 0.113				
	90% C.I. of RMSEA (0.098, 0.126)				

Table 3. Discriminant Validity Assessment: Pairwise CFAs

Possible Pair		χ^2_{fixed}	χ^2_{free}	$\Delta\chi^2_{(d.f.=1)}$	Prob.
E-E	Compt.	47.87	26.47	21.40	$p < .001$
E-E	Ex. KN	85.27	18.72	66.55	$p < .001$
E-E	Tacit KN	115.31	26.16	89.15	$p < .001$
E-E	IT Innov.	118.32	42.01	76.31	$p < .001$
Compt.	Org. KN	59.53	16.44	43.09	$p < .001$
Compt.	Tacit KN	81.76	6.36	75.40	$p < .001$
Compt.	IT Innov.	149.88	50.87	99.01	$p < .001$
Ex. KN	Tacit KN	75.42	42.14	33.28	$p < .001$
Ex. KN	IT Innov.	100.82	52.69	48.13	$p < .001$
Tacit KN	IT Innov.	84.12	43.99	40.13	$p < .001$

Table 4. Structure Model and Path Coefficients (N = 206)

Relationship	Unstd. Coeff.	Std. Coeff.	R^2	Hypothesis Supported?
IT Innov. -> Tacit KN	0.513(0.104)***	0.624	47.40%	Supported
E-E -> Tacit KN	-0.123(0.035)***	-0.289		Supported
Compt. -> Tacit KN	0.088(0.035)**	0.191		N.A.
IT Innov. -> Ex. KN	0.282(0.161)*	0.153	7.20%	Marginally Supported
E-E -> Ex. KN	-0.212(0.077)***	-0.221		Supported
Compt. ->Ex. KN	0.061(0.079)	0.059		N.A.
Compt. -> IT Innov.	-0.092(0.046)**	-0.164	2.70%	N.A.
Compt. -> E-E	0.181(0.083)***	0.167	3.10%	N.A.
Fit Statistics	$\chi2 = 236.288$, d.f. = 78, CFI = 0.900			
	RMSEA = 0.099, 90% C.I. of RMSEA (0.085, 0.114)			

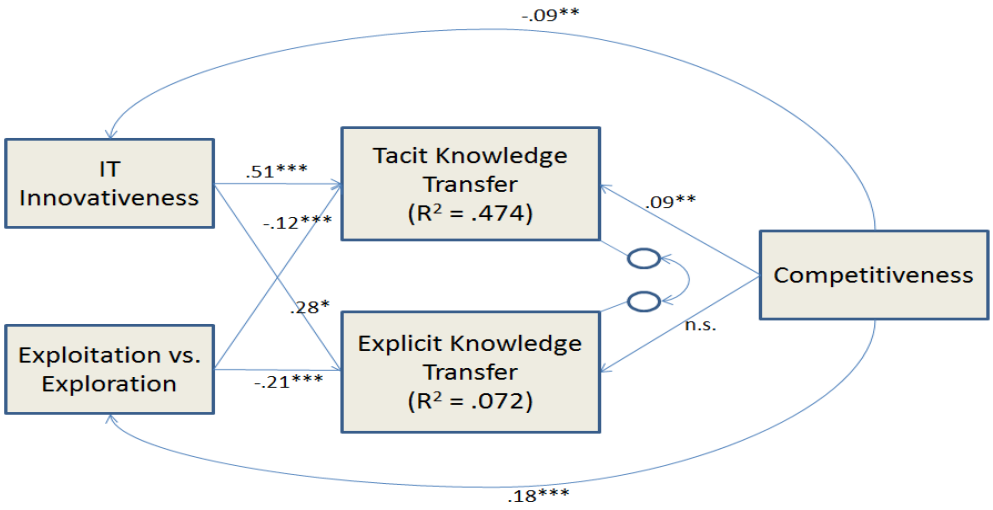
** p < 0.10, ** p < 0.05, *** p < 0.01, standard error in parentheses*

The descriptive statistics show that the average IT innovativeness in the sample is 5.05 with standard deviation of 0.74, and the Exploitation-Exploration, organizational knowledge transfer and tacit knowledge transfer are averaged at 4.54, 4.23 and 4.13, respectively. The average competitiveness in the sample is 3.14. Pearson's correlations between all the constructs are tested, and the results show that IT innovativeness is positively correlated with explicit ($p < 0.05$, one tailed) and tacit knowledge transfer ($p < 0.01$, one tailed); as well IT innovativeness is negatively correlated with competitiveness ($p < 0.10$, one tailed). Exploitation-Exploration is negatively correlated with explicit ($p < 0.01$, one tailed) and tacit knowledge transfer ($p < 0.01$, one tailed) and positively correlated with competitiveness ($p < 0.01$, one tailed). Finally, both types of knowledge transfer are positively correlated ($p < 0.01$, one tailed).

Items reliability, factor loading, and average extracted variance are assessed. After purification, Exploitation-Exploration has three items, with *Cronbach*'s Alpha of 90%; IT innovativeness has four items, with Alpha of 75%; Explicit Knowledge Transfer has three items, with Alpha of 84%; Tacit Knowledge Transfer has three items, with Alpha of 77% and Competitiveness has 2 items with Alpha of 94%. The number of items is consistent with the rule of thumb "Two might be fine, three is better, four is best, and anything more is gravy" (Kenny, 1979), and reliabilities are also in an acceptable range. I further test the composite reliability according to Fornell and Larcker (1981). The composite reliability of each construct ranges from 0.69 to 0.89. I also test the average variance extracted (AVE) according to Fornell and Larcker (1981) and AVE for all five constructs ranges from 41% to 80%. The standardized factor loading for all constructs ranges from 0.60 to 1.00. The rule of thumb of the factor loading is 0.707, however generally 0.5 is accepted, therefore the loadings are valid in this study.

Chi-Squared of the CFA is 287.982 with degree of freedom of 80, and CFI is 0.868, RMSEA is 0.113 and its 90% confidence interval is 0.098 to 0.126. Discriminant validity is assessed by two methods. First, I calculated the shared variance between each possible pair of constructs and verified that it was lower than the variances extracted for the involved constructs (Fornell and Larcker, 1981). Because factor loading and error variance were standardized, shared variance was equal to the squared correlation between the two constructs. The highest shared variance is between IT capability and Tacit Knowledge Transfer, they share 18% of the variance, but it is still lower than the AVE of both constructs. Thus, this test indicates the supports to the discriminant validity of the study. The second test I use is to compare all possible pairs of constructs by Anderson (1987) and Bagozzi and Phillips (1982). For each possible pair of constructs, I run the CFA and constraint the covariance to be 1 and then free the constraint. All χ^2 are lower in the model with free covariance than the one with covariance of unity. I compare the difference of the χ^2 for both models and found all the differences are significant. This indicates that the model with free covariance performs better than the model with fixed covariance. Hence, it indicates that all pairs of constructs are significantly different, or they are discriminant.

Figure 1. Model Diagram



2. Results

As stated in the hypotheses development section, Tacit Knowledge Transfer and Explicit Knowledge Transfer are hypothesized to be positively correlated with IT Innovativeness and negatively correlated with Exploitation. Competitiveness is used as a control variable for the dependent variable and is expected to be negatively correlated with both knowledge transfers. Competitiveness is also expected to be correlated with IT Innovativeness negatively and with Exploitation positively. Hence the model tests (1) the main effect of IT Innovativeness and E-E on two types of knowledge transfers, and (2) the mediating effects of IT capability and E-E of the relationships between competitiveness and knowledge transfers. Even the Tacit Knowledge Transfer and Explicit Knowledge Transfer are different in the type of knowledge transferred to the company; they may be caused by some common factor because the necessary condition for knowledge transfer could be the same. I co-vary the error terms of those two latent factors construct to account for unexplained common cause of both knowledge transfers.

Using EQS 6, I tested all above hypothesized paths and found following results. Positive association is found between IT Innovativeness and Tacit Knowledge Transfer (b = 0.513, β = 0.624, $p < 0.01$); negative association is found between E-E and Tacit Knowledge Transfer (b = -0.123, β = 0.035, $p < 0.05$); positive association is found between Competitiveness and Tacit Knowledge Transfer (b = -0.123, β = 0.035, $p < 0.05$). Those three constructs explain 48% of the variances of Tacit Knowledge Transfer. Marginally positive association is found between IT Innovativeness and Explicit Knowledge Transfer (b = 0.282, β = 0.153, $p < 0.10$); negative association is found between E-E and Explicit Knowledge Transfer (b = -0.212, β = -0.221, $p < 0.01$); non-significant association is found between Competitiveness and Explicit Knowledge Transfer (b = 0.061, β = 0.059, $p > 0.10$). Those three constructs explain 7.2% of the variances of Explicit Knowledge Transfer. Negative association is found between Competitiveness and IT (b = -0.092, β = -0.164, $p < 0.05$); positive association is found between Competitiveness and E-E (b = 0.181, β = 0.167, $p < 0.01$).

Competitiveness explains 2.7% of the variances of IT and 3.1% of the variances of E-E. Chi-Squared of the structure model is 236.288 with degree of freedom of 78, and CFI is 0.90, RMSEA is 0.099 and its 90% confidence interval is 0.085 to 0.114.

Discussion and Implication

In this study, a framework for studying IT innovativeness, exploitation strategy and knowledge transfer was developed. The model was tested using data collected from large US firms. Based on the findings, several guidelines can be offered to both scholars and practitioners regarding the role of IT in firm knowledge transfer. The main effect of IT innovativeness on knowledge transfer indicates that IT does help for both kinds of knowledge transfers (even marginal for explicit; however, the effect on tacit knowledge transfers is stronger than that on explicit organizational knowledge transfer. One of the explanation is that for more tacit knowledge, IT is more useful, especially innovative IT. Hence the implication here is that for those firms have more tacit knowledge such as the experiences of knowledge workers, the innovative IT is more important. Another implication is that when company deploys exploitation strategy, in long run, it will impede the both types of knowledge transfers. Those findings are strong that even I control competitiveness (which is found to be correlated with tacit knowledge transfer), those effects are still significant at 5% (except the effect of on explicit knowledge transfer).

Limitations and Future Research

Though this study is valid, reliable and results are generalizable, it still has some limitations. Firstly, the measurements for IT Innovativeness include other aspects such as innovation in managerial practices, though they are all IT-enabled like discussed, it will be more ideal if the data is measuring pure IT innovation. The second limitation is that only about 7% of the variance of explicit knowledge transfer is explained by the model, indicating there is a very important hidden factor that is missing which could explain more variance. It might be interesting to explore it in future studies.

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