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# Search-Transfer Behavior, Knowledge Heterogeneity and Organizational Learning

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**Abstract**—This paper examines the impact of intra- and inter-organizational interaction in innovation process on the level of individual and organizational learning. It contributes to social capital and organizational learning theory through increasing the knowledge on learning process in networked R&D. This paper adopts a process-oriented research approach. It examines the patent development process of a case company both quantitatively and qualitatively. As a result, knowledge search-transfer behavior is found to influence differently individual and organizational learning. The knowledge search outside organizational boundaries has the highest impact on individual learning due to enhanced knowledge heterogeneity. In order for organizational learning to occur, internal multi-functional knowledge transfer is needed to implement the new solution and thus improve existing organizational routines.

**Keywords**—Organizational learning, social capital, networked R&D, innovation.

## I. INTRODUCTION

Prior research on social capital and innovation management has emphasized the value of intra- and inter-organizational networks in facilitating the creation of new intellectual capital through knowledge exchange and combination. It has been demonstrated that organizations with a central network position connecting otherwise disconnected contacts within a sparse network are more innovative and perform better than others [1]. Moreover, intra-organizational interaction between different organizational functions such as research and development (R&D), manufacturing, sales, marketing and strategy enhances the creation of combined market-technology knowledge [2]. This knowledge supports the development of products that fit well to the needs of target customers. Although the value of intra- and inter-organizational interaction has widely been recognized, there is yet little research that would examine the process of learning in a networked context [3].

The objective of this paper is to contribute to social capital and organizational learning theory in two ways. First, it clarifies the implications of knowledge search-transfer behavior in innovation process on the level of individual and organizational learning. Second, it provides an increased understanding on how individual and organizational learning operates in networked R&D.

This paper adopts a process-oriented research methodology with the process of innovation as the unit of analysis. The process view allows the examination of only those network relationships that have actually been utilized for innovation development and their direct impact on the learning outcome. The research sample covers the individual process behind the creation of 90 case company patents and the possible implementation of them into new products and services in the time period of 1996-2004. The role of quantitative analyses is to detect possible behavioral differences between individual and organizational learning. This issue has largely been neglected in prior research on organizational learning as many researchers have simply treated organizational learning as learning by individuals within an organizational context [3]. This despite that organizational learning theory makes a clear distinction between these two. The role of qualitative analysis is to clarify the process of learning in networked R&D, whereas the prior research in social capital has mainly focused on the pre-requisites for resource combination [5-6]. Thus, in addition to examining knowledge creation, this paper also analyzes knowledge transfer and exploitation.

## II. THEORIES ON KNOWLEDGE CREATION AND LEARNING

### A. Social Capital and Innovation Management

The organizational advantage has been emphasized to derive especially from the capabilities organizations have for creating and sharing knowledge [5, 7]. These capabilities lay ground for the creation of innovations that can be defined as novel combinations of existing resources [8-9]. Prior research has demonstrated social capital to facilitate knowledge exchange and combination [10]. Social capital is the sum of actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit [5]. The existence of network ties is needed for resource exchange and combination, whereas trust and shared codes between partners enhance this process [5]. The absorptive capacity - the ability to value, assimilate, and utilize new knowledge derived from a network relationship is a pre-requisite for learning [11]. In addition to the cognitive and relational aspects of value creation, knowledge characteristics affect the likelihood of resource combination. Tacitness and complexity of knowledge makes it

difficult to exchange between intra- or inter-organizational actors [6, 9].

Prior research on innovation management has similarly emphasized that information resulting in new ideas or approaches can be found most effectively via external interaction with universities, suppliers or customers [12-14]. The employees that are either in a direct contact with external organizations or read more of literature than others are valuable gatekeepers for an organization [15]. While individuals develop new knowledge, organizations have critical role in articulating and amplifying that knowledge [16].

### B. Organizational Learning

The organizational learning theory focuses on how individuals, groups, and organizations find and interpret information and use it to alter their fit with their environments [3]. Individual learning occurs when individual's experience is distilled into understandings that can be viewed as personal skills and knowledge [4]. The organization learns only insofar as individual insights and skills become embodied in organizational routines, practices and beliefs [4].

According to the adaptive learning perspective variations in organizational routines are triggered by problem-driven search routines [17]. The main mechanisms that change organizational routines and beliefs are trial-and-error and experimentation, when they are associated with successful outcomes [17]. The learning by doing is the purest form of learning, but new knowledge can also transfer through recording it to written documents or presenting it directly to other organizational members [4]. The knowledge development perspective sees variations to increase under cognitive confusion and misunderstandings [3]. Selection results from the compatibility of new information and beliefs with current organizational knowledge. The retention requires that that the culture of the organization is altered [3].

In evolutionary theory, the concept of local search is a central assumption. This means that organizations tend to initiate new projects that are closely related to earlier ones, which constrains the corporate R&D. The tendency towards local search derives from the history-dependent organizational routines and technological capabilities [18]. The organizational learning theory stresses the same dilemma. When organizations have built high competences in existing procedures, they are reluctant to develop new ones. The exploration of new alternatives reduces the speed at which skills of existing ones are improved [4]. Thus, organizations face the decision on how to balance their scarce resources between explorative and exploitative learning [19]. The focus on exploitation is a short-term strategy as this may inhibit an organization to respond well to long-term environmental changes [19].

### III. HYPOTHESES DEVELOPMENT

This paper extends the prior findings of social capital and innovation management to organizational learning theory. It forms hypotheses to test the impact of social capital on the

level of individual and organizational learning. The earlier research has demonstrated distant and infrequent relationships, weak ties, to be more likely to provide new information and opportunities for organizations than strong ties [13-15, 20]. The actors that rely on these weak ties as sources of ideas are more innovative than those that rely on strong ties [21]. Collaboration with a multiplicity of partners along the value chain makes it possible to realize cumulative learning effects with positive impacts on the efficiency of firms' own R&D [22]. Thus, it can be hypothesized that external knowledge search enhances both individual and organizational learning.

*Hypothesis I-A: The search of new knowledge outside organizational boundaries is positively associated with the level of individual learning.*

*Hypothesis I-B: The search of new knowledge outside organizational boundaries is positively associated with the level of organizational learning.*

The internal multi-functional cooperation is required for the combination of market-technology knowledge that is needed for the implementation of successful products [2]. Especially, if knowledge is highly complex and tacit, strong internal ties are needed for the knowledge exchange [21]. Thus, it may be hypothesized that internal knowledge search enhances both individual and organizational learning.

*Hypothesis II-A: The search of new knowledge within organizational boundaries is positively associated with the level of individual learning.*

*Hypothesis II-B: The search of new knowledge within organizational boundaries is positively associated with the level of organizational learning.*

While tacit knowledge lies in the heart of knowledge creation, realizing practical benefits requires dynamic interaction in converting the tacit knowledge into explicit one in order to transfer it efficiently in the organization [16]. The internal interaction that involves overlapping activities between organizational members enhances the process of product development [2, 16]. Thus, it can be hypothesized that internal multifunctional knowledge transfer enhances organizational learning.

*Hypothesis III: The transfer of new knowledge through multifunctional intra-organizational interaction is positively associated with the level of organizational learning.*

### IV. METHODS AND DATA

This research adopts a process-oriented research approach [23]. It examines the process behind the creation and implementation of patents. Although patents have commonly been used as a measure for innovativeness in prior research, the underlying process of patent development has received less attention. The primary research data is obtained through a survey to the actual inventors of patents. The ordinal logistic regression is used for testing the hypotheses as the dependent variable is discrete [24]. In addition, ten semi-structured interviews are used to clarify the process of learning in networked R&D. These interviews were selected to contain highly networked R&D processes, which utilize both external and internal interaction for knowledge creation.

The case company is a major telecommunications operator in Northern Europe. It has a long history of innovations,

including the launch of the world's first multinational cellular system, NMT (Nordic Mobile Telephone), in 1981. Thus, it provides an interesting research case on networked R&D. This paper examines its patents and patent applications that have been developed in Finland in 1996-2004. Since a patenting process takes approximately two years, also patent applications were examined, as the inventors had the most up-to-date knowledge on the creation of them. In order to increase content validity, the survey measurement was reviewed with both academic members and company R&D managers. In addition, the reviewed survey was tested with two inventors of patents in order to detect sources of misunderstanding in the survey. Then, the survey was sent to all the inventors of patents that were employed by the case company at the end of 2004. Altogether 30 responses on 90 patent development processes were received after several inquiries. The response rate was 27% and the responses covered 54% of case company patents.

The two dependent variables of the study are individual and organizational learning. The inventors estimated, with 5-point Likert scale, whether they or other organizational members had learnt substantially new knowledge that had benefited them later at work. The informant bias is not likely to violate the results as the survey aimed at receiving comparable data, not absolute truths. The responses are nearly normally distributed in the survey scale based on the histogram of responses.

There are three independent variables: external knowledge search, internal knowledge search and internal knowledge transfer. As the prior research on social capital emphasizes, the access to diverse contacts is not enough for knowledge exchange and combination, but also trust and shared language and codes between contacts is needed [5]. Thus, the inventors reported only those of their contacts that had actually enhanced knowledge creation and exploitation in the innovation process. The knowledge search is a count variable of different kinds of internal or external contacts that enhanced knowledge creation. The external and internal knowledge search is measured separately. The knowledge transfer is a count variable of different kinds of internal contacts that enhanced the implementation of a patent to a new product. The different external contacts in knowledge search are divided into customers, suppliers or vendors, universities or research institutes and R&D consortia as prior research has recognized these to be important sources of innovation [12, 25-27]. The different internal contacts in knowledge search and transfer are divided into co-inventors, own team members, other R&D colleagues, networks & production colleagues and sales & marketing colleagues. These were determined based on prior research that has emphasized the importance of multifunctional interaction and knowledge heterogeneity in innovation process [2, 16, 28]. The control variables of R&D intensity, the age and the job tenure of the inventor were adopted from prior research in order to control their possible effect on learning.

## V. RESULTS

### A. Test of Hypotheses

Table 1 presents a correlation matrix and descriptive statistics for all variables. Multicollinearity does not cause problems to ordinal logistic regression method as there are no significant correlations between independent variables. Table 2 presents the summary of results. The dependent variable is individual learning in model 1 and organizational learning in model 2. Both models exhibit statistical significance, and the relationship between knowledge search-transfer behavior and learning appears significant. The pseudo R-square statistics are 0.24 and 0.39, which indicates that the variables explain a considerable amount of differences in learning outcome.

The results demonstrate that the knowledge search-transfer behavior has different impact on individual and organizational learning. The external knowledge search is positively related to individual learning ( $p < 0.05$ ), but not to organizational learning. These results support Hypothesis I-A, but discard Hypothesis I-B. Hypotheses II-A and II-B are not supported as the internal knowledge transfer does not influence significantly individual or organizational learning.

TABLE 1  
CORRELATION MATRIX

Variables	Mean	s.d.	1	2	3	4	5	6	7
1. External search	0,28	0,56							
2. Internal search	1,43	0,74	0,20						
3. Internal transfer	0,38	0,82	0,21	0,12					
4. Age	31,8	5,19	-0,24	-0,04	0,06				
5. Job tenure	4,76	3,78	-0,07	-0,07	0,06	0,45			
6. R&D intensity	3,62	0,24	-0,05	-0,12	-0,35	-0,04	-0,08		
7. Individual learning	3,34	1,03	0,12	0,08	0,06	0,27	-0,12	-0,18	
8. Organizational learning	2,25	0,82	0,14	-0,10	0,50	0,13	0,26	-0,35	0,25

TABLE 2  
TEST OF HYPOTHESES

Variables	Model 1	Model 2
	Individual learning	Organizational learning
Const (1)		-8,417
Const (2)		-5,648
Const (3)		-2,600
Const (4)		1,462
External search	0,788 *	0,477
Internal search	0,101	-0,567
Internal transfer	-0,153	1,263 **
Age	0,189 **	0,007
Job tenure	-0,180 **	0,135 *
R&D intensity	-1,633	-1,932 *
Chi-Square	22,460	38,255
df	6	6
p-value	0,001	0,000
Nagelkerke's Pseudo R-Square	0,236	0,385

N=90; \*p<0,05; \*\*p<0,01

There is strong support for Hypothesis III as internal knowledge transfer has a significant influence on organizational learning ( $p < 0.01$ ). Thus, in order for the organization to benefit from individual learning, internal knowledge transfer is needed to implement the new solution.

In addition, the control variables present significant influence on the dependent variable. Age enhances the level of individual learning. High job tenure enhances organizational learning, but decreases individual learning. High R&D intensity is found to decrease organizational learning. This result may be company-specific as the R&D expenditure of case company did not increase as rapidly as the revenues during the high mobile growth. This period was though characterized with high innovativeness supported by the top management.

### B. Process of Networked Learning

Figure 1 presents the evolutionary processes of variation, selection and retention and the knowledge search-transfer behavior in four networked R&D projects that were examined in detail. The problemistic search initiated the variation in two case projects as described in the organizational learning theory [16]. In the other two projects, knowledge search can be described as opportunistic. It originated from a strong management aspiration to create new business for the organization, not to solve a problem in existing routines or a specified customer requirement within current businesses. The management created a new venture organization that was to overcome the dilemma of local search.

Knowledge heterogeneity enabled the development of innovations in all these projects. The combination of different existing knowledge, from internal and external sources, was central for the creation of new knowledge. The inventors emphasized that especially the discussions with customers and vendors enhanced their own learning. Knowledge sharing was open with customers and vendors in all projects due to existing long-term relationships. Absorbing new knowledge from external sources was improved by the experience of several case company employees from customer industries. In addition, internal discussions with specialists from different technology areas triggered individual learning.

The patent and the related solution/service concept were developed in a small group of internal R&D employees. In two of the projects, the inventors shared the same office room and through informal discussions and idea sessions they drafted the new solution on the flap board of the room. The inventors that had participated in projects with high knowledge heterogeneity were the ones to have learnt most in the process of innovation. The combination of merely technical knowledge did not result in high individual learning, although it could provide great benefit for the organization.

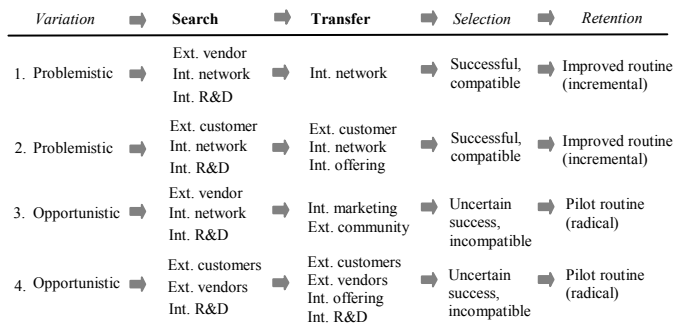


Fig. 1 Process of networked learning

The barrier of changing organizational routines was much smaller in the projects of problemistic search than of opportunistic search. As the problem solving required only small and incremental changes in the existing organizational routines, it was easier to implement than a completely new solution that would have required the development of new organizational routines. The implementation of the solutions based on problemistic search was fast. It was easy to transfer knowledge to all relevant internal and external stakeholders as it was compatible with the existing way of thinking. The selection process was smooth and straightforward as the new solution was successful and enhanced clearly the capability of all stakeholders to reach their targets. The organizational learning occurred through the improvement of an existing routine. Both improvements provided a new feature for an existing service that increased customer satisfaction and loyalty.

In the opportunistic projects, the knowledge transfer within the organization was scarce as the reporting was directed to the venture management. The new service concept was presented internally to the core organization and also externally to potential customers and vendors or to a wider industry audience. The core organization was interested in both service concepts, but reluctant to invest in the implementation due to their uncertain future success. Moreover, these radical ideas did not fit well with existing organizational routines and the way of thinking. Both ventures were launched as a pilot service through the development of a new routine. However, the impact of these pilot routines on the whole organization remained marginal and thus the organizational learning very limited.

## VI. DISCUSSION AND CONCLUSIONS

This paper contributes to organizational learning theory and social capital through examining separately individual and organizational learning in networked R&D. It demonstrates that external knowledge search enhances significantly individual learning, whereas internal knowledge search does not have a similar effect. Moreover, organizational learning requires internal multifunctional knowledge transfer in implementing the new solution. The qualitative analysis indicates that both problemistic and opportunistic search may initiate the process of learning. As the organizational learning

theory has focused on incremental learning [3], its findings cover the case of problemistic search, but not the opportunistic search. The process of individual learning is found to be similar in both of them. Knowledge heterogeneity enhances individual learning, especially through informal discussions, which enable the exchange of tacit knowledge. The process of organizational learning is found to be more difficult in opportunistic search than in problemistic search. First, new pilot routines cannot fulfill the selection criteria as the success of them is uncertain and they are incompatible with current organizational knowledge. Second, these new routines are likely to conflict with existing organizational routines and culture. The organizational learning remains marginal in opportunistic search, unless the organization is able to overcome these barriers.

As managerial implications, these results are of value in the design of effective knowledge management system that balances with explorative and exploitative learning. They suggest the adoption of different selection and retention mechanisms for radical innovations. They are needed in order to ensure that organizational learning occurs also from opportunistic search. Moreover, it is notified that inventors are the only ones in the organization who can fully understand the complex and tacit knowledge that their patent involves. Thus, it seems important that inventors are not only rewarded based on accepted patents, but also on the support they give for other organizational actors to implement the patent benefits.

The main limitation of this paper derives from the concentration on a single firm. Although this research was able to systematically clarify the process behind a majority of case company patents, the generalization of results would require the examination of multiple firms and industries. Another limitation lies in the measurement of regression variables. As the count of different contacts was measured in the knowledge search-transfer process, it was not possible to evaluate the importance of different contacts in relation to each other on enhancing the level of learning. The measurement of dependent variables based on multi-item scale would also enhance the result accuracy.

The qualitative analysis of this paper extends organizational learning theory through the concept of opportunistic search. It reveals that the selection and retention mechanisms of organizational learning theory cannot support organizational learning from opportunistic search. The suggestion for future research is to test the applicability of these research results to multiple companies and industries. Above all, it would be important for organizational learning theory and practice that future research examines the mechanisms that enhance organizational learning from radical innovations.

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