

Tacit Knowledge Transfer from Manufacturing Firms to Suppliers in New Product Development: A Study of Suppliers

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Abstract—Integrating suppliers' knowledge and expertise in new product development becomes increasingly important for manufacturing firms' product success. Most studies adapt the manufacturing firms' standpoint and research the benefits of manufacturing firms in new product development. Relatively little attention has been given to the suppliers' perspective in their research. This paper studies suppliers in working partnerships with manufacturing firms in new product development. A model is proposed to study the impact of relationship strength on the tacit knowledge transfer from manufacturing firms to suppliers in new product development. It also investigates the impact of tacit knowledge transfer on supplier new product performance.

Index Terms—Supplier, tacit knowledge transfer, new product development.

I. INTRODUCTION

Supplier integration in new product development (NPD) has received increased attention in research of supply chain and product innovation management [1], [2]. Many studies demonstrate that suppliers contribute design skills, experience, and new technology to manufacturing firms' NPD [3], [4]. As a result, manufacturing firms achieve fast development times, innovative products, and lower product costs [4]. More and more manufacturing firms recognize that developing partnerships with suppliers is a means to gain competitive advantage and win in the marketplace [2], [5], [6]. They rely on their suppliers to share innovative ideas, provide critical technologies, and develop components and subassemblies in NPD, and as a consequence, tremendous amounts of knowledge is exchanged between suppliers and manufacturing firms [7]-[9].

Suppliers' knowledge on NPD is a source of competitive advantage for manufacturing firms, and acquiring knowledge from suppliers in NPD is necessary in today's complex, uncertain, and high-velocity environment [2], [10], [11]. Previous studies hold that the effectiveness of knowledge management in the working partnerships with suppliers is critical for manufacturing firms' NPD success because the product development process covers a variety of distinct knowledge bases, and suppliers' expertise and knowledge in product innovation is an important complement to

manufacturing firms' NPD strategy aimed at increasing product development speed and enhancing product innovativeness [3], [6], [12], [13]. If suppliers understand manufacturing firms' requirements and develop a long-term partnership with manufacturing firms, both the suppliers' and manufacturing firms' NPD performance can be enhanced [5], [14], [15].

Reviewing the literature, it is found that most studies focus on manufacturing firms and address the benefits of manufacturing firms in working partnerships. The supplier's side, however, is relatively neglected [16], [17]. Although scholars recognize the important role of suppliers to the manufacturing firms in NPD, less research has been conducted to explore the benefits of suppliers in working relationships with manufacturing firms in NPD [17]. However, the success of manufacturing firms' product development depends heavily on the performance of suppliers in NPD. If suppliers fail to provide cutting-edge technology required for manufacturing firms' product development, the manufacturing firms' product performance may suffer [3], [15].

This study focuses on suppliers in working partnerships with manufacturing firms in NPD. Two research questions are addressed in the study. First, how does relationship strength influence tacit knowledge transfer from manufacturing firms to suppliers in NPD? As tacit knowledge is embodied in the individual firm, rooted in practice and experience, it is very important but difficult to communicate between firms as information [18]-[20]. Nonaka [19] recognized tacit knowledge being an important source of competitive advantage for firms. It is critical for suppliers to obtain tacit knowledge for their own product development. Second, how does tacit knowledge influence suppliers' new product performance? As acquisition of tacit knowledge is important for new product success, this study will provide insights for suppliers about how to improve product performance in the working partnerships with manufacturing firms through tacit knowledge transfer.

The next section introduces the research framework and several hypotheses for studying the impact of relationship strength on tacit knowledge transfer, as well as the influence of knowledge transfer on suppliers' new product performance. The paper concludes with discussions, theoretical contributions, and, managerial implications

II. THE RESEARCH FRAMEWORK

A. The Framework

Fig. 1 presents the research framework for studying tacit

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knowledge transfer from manufacturing firms to suppliers in working partnerships in NPD. The antecedent of tacit knowledge transfer is relationship strength. Previous research has noted that relationship strength is very important for tacit knowledge transfer between firms since tacit knowledge is un-coded, and the transfer of tacit knowledge requires strong relationships and frequent interaction between the suppliers and manufacturing firms [18], [19]. Therefore, the stronger the relationship strength, the more the tacit knowledge transfer from manufacturing firms to suppliers. The framework shows that tacit knowledge influences suppliers' new product performance. Tacit knowledge from manufacturing firms is critical for suppliers to create their own knowledge, to shorten product development time, and enhance new product quality [9], [14]. Therefore, tacit knowledge transfer and supplier new product performance are positively related. This study proposes a direct link between relationship strength and supplier product performance. A strong relationship is characterized by frequent interaction and information sharing, which leads to high product performance [3]. It also investigates the moderating effects of technology uncertainty on 1) the relationship between tacit knowledge transfer and suppliers' new product performance, and 2) that between relationship strength and suppliers' new product performance.



Fig. 1. The research framework.

B. Relationship Strength

Relationship strength is an indicator of relationship quality between manufacturing firms and suppliers. In this study, relationship strength is defined as the degree to which the manufacturing firms and suppliers have strong inter-organizational interactions with each other in NPD [22]. The relationship strength construct is central to relationship research [21]-[23]. This study uses four dimensions of relationship strength from Hansen [22] and Kraatz [24]: 1) frequency of interactions, 2) confidence in one another, 3) desire to maintain the relationship, and 4) bidirectionality.

Frequent interaction between manufacturing firms and suppliers in a partnership promotes a timely and meaningful informal exchange between the parties [24]. This kind of information sharing is crucial to manufacturing firms and suppliers in product development. In NPD, manufacturing firms often ask suppliers to independently develop new components or subassemblies based on manufacturing firms' requirements. Suppliers assume the full responsibility to fulfill the design to satisfy the manufacturing firms' product needs. Suppliers are challenged to develop new technology, and manufacturing firms are required to "develop" suppliers in creating new knowledge to improve suppliers' performance.

Supplier development is a strategy of manufacturing firms to improve supplier performance [25]. It involves the transfer of resources and knowledge for the purpose of enhancing supplier innovation performance [26]. If suppliers are found to be weak in certain areas, manufacturing firms could use

supplier development to train suppliers' engineers, to frequently visit suppliers' R&D teams, or to offer more incentives to suppliers to achieve the goals of product development [26]. This kind of give-and-take requires open-mindedness and a non-defensive attitude. Information sharing has a substantive effect on NPD performance when product requirements are modified because of changing customer needs [6], [11], [15], [22], [27].

Strong relationships are more likely to facilitate in-depth, two-way communication and to promote mutual trust between manufacturers and suppliers [24]. In this collaborative environment, R&D teams of manufacturing firms and suppliers can freely share design thoughts, new technology, collaborative experience, and mental models through physical, face-to-face contacts. A close relationship is, therefore, the base for knowledge transfer [19].

C. Tacit Knowledge and Its Transfer

Supplier integration and NPD literature has identified two types of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge is easy to obtain since it has been codified and stored in manuals, files, or on the web. Explicit knowledge is less valuable since it is readily available to all competitors. Tacit knowledge is un-coded knowledge and resides in the firm's system [18]. Tacit knowledge is important but difficult to interpret and transfer from one firm to another [28].

Studies on knowledge management refer to knowledge transfer as the movement of a body of manufacturing firms' knowledge, skills, ideas, and experience to suppliers [15]. Dyer and Singh [29] and Sherwood and Covin [30] found that knowledge transfers smoothly between firms when inter-organizational mechanisms such as trust and information sharing promote knowledge transfer, recombination and generation. Alwis and Hartmann [28] noted that tacit knowledge begins with the individual, such as a brilliant engineer who has a new design of the product. The individual engineer's knowledge is transformed into the project team's knowledge and then expands to the entire organization. In the working partnership between manufacturing firms and suppliers, new ideas or expertise of engineers of manufacturing firms could be transformed into suppliers' project team's knowledge through supplier development activities such as trainings, face-to-face meetings, joint teams, and co-development.

Relationship strength is positively related to tacit knowledge transfer from manufacturing firms to suppliers. In the close relationships between the two organizations, engineers from both firms frequently discuss important advances in technology and work together to face the technological turbulence in the market. In these frequent back-and-forth interactions, knowledge in manufacturing firms is converted into terms and concepts shared with suppliers. Thus, tacit knowledge rooted in manufacturing firms is likely to be transferred into suppliers' knowledge.

In the study of the knowledge transfer among the sub-units of an organization, Hansen [22] found that units with strong ties have greater motivation to be of assistance and are typically more easily available to each other than units with weak ties. He highly valued the two-way interactions between the source and recipient in strong ties. Tacit knowledge transfer is not likely to be completed the first time

due to the difficulty of transfer. Repeated two-way interactions are necessary, for then the recipient firm can "try, err, and seek instruction and feedback" from the source (p. 88) [22]. When problems occur and questions arise, the source firm is immediately available. The proposed hypothesis is:

Hypothesis 1: The stronger the relationship, the more tacit knowledge can be transferred from manufacturing firms to suppliers.

D. Tacit Knowledge and New Product Performance

Tacit knowledge is difficult to obtain and valuable to suppliers since it is unique, rare, and difficult for competitors to replicate according to resource-based theory [31]. Suppliers need to develop knowledge acquisition strategy from the manufacturing firms in order to meet their requirements. Since new product development is a process of problem solving and knowledge creation and integration, tacit knowledge directly from manufacturing firms is extremely valuable for the suppliers' new product success [3], [6], [17], [18].

Manufacturing firms are customer firms in working partnerships with suppliers in NPD [2], [32]. Therefore, for suppliers, the performance of new product development is the success of their products in fulfilling manufacturing firms' special requirements [33]. Products developed by integrating manufacturing firms' tacit knowledge and skills have great competitive advantage to meet customer firms' needs [5], [18], [34]. Atuahene-Gima [35] pointed out that tacit knowledge from manufacturing firms offers suppliers a unifying focus for the proficiency in NPD. By listening closely to manufacturing firms, suppliers can develop products with greater advantage over the competition [4], [7], [32], [35], [36].

Moreover, with the technical expertise from manufacturing firms, suppliers can develop accurate and detailed specifications, incorporate advanced technology from manufacturing firms, modify the design process, and avoid the weaknesses of products, which lead to innovative products [1], [33], [37]. Further, with the expertise or technology from manufacturing firms, suppliers are more likely to develop new knowledge or skills, generate more product ideas, and think unconventionally, resulting in greater product performance. The hypothesis is:

Hypothesis 2: The more tacit knowledge transferred from manufacturing firms, the higher the suppliers' new product performance.

E. Relationship Strength and New Product Performance

In this study, the relationship strength is proposed to influence supplier new product performance. The purpose is to test the possible mediating effect of tacit knowledge on the relationship between relationship strength and suppliers' new product performance. The rationale is that the strong relationship between manufacturing firms and suppliers is a signal that suppliers will respond proactively to satisfy manufacturing firms' requirements in NPD. The use of manufacturing firms' information and collaborative activities in product development enable suppliers to develop superior products and provide high quality service to manufacturing firms, leading to greater product performance. Hence, the hypothesis is:

Hypothesis 3: the greater the relationship strength, the higher the supplier's new product performance.

F. Moderating Effect of Technology Uncertainty

Technology uncertainty refers to the perceived speed of change and unpredictability of technological development in an organization's industry [5], [38], [39]. In a highly technologically unpredictable market, suppliers face the pressure of short product development cycles and fast technological obsolescence. Suppliers are forced to work closely with manufacturing firms in NPD to meet their requirements [35]. Therefore, relationship strength and tacit knowledge transfer from manufacturing firms are more important for suppliers' new product performance in a highly uncertain environment than in a less uncertain environment. The hypotheses are:

Hypothesis 4: Technology uncertainty positively moderates the effects of tacit knowledge transfer on suppliers' new product performance.

Hypothesis 5: Technology uncertainty positively moderates the effects of relationship strength on suppliers' new product performance.

III. DISCUSSIONS

In this study, a research framework is proposed to study tacit knowledge transfer in the working partnership of manufacturing firms and suppliers in NPD. The research focuses on suppliers in the relationship. It is proposed that relationship strength positively influences tacit knowledge transfer to suppliers and that tacit knowledge transfer to suppliers positively affects suppliers' new product performance.

The study also tests the mediating effect of tacit knowledge transfer on the relationship between tacit knowledge transfer and suppliers' new product performance. The testing of this hypothesis will enhance our understanding of the role of tacit knowledge in NPD. The study proposes that technology uncertainty moderates the impact of relationship strength and tacit knowledge transfer on suppliers' new product performance.

There are some theoretical and managerial implications from this study. First, tacit knowledge transfer and management is a central issue in this study. Resource-based theory has long recognized that knowledge is a source of competitive advantage for firms. This study shows that tacit knowledge is critical for suppliers' new product success. Second, suppliers are the focus of this research. Previous studies have found that suppliers could be weak in quality or product development [17], [26]. Manufacturing firms have a strategy of supplier development to help suppliers improve production efficiency, reduce costs, and enhance product performance. This study offers insights from the supplier's side into how to meet the manufacturing firms' needs through relationship and knowledge management in NPD.

Product managers of suppliers should emphasize relationship development with product teams of manufacturing firms in NPD. Tacit knowledge is critical for the development of successful new products. Tacit knowledge, which is usually in the form of experience or skills, is important but hard to be transferred between firms. It is recommended that suppliers emphasize the development of mechanisms for the transfer of tacit knowledge from manufacturing firms. These include formal or informal meetings, flexible schedules, a joint reward system, joint

product team meetings, face-to-face knowledge sharing, and a rich communication media. Finally, future research may be conducted to test the framework using data from different industries. The empirical testing is very important to assess the possible mediating effect of tacit knowledge transfer on the relationship between relationship strength and supplier's new product performance. This mediating effect is helpful for us to understand the role of tacit knowledge in NPD.

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