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R&D employee's intention to exchange knowledge within open innovation projects

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R&D Employee's Intention to Exchange Knowledge within Open

Innovation Projects

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R&D Employees' Intention to Exchange Knowledge within Open Innovation Projects

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Abstract

The existing literature on open innovation strongly emphasizes on the organizational level, while neglecting the people side and especially the perspective of employees working in OI-projects. This study analyzes determinants of R&D employees' knowledge exchange in OI-projects by means of the theory of planned behavior (TPB) and a literature review regarding motivational factors influencing individuals' attitude toward knowledge exchange. An online survey amongst 133 R&D employees was conducted and data was analyzed through variance-based structural equation modeling (PLS). In our sample, subjective norm had by far the strongest impact on employees' intention to exchange their knowledge in OI-projects, although attitude and perceived behavioral control also showed highly significant and positive effects on intention. From all five identified motivational factors, enjoyment in helping was found to have the strongest influence on attitude, followed by intrinsic rewards and sense of self-worth. Extrinsic rewards and reciprocity did not show any effect on attitude.

Keywords

open innovation; interorganizational cooperation; R&D partnerships; knowledge exchange; knowledge sharing, R&D employees; theory of planned behavior; TPB; motivation, structural equation modeling.

1. Introduction

In many industries, R&D possesses a degree of complexity and multi-disciplinarily that a single player cannot handle. If a company wants to stay competitive and innovate sustainably, it is no longer feasible to solely rely on its own resources and abilities (Fichter, 2005; Miotti and Sachwald, 2003). Companies address this issue by opening up their innovation processes and integrating external partners (e.g., customers, suppliers) in order to accelerate the own innovation process and/or facilitate the external use of their internally developed innovations (Chesbrough, 2003; Chesbrough, Vanhaverbeke and West, 2006). This phenomenon is called open innovation (OI). Knowledge in- and outflows are central to the OI-definition (Chesbrough, 2006), indicating that open innovation is associated with knowledge management and especially with knowledge exchange. However, this connection is seldom addressed in the literature.

A major gap in OI-research concerns the examination object. Despite the wide range of possible OI-research levels (Vanhaverbeke and Cloudt, 2006; West, Vanhaverbeke and Chesbrough, 2006), current empirical studies clearly emphasize on the organizational level. Only few focus on individuals. Especially the employees' perspective on open innovation is most widely neglected in the literature. However, employees are the ultimate decision makers in any organizational process and deserve special attention (Husted and Michailova, 2010). Furthermore, explanations on a macro-level (organization) should always be based on examinations on the micro-level (employees) (Coleman, 1990).

Assuming that innovations mostly start off in companies' R&D departments, R&D employees play an important role in open innovation and, thus, were selected as examination object in this study. By facilitating the in- and outflows of knowledge through their knowledge exchange with external partners, R&D employees lay the foundation for a collaborative innovation. This implies, on the other hand, that their behavior can also be a risk to open innovation. Consequently, companies following an OI-approach heavily depend on the

support of their R&D employees. Since, employees cannot be forced to behave appropriately, but only encouraged, companies need to understand their R&D employees' motives to exchange knowledge in OI-projects in order to benefit from the OI-approach. However, very little is known about open innovation at the level of R&D employees and especially about determinants of their knowledge exchange in OI-projects. Our study tries to make a contribution by attending to this research gap. Its main objective is to unveil the reasoning behind R&D employees becoming active in OI-projects and participating in knowledge exchange with external partners in OI-projects, respectively.

2. Literature review

2.1 Open Innovation

The term open innovation can be traced back to the eponymous book of Chesbrough (2003), where he describes the shift from the conventional, rather closed innovation process to an open innovation approach and, thus, establishes a broadly known keyword for the integration of external sources into companies' innovation processes. The OI-concept assumes that it is impossible for a company to have all required expertise and suitable knowledge in-house. Useful and high quality knowledge is rather widely distributed. Internal and external knowledge is considered equally important, which makes knowledge exchange with external sources necessary and valuable. For an optimal outcome, companies need to find the appropriate balance between internal and external R&D. (Chesbrough, 2003, 2006)

Chesbrough's work is not detached from prior research. It is based on and in line with a great amount of previous studies. Nevertheless, he successfully labeled a collection of previous and novel research activities and coined an umbrella term for a variety of phenomena such as (lead) user innovation (Hippel, 1976, 1986, 1988), collective invention (Allen, 1983), complementary assets (Teece, 1986), absorptive capacity (Cohen and Levinthal, 1990; Zahra

and George, 2002), strategic R&D alliances (Mowery, Oxley and Silverman, 1996), open source (Raymond, 1999), and crowdsourcing (Howe, 2006b, 2006a, 2009).

Open innovation has become a relevant topic for different industries and researchers. Companies' motives for engaging in OI-activities are manifold and include the access to unique knowledge, the exploration of new trends and business opportunities, the mitigation of risks, and improvements in efficiency (Chesbrough and Brunswicker, 2013; Fichter, 2005; Wallin and Krogh, 2010). Researchers are interested in open innovation, because it offers many points of contact to other topics. During the last decade, open innovation has, therefore, gradually developed into a very broad and popular research field with many different streams, perspectives, and various connections to other research areas (Gassmann, 2006; Gassmann, Enkel and Chesbrough, 2010). The great interest and the resulting explosion of OI-related articles made it hard to keep track with all developments within the field. Thus, several researchers contributed to OI-research by reviewing and structuring existing literature (e.g., Dahlander and Gann, 2010; Elmquist, Fredberg and Ollila, 2009; Lichtenthaler, 2011; Schroll and Mild, 2012; Vrande, Vanhaverbeke and Gassmann, 2010; West and Bogers, 2013). The bottom line of these reviews was that quantitative OI-research is comparably seldom and often limited to the organizational level – although open innovation could be analyzed at different levels (Vanhaverbeke and Cloudt, 2006; West, Vanhaverbeke and Chesbrough, 2006). The rare studies analyzing the level of individuals either focus on people engaged in open source projects and other OI-communities (Schattke and Kehr, 2009; Fleming and Waguespack, 2007; Hars and Ou, 2002; Henkel, 2009) or on lead-users (Franke, Hippel and Schreier, 2006; Lüthje, 2004; Schreier and Prügl, 2008). Very few studies address employee-related topics like OI-relevant competencies and attributes (Enkel, 2010; Du Chatenier et al., 2010; Pedrosa, Valling and Boyd, 2013) or possible OI-barriers (Enkel, 2009).

2.2 Knowledge Exchange

Rooted in Penrose's (1959) theory of the firm and other spadework in the field of strategic management, Wernerfelt (1984) introduced the concept of the resource-based view, which assumes that the possession of critical resources lead to competitive advantages for the company holding these resources. When the resource-based view was already an established concept, Drucker (1993) pointed out that knowledge is not only one of the traditional production factors, but rather the most important and strategically significant resource for a company. By combining this idea with the resource-based view, the knowledge-based view evolved (Grant, 1996a, 1996b; Spender, 1996).

Knowledge can either be explicit (e.g., documents) or tacit/implicit (e.g., routines, processes). Explicit knowledge can be coded and documented in writings or symbols. It is easy to communicate and, thus, transferable from one person to another with reasonable effort. Tacit knowledge, in contrast, is very complex and can hardly be reproduced in documents or databases. It is developed or arduously acquired by and stored within individuals, which makes it impossible to transfer it as separate entity. The transfer of tacit knowledge is generally difficult, requires a lot of time and personal contact, and the success is uncertain. It can only be revealed through application and acquired through observation and practice. All these characteristics make tacit knowledge crucial for sustainable competitive advantage and to some extent more valuable than explicit knowledge, because it is harder to imitate. (Polanyi, 1966)

In the context of open innovation, knowledge exchange is the most relevant phase of the knowledge management process. Following the knowledge-based view, companies' strongest value driver is knowledge, which inherently resides within knowledgeable personnel. Consequently, the success of knowledge exchange heavily depends on employees' knowledge exchange efforts (Bock et al., 2005; Husted and Michailova, 2010). Since companies cannot force, but only encourage their employees (Gibbert and Krause, 2002; Osterloh and Frey,

2000), employees are the ultimate decision-makers about exchanging or keeping their knowledge. They can freely decide on when to exchange what with whom (Husted and Michailova, 2010). Despite the obvious relevance of the employees' knowledge exchange behavior for the success of a company, only little is known about its determinants (Bock and Kim, 2002). The literature on knowledge exchange neglects to build a micro-foundation and to formulate assumptions about individual actions, even though it would be important to obtain a better understanding about individual knowledge exchange behavior (Foss, Husted and Michailova, 2010; Ho, Hsu and Oh, 2009).

2.3 Theory of Planned Behavior

Ajzen's (1985) TPB is an extension of the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980). It aims to explain human behavior and assumes individuals' intention to be the most important influencing factor. Intention, in turn, is determined by three factors: people's attitude toward the behavior (A), the subjective norm or perceived social pressure to perform or not perform the behavior (SN), and perceived behavioral control about performing the behavior (PBC). Perceived behavioral control is also anticipated to directly influence the behavior of individuals (Figure 1).

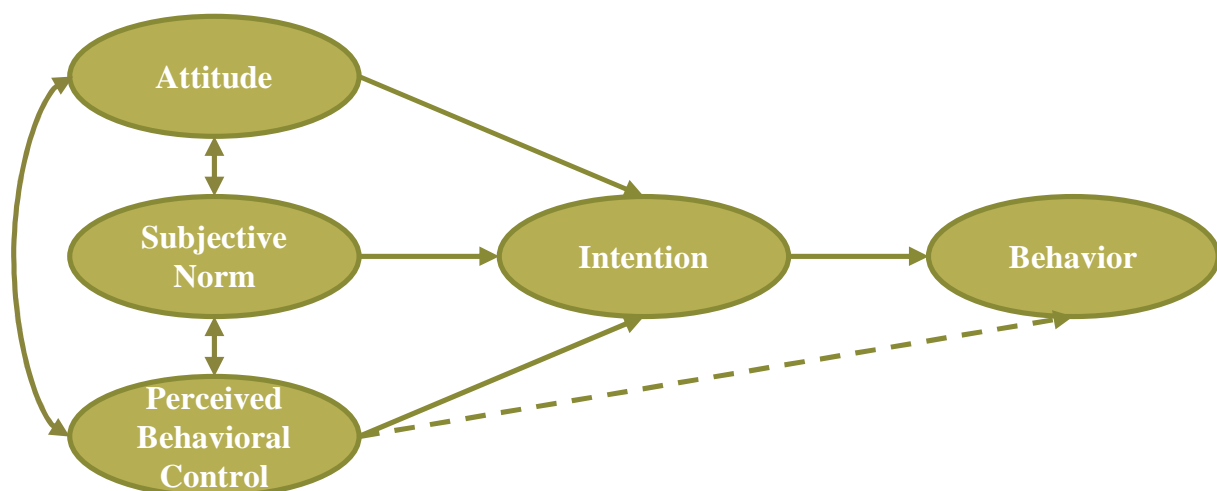


Figure 1: Theory of Planned Behavior

Due to this study's focus on the employee level, the relationship between intention and behavior is not expected to be very stable. The assessment of both factors would need to be conducted without great time lag. Furthermore, the risk of literal inconsistency would require asking R&D employees about their intentions and colleagues or supervisors about the actual behavior of the R&D employees. The combination of both requirements would make it very complex and time-consuming – if not impossible – for companies to identify the matching couples and deliver all relevant data in time. Therefore, the decision was taken to exclude the behavior construct from this study and to focus on the prediction of R&D employees' intention to exchange knowledge with external partners in OI-projects. (Ajzen and Fishbein, 1980; Ajzen, 2002; Ajzen and Fishbein, 2005).

2.4 Motivators for Knowledge Exchange

In the knowledge management literature, the TPB has been repeatedly used to analyze knowledge exchange between individuals – but not yet in an OI-context. Therefore, articles investigating individuals' knowledge exchange by means of the TRA or TPB had to be used as a proxy in order to identify variables that would presumably influence individuals' attitude toward exchanging their knowledge in OI-projects and to find established measures that could later be used for the operationalization of the constructs included in our research model.

In order to identify relevant studies, EBSCOHost Research Database and Google Scholar were employed and the words “knowledge exchange”, “knowledge sharing”, and “knowledge transfer” were combined with the search terms “theory of planned behavior” and “theory of reasoned action”. After a systematically sorting of the results, a list of 24 relevant articles was compiled (Table 1). Predictors of attitude were included in 17 of the 24 articles (Table 2). These publications greatly contributed to the identification of attitude-predicting motivational factors and to the selection of relevant constructs for the study. Articles that stated the applied questionnaire items became important in the later operationalization phase.

Table 1 Literature Review about Motivational Factors Facilitating Knowledge Exchange

Source	Applied Theory	Predictor of Attitude	Questionnaire Items
1 Bock and Kim (2002)	TRA	Included	–
2 Bock (2005)	TRA	Included	Included
3 Chatzoglou and Vraimaki (2009)	TPB	–	Included
4 Chow and Chan (2008)	TRA	Included	Included
5 Erden et al. (2012)	TPB	Included	Included
6 Ho et al. (2009)	TRA	(Included) ¹	–
7 Huang et al. (2008)	TRA	Included	Included
8 Jeon et al. (2011)	TPB	Included	Included
9 Jewels and Ford (2006)	TPB	–	Included
10 Kuo and Young (2008a)	TPB	–	Included
11 Kuo and Young (2008b)	TPB	–	Included
12 Kwok and Gao (2005)	TRA	Included	Included
13 Lin (2007a)	TRA	Included	Included
14 Lin and Lee (2004)	TPB	–	Included
15 Minbaeva and Pedersen (2010)	TPB	Included	Included
16 Ryu et al. (2003)	TPB	–	Included
17 So and Bolloju (2005)	TPB	–	Included
18 Teh et al. (2010)	TPB	Included	–
19 Teh and Yong (2011)	TRA	Included	Included
20 Tohidinia and Mosakhani (2010)	TPB	Included	Included
21 Wu and Wei (2010)	TPB	Included	–
22 Xie (2009)	TPB	Included	–
23 Yang and Lai (2011)	TPA	Included	Included
24 Zhang and Ng (2012)	TRA	Included	Included

Table 2 Articles with Predictors of Attitude

Source	Sample	Predictor of Attitude	Hypothesis	Result*
Bock and Kim (2002)	N = 467 Four large companies, Korea	Expected associations	+	+
		Expected contribution	+	+
		Rewards	+	–
Bock (2005)	N = 154 27 companies across 16 industries, Korea	Reciprocity	+	+
		Rewards	+	–
		Sense of self-worth	+	o
Chow and Chan (2008)	N = 190 Managers, Hong Kong, China	Shared goals	+	+
		Social network	+	+
		Social trust	+	o
Erden et al. (2012)	N = 531 Online community members, Korea	Community munificence	+	+
Ho et al. (2009)	N = 70 Three large high-tech companies, Taiwan	Expected associations	+	
		Expected contribution	+	
		Level of understanding	+	
		Rewards	+	Game theory approach
		Self-Esteem	+	
		Cost of sharing	–	
Self-interest	–			

¹ This study applies game theory instead of structural equation modeling, so that predictors of attitude are stated, but the predictive power is not assessed for each individual factor.

Huang et al. (2008)	N = 159 MBA students, China	Image	+	o
		Reciprocity	+	o
		Rewards	+	+
		Sense of self-worth	+	+
		Codification effort	-	o
Jeon et al. (2011)	N = 282 Four large high-tech companies, Korea	Loss of knowledge- power	-	-
		Enjoyment in helping	+	+
		Image	+	+
		Need for affiliation	+	+
		Reciprocity	+	+
Kwok and Gao (2005)	N = 75 Students, Hong Kong, China ²	Absorptive capacity	+	o
		Channel richness	+	+
		Extrinsic motivation	-	o
Lin (2007a)	N = 172 50 companies across 15 industries, Taiwan	Enjoyment in helping	+	+
		Knowledge self-efficacy	+	+
		Reciprocity	+	+
		Rewards	+	o
Minbaeva and Pedersen (2010)	N = 470 Two large companies, Denmark	Rewards	+	-
Teh et al. (2010)	N = 301 Students, Malaysia	Internet self-efficacy	+	+
Teh and Yong (2011)	N = 116 Three IT-companies, Malaysia	In-role behavior	+	+
		Sense of self-worth	+	+
Tohidinia and Mosakhani (2010)	N = 502 50 oil-companies, Iran	Reciprocity	+	+
		Rewards	+	o
		Self-efficacy	+	+
Wu and Wei (2010)	N = 150 Students, Taiwan	Enjoyment in helping	+	+
		Expected contribution	+	+
		Expected relationship	+	o
		Disincentives	+	+
		Positive reinforcement	+	o
		Expected loss	-	-
		Sharing interference	-	o
Xie (2009)	N = 322 ³ 13 industries, China	Extrinsic motivators	+	o
		Intrinsic motivators	+	+
		Org. commitment	+	+
		Org. climate	+	o
Yang and Lai (2011)	N = 219 Wikipedia members	Information quality	+	+
		System quality	+	+
Zhang and Ng (2012)	N = 231 Construction workers, Hong Kong, China	Enhanced relationship	+	o
		Knowledge feedback	+	+
		Knowledge self-efficacy	+	+
		Reduced workload	+	o
		Rewards	+	o
		Losing face	-	-

+ Positive relationship hypothesized / significant positive effect

- Negative relationship hypothesized / significant negative effect

o No significant effect

* Results with minimum significance level $p < 0.05$

² This information was derived from the statement that the data were collected in an information systems department. Since only one of the two author works in such a department, it was assumed that his university and country are the origin of data, respectively.

³ The information given in the article's abstract and in the article itself is contradictory. The abstract states $N = 322$. In the article $N = 320$.

3. Research Model and Hypotheses

The purpose of our study was to investigate, firstly, which factors determine the intention of R&D employees to exchange knowledge with external partners in OI-projects and, secondly, which motivational factors can positively influence R&D employees' attitude to exchange their knowledge in OI-projects. Based on the TPB and the literature review (Table 2), a research model and related hypotheses were derived.

As displayed in Figure 2, the TPB builds the core of the research model and helps to explain R&D employees' intention. The first three hypotheses are, therefore, derived from the TPB's underlying assumption that individuals' attitudes, subjective norm, and perceived behavioral control are positively related to intention, although the relative predictive power of the factors might vary across situations and behaviors (Ajzen, 1985, 1991). This set of relationships and the related assumptions have been repeatedly examined in the context of knowledge exchange (e.g., Jeon, Kim and Koh, 2011; Lin and Lee, 2004; Minbaeva and Pedersen, 2010; Ryu, Ho and Han, 2003; Tohidinia and Mosakhani, 2010).

Hypothesis 1: R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects has a positive impact on their intention to exchange knowledge with external partners in OI-projects.

Hypothesis 2: The subjective norm concerning knowledge exchange with external partners in OI-projects has a positive impact on R&D employees' intention to exchange their knowledge with external partners in OI-projects.

Hypothesis 3: R&D employees' perceived behavioral control over their knowledge exchange with external partners in OI-projects has a positive impact on their intention to exchange knowledge with external partners in OI-projects.

The identified 17 publications (Table 2) with predictors of attitude included in their research models gave an indication on possible motivational factors influencing R&D employees' attitude. Constraining our research model to the most relevant motivational constructs, the most frequently investigated factors were included in this study (Figure 2).

Enjoyment in helping is related to pro-social behavior and the concept of altruism (Jeon, Kim and Koh, 2011). Altruism is a kind of payment in knowledge markets and reflects people's motivation to exchange knowledge without expecting more than a "thank you" in return (Davenport and Prusak, 1998). Altruism and respectively enjoyment in helping belongs to the intrinsic motivators, which are generally important for knowledge exchange and considered superior to extrinsic motivators, when it comes to the generation and exchange of tacit knowledge (Osterloh and Frey, 2000). The importance of enjoyment in helping with respect to individual's knowledge exchange behavior received empirical support by the study of Wasko and Faraj (2000). Furthermore, several researchers examined the predictive power of enjoyment in helping with respect to individuals' attitude to exchange knowledge and found a significant positive relationship between both variables (Jeon, Kim and Koh, 2011; Lin, 2007a; Wu and Wei, 2010).

Hypothesis 4: Enjoyment in helping has a positive impact on R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects.

A person's sense of self-worth is part of his/her overall self-concept (Kinch, 1963, 1973) and can be derived from different fields (work, family life, etc.). In the context of an organization and with respect to knowledge exchange, sense of self-worth "[...] captures the extent to which employees see themselves as providing value to their organizations through their knowledge sharing." (Bock et al., 2005, p. 91). Following Cabrera and Cabrera (2002), employees are more willing to exchange knowledge, if they expect to make a considerable contribution and, thus, generate value for their company. Feedback regarding their contribution is, thereby, an important control mechanism (Kinch, 1973). Several researchers examined the predictive power of sense of self-worth with respect to individuals' attitude to exchange knowledge and mostly found a significant positive relationship between both variables (Bock et al., 2005; Huang, Davison and Gu, 2008; Teh and Yong, 2011).

Hypothesis 5: Sense of self-worth (in an organizational context) has a positive impact on R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects.

Similar to altruism, reciprocity is considered as a kind of payment in knowledge markets (Davenport and Prusak, 1998). It represents a pattern of mutual exchange, dependence, and indebtedness between two or more parties and entails that each party has rights, but also obligations, resulting from a history of previous interactions between the parties (Gouldner, 1960; Ipe, 2003; Lin, 2007a; Molm, 1997). This indicates that reciprocity is closely related to social exchange theory (Blau, 1964; Emerson, 1976; Homans, 1961; Kelley and Thibaut, 1978). The importance and motivational power of reciprocity with respect to individual's knowledge exchange behavior received empirical support by the study of Wasko and Faraj (2000). However, the study did not confirm that people, indeed, expect a direct reciprocity as noted in the social exchange theory, but rather a generalized form of reciprocal behavior. Several researchers examined the predictive power of reciprocity with respect to individuals' attitude to exchange knowledge and mostly found a significant positive relationship between both variables (Bock et al., 2005; Huang, Davison and Gu, 2008; Jeon, Kim and Koh, 2011; Lin, 2007a; Tohidinia and Mosakhani, 2010).

Hypothesis 6: Reciprocity has a positive impact on R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects.

Exchange theory indicates that the behavior of individuals is guided by their dominant objective to maximize benefits and minimize costs (Molm, 1997). This implies that people expect to receive rewards for participating in interactions with others (Kelley and Thibaut, 1978), which is why Davenport and Prusak (1998) pointed out the need to reward knowledge exchange. Several researchers examined the predictive power of rewards with respect to individuals' attitude to exchange knowledge (Bock and Kim, 2002; Bock et al., 2005; Ho, Hsu and Oh, 2009; Huang, Davison and Gu, 2008; Lin, 2007a; Minbaeva and Pedersen, 2010; Tohidinia and Mosakhani, 2010; Zhang and Ng, 2012). All of them anticipated a positive

relationship between both variables (Table 2). Surprisingly, most of the studies either could not find a significant relationship at all or found a significant negative effect on individuals' attitude to exchange knowledge. Herzberg's motivation-hygiene theory (Herzberg, 1968, 1974) in combination with the operationalization of the reward construct provides an explanation attempt for this observation. Following his theory, a differentiation between factors leading to job satisfaction (i.e., motivators) and factors leading to job dissatisfaction (i.e., hygiene factors) is imperative. The operationalization of the reward construct in many studies draws on elements that are hygiene factors rather than motivators (e.g., salary, bonus, job security). In these cases, it is not surprising that rewards are without effect or even impede the formation of a positive attitude towards knowledge exchange. However, the results might be different, if rewards are operationalized by drawing on elements that are motivators. This differentiation was also supported through the survey pretest.

Hypothesis 7a: Reward A (hygiene factors) does NOT have a positive impact on R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects.

Hypothesis 7b: Reward B (motivators) has a positive impact on R&D employees' attitude toward exchanging their knowledge with external partners in OI-projects.

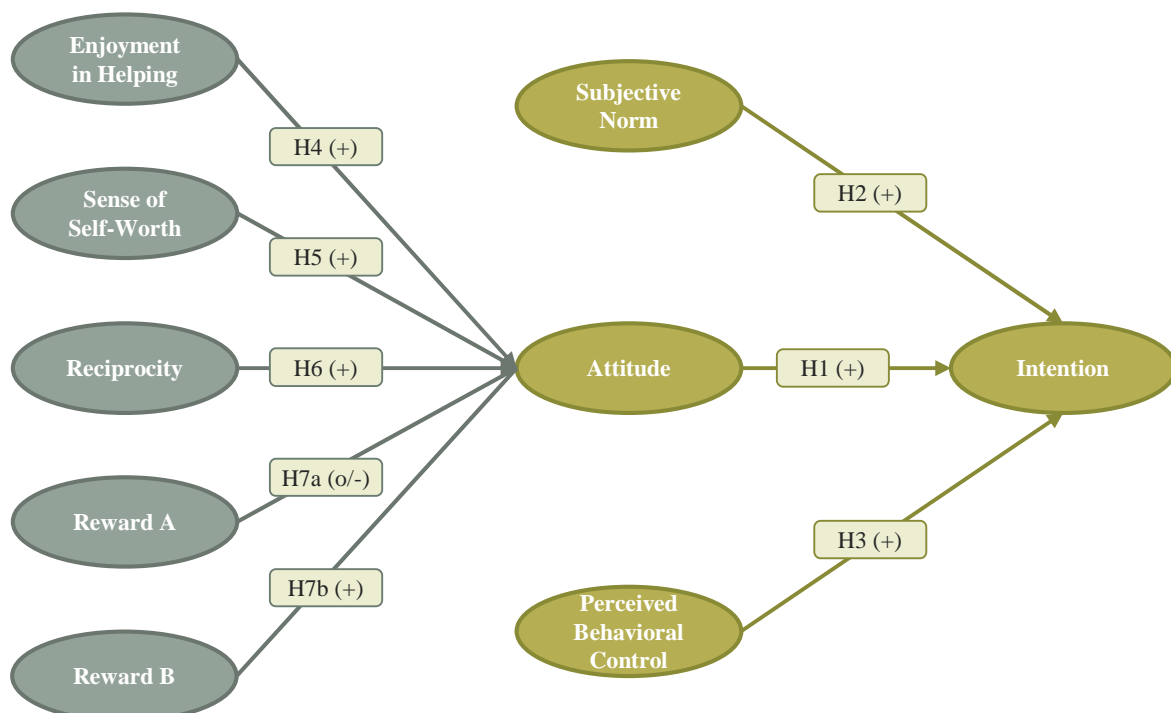


Figure 2 Research Model

4. Research Methods

For testing our research model, an online survey among R&D employees was conducted and hypotheses were examined by applying the partial least square (PLS) method to the collected data.

4.1 Sample & Data Collection

In order to be identified as a relevant candidate for our study, a company had to fulfill three criteria: OI-experience expressed through public communication of OI-application, a considerable number of R&D employees with OI-experience, and headquarters in a German speaking country. After consulting two company lists, 21 relevant companies were identified, whereof four were willing to participate in the study. These four companies were all manufacturers with global business, headquartered in Germany, active in the B2B market, and operating in the fields of chemistry, automation and steel treatment. The online survey link was sent to a total of 283 R&D employees. 199 R&D employees reacted to the request, whereof 133 submitted usable responses representing the final sample (Table 3).

Table 3 Sample and Sub-Sample Characteristics

		Total Sample	Company A	Company B	Company C	Company D
Responses	<i>(usable)</i>	133	58	33	35	7
Age	<i>(average)</i>	42.3 y	42.0 y	43.4 y	41.9 y	42.0 y
Gender	Male:	82.0 %	83.3 %	65.5 %	93.9 %	83.3 %
	Female:	18.0 %	16.7 %	34.5 %	6.1 %	16.7 %
Highest Degree	Apprenticeship:	10.0 %	0 %	36.4 %	2.9 %	0 %
	Bachelor:	1.6 %	3.6 %	0 %	0 %	0 %
	Master/diploma:	29.2 %	14.3 %	9.1 %	67.7 %	57.1 %
	PhD:	59.2 %	82.1 %	54.5 %	29.4 %	42.9 %
Field of Education	Natural science:	61.7 %	87.3 %	90.6 %	2.9 %	14.3 %
	Engineering:	33.6 %	7.3 %	3.1 %	94.2 %	85.7 %
	Economics:	4.7 %	5.4 %	6.3 %	2.9 %	0 %
Tenure	<i>(average)</i>	13.0 y	11.0 y	15.7 y	14.0 y	11.3 y
Location	Germany:	82.3 %	66.1 %	87.9 %	100.0 %	100.0 %
	Europe (rest):	6.2 %	12.5 %	3.0 %	0 %	0 %
	Brazil:	9.2 %	19.6 %	3.0 %	0 %	0 %
	Others:	2.3 %	1.8 %	6.1 %	0 %	0 %
Number of OI-Projects	Last 3 years	4.7	5.8	4.8	2.7	5.1
	Last 10 years	9.2	10.0	11.1	6.2	9.0

In order to control for common method bias, design-related as well as statistical remedies were employed (Podsakoff et al., 2003). Following Tourangeau et al. (2000), a clear and consistent language was employed, key terms were defined at the beginning of the survey, and established items and measurement scales were applied. Furthermore, the respondents' anonymity was ensured (Podsakoff et al., 2003). As statistical remedy, Harman's single factor test was conducted. When only one factor was extracted, this single factor explained only 22.27 % of the variance. Furthermore, ten factors with eigenvalues greater one were identified. Both results indicated that the extent of variance, which cannot be attributed to the construct but to the measurement method, is not substantial (Aulakh and Gencturk, 2000; Podsakoff and Organ, 1986). Additionally, we checked the correlation matrix (Table 7). The highest correlation was 0.511 and occurred between the intention to exchange documented knowledge (intention_doc) and the intention to exchange undocumented knowledge (intention_undoc). In case of common method bias, very high correlations of above 0.9 would be expectable (Pavlou, Liang and Xue, 2007). In summary, the questionnaire design as well as the tests conducted after the data collection suggested that common method bias is not a serious issue for this study.

4.2 Measures

Most of the applied measures have been used in other studies before and showed respectable psychometric characteristics relating to reliability and validity (Ajzen, 2002; Armitage and Conner, 1999; Bock et al., 2005; Chatzoglou and Vraimaki, 2009; Huang, Davison and Gu, 2008; Jeon, Kim and Koh, 2011; Kankanhalli, Tan and Wei, 2005; Lin, 2007b). Table 4 and 5 give an overview about all employed constructs and items. The survey pretest added extra items to the questionnaire and made the distinction between rewards A and B necessary. All constructs with the exception of subjective norm were measured reflectively. In order to measure intention, a second-order construct composing of intention to exchange documented knowledge and intention to exchange undocumented knowledge was employed (Bock et al.,

2005). In all cases, a 5-point Likert scale was applied ranging from “strongly disagree” to “strongly agree” or from “very unlikely” to “very likely”, if not otherwise stated in Table 4 and 5.

Table 4 Operationalization of Theory of Planned Behavior Constructs

Construct	Code	Item
Attitude	A1	My knowledge exchange with external partners in OI-projects is a ... experience. (<i>very unpleasant/very pleasant</i>)
	A2	My knowledge exchange with external partners in OI-projects is ... to me. (<i>very worthless/very valuable</i>)
	A3	My knowledge exchange with external partners in OI-projects is a ... move. (<i>very unwise/very wise</i>)
	A4	Overall, my knowledge exchange with external partners in OI-projects is ... (<i>very bad/very good</i>)
Subjective Norm	<i>Normative Beliefs</i>	
	SNn ₁	My CEO wants me to exchange knowledge with external partners in OI-projects.
	SNn ₂	My immediate supervisor wants me to exchange knowledge with external partners in OI-projects.
	SNn ₃	My colleagues want me to exchange knowledge with external partners in OI-projects.
	<i>Motivation to Comply</i>	
	SNm ₁	Generally speaking, I try to follow the CEO's policy and intention.
	SNm ₂	Generally speaking, I accept and carry out my immediate supervisor's decision even though it is different from mine.
SNm ₃	Generally speaking, I respect and put in practice my colleagues' decision.	
Perceived Behavioral Control	<i>Perceived Controllability</i>	
	PBC1	Whether or not I exchange knowledge with external partners in OI-projects is entirely up to me.
	PBC2	I have full personal control over exchanging knowledge with external partners in OI-projects.
	<i>Perceived Self-Efficacy</i>	
	PBC3	If it is entirely up to me, I am confident that I am able to exchange knowledge with external partners in OI-projects.
PBC4	I believe I have the ability to exchange knowledge with external partners in OI-projects.	
PBC5	I am capable of exchanging knowledge with external partners in OI-projects.	
Intention	<i>Intention to Exchange Documented Knowledge (Intention_doc)</i>	
	I1	I will exchange work reports and official documents with external partners in future OI-projects.
	I2	I will exchange manuals, methodologies, and models with external partners in future OI-projects.
	<i>Intention to Exchange Undocumented Knowledge (Intention_undoc)</i>	
	I3	I will exchange experience or know-how from work with external partners in future OI-projects.
I4	I will provide my know-where or know-whom at the request of external partners in OI-projects.	
I5	I will exchange my expertise from my education or training with external partners in future OI-projects.	

Table 5 Operationalization of Motivational Constructs

Construct	Code	Item
Enjoyment in Helping	JOY1	I enjoy exchanging knowledge with external partners in OI-projects.
	JOY2	I enjoy helping others by exchanging knowledge with external partners in OI-projects.
	JOY3	It feels good to help someone else by exchanging knowledge with external partners in OI-projects.
Sense of Self-Worth		My knowledge exchange with external partners in OI-projects ...
	SW1	... helps other members in my organization to solve problems.
	SW2	... improves work processes in my organization.
	SW3	... increases productivity in my organization.
Reciprocity		When I exchange knowledge with external partners in OI-projects ...
	RP1	... I expect somebody to respond when I'm in need.
	RP2	... I expect to get back knowledge when I need it.
	RP3	... I believe that my queries for knowledge will be answered in future.
Rewards		When I exchange knowledge with external partners in OI-projects it is important to me ...
		<i>Literature Based (Reward A)</i>
	REW1	... to get better work assignments.
	REW2	... to be promoted.
	REW3	... to get a higher salary.
	REW4	... to get a higher bonus.
		<i>Pretest Based (Reward B)</i>
	REW5	... to enhance my reputation.
	REW6	... to build a network.
	REW7	... to increase my knowledge.
REW8	... to add value for my company.	

5. Data Analyses and Results

The data was analyzed through variance-based structural equation modeling (Wold, 1966, 1975) and SmartPLS 2.0 (Ringle, Wende and Will, 2005), respectively. As suggested by Hair et al. (2012) we used the following PLS algorithm settings: path weighting scheme; data metric: mean 0, var 1; maximum iterations: 300; abort criterium: 10-5; initial weights: 1.

5.1 Measurement Model

In order to assess the measurement model of the reflective constructs, a confirmatory factor analysis was conducted.

Table 6 Indicator Reliability, Internal Consistency Reliability, and Convergent Validity

		<i>INDICATOR RELIABILITY</i>		<i>INTERNAL CONSISTENCY RELIABILITY</i>		<i>CONVERGENT VALIDITY</i>
Construct	Item	Standardized Indicator Loading λ	T-Value	Dillon-Goldstein's ρ	Standardized Cronbach's α	Average Variance Extracted
Critical Value		$\lambda \geq 0.7$	$\geq 1.96: p < 0.05$ $\geq 2.58: p < 0.01$ $\geq 3.29: p < 0.001$	$\rho \geq 0.7$	$0.7 \leq \alpha \leq 0.9$	AVE ≥ 0.5
Attitude	A1	0.715	10.588	0.809	0.688	0.515
	A2	0.767	16.022			
	A3	0.643	7.624			
	A4	0.740	14.083			
Perceived Behavioral Control	PBC1	0.727	14.104	0.902	0.865	0.649
	PBC2	0.777	18.861			
	PBC3	0.811	22.955			
	PBC4	0.866	23.089			
	PBC5	0.840	20.270			
Intention (2nd order)	Path_1	0.802	20.663	0.867	n.a.	0.748
	Path_2	0.923	66.287			
Intention_doc (1st order)	I1	0.857	26.726	0.862	0.681	0.758
	I2	0.884	46.036			
Intention_undoc (1st order)	I3	0.816	21.181	0.888	0.811	0.727
	I4	0.861	27.801			
	I5	0.879	37.019			
Enjoyment in Helping	JOY1	0.857	25.183	0.887	0.814	0.724
	JOY2	0.928	52.172			
	JOY3	0.760	9.633			
Sense of Self-Worth	SW1	0.740	12.580	0.833	0.744	0.557
	SW2	0.648	7.354			
	SW3	0.804	14.570			
	SW4	0.782	12.861			
Reciprocity	RP1	0.820	7.647	0.879	0.797	0.708
	RP2	0.878	9.673			
	RP3	0.826	10.300			
Reward A	REW1	0.761	3.448	0.906	0.876	0.659
	REW2	0.865	3.953			
	REW3	0.835	3.590			
	REW4	0.845	3.781			
	REW5	0.746	3.437			
Reward B	REW6	0.803	16.250	0.838	0.707	0.635
	REW7	0.874	24.046			
	REW8	0.704	8.940			

Bootstrapping conducted with 133 cases and 8,000 samples

As shown in Tables 6 and 7, the measurement model fulfilled all required quality criteria concerning indicator reliability, internal consistency reliability, convergent validity, and construct validity (Bagozzi and Yi, 1988; Chin, 1998; Fornell and Larcker, 1981; Hair, Ringle

and Sarstedt, 2011; Hair et al., 2012; Hair et al., 2014; Henseler, Ringle and Sinkovics, 2009; Henseler, Ringle and Sarstedt, 2012; Hulland, 1999; Nunnally and Bernstein, 1994).

Table 7 Correlations and Discriminant Validity

	1	2	3	4	5	6	7	8	9
1 Attitude	0.718								
2 Perceived B. Control	0.280	0.806							
3 Intention_doc	0.280	0.366	0.871						
4 Intention_undoc	0.380	0.443	0.511	0.852					
5 Enjoyment in Helping	0.477	0.122	0.224	0.375	0.851				
6 Self-Worth	0.382	0.077	0.252	0.356	0.362	0.746			
7 Reciprocity	0.247	0.217	0.249	0.275	0.325	0.269	0.842		
8 Reward A	0.155	-0.097	0.015	0.001	0.246	0.124	0.277	0.812	
9 Reward B	0.406	0.445	0.295	0.444	0.372	0.389	0.371	0.224	0.797

Bold numbers on the diagonal illustrate the squared root of the AVE.

The quality of the formatively measured subjective norm construct was evaluated by considering its content and face validity (Nunnally and Bernstein, 1994), indicator weights and loadings (Hair, Ringle and Sarstedt, 2011), and the degree of multicollinearity (Hair et al., 2012; Henseler, Ringle and Sinkovics, 2009). Content and face validity was ensured through the survey pretest and application of carefully developed and repeatedly employed measures. As shown in Table 8, the formative construct also fulfilled the other quality criteria.

Table 8 Evaluation of Formative Measures of Subjective Norm

	Indicator Weight	Indicator Weight's T-Value	Indicator Loading	Indicator Loading's T-Value	Tolerance	Variance Inflation Factor
Critical Value		≥ 1.96: p<0.05 ≥ 2.58: p<0.01 ≥ 3.29: p<0.001		≥ 1.96: p<0.05 ≥ 2.58: p<0.01 ≥ 3.29: p<0.001	> 0.2	VIF < 5
SN1 (CEO)	0.542	3.910	0.860	13.382	0.618	1.619
SN2 (supervisor)	0.146	0.873	0.698	5.890	0.614	1.630
SN3 (colleagues)	0.522	3.833	0.829	11.561	0.746	1.340

Bootstrapping conducted with 133 cases and 8,000 samples

5.2 Structural Model

In order to evaluate the structural model with respect to quality and hypothesized relationships, all relevant criteria were considered (Chin, 1998; Hair, Ringle and Sarstedt, 2011; Hair et al., 2012; Henseler, Ringle and Sarstedt, 2012). Figure 3 and Table 9 summarizes the results.

Considering all constructs linked to the dependent variable intention, subjective norm had by far the strongest and most significant positive impact. The link between subjective norm and intention was even the strongest and most significant relationship in the whole structural model. Attitude was also found to have a meaningful and highly significant, positive impact on intention, followed by perceived behavioral control. Consequently, all three TPB-related hypotheses (H1, H2, H3) were strongly supported by the data.

Considering all independent variables linked to the attitude construct, enjoyment in helping had the strongest and most significant positive impact, followed by reward B and sense of self-worth. As anticipated, reward A was not found to have a significant positive influence on attitude. Contrary to our expectation, also reciprocity did not show any impact on attitude. Consequently, four of the five motivation-related hypotheses were supported by the data (H4, H5, H7a, H7b). Only H 6 were not confirmed by the data.

The variances of the two dependent variables were explained to a substantial extend. The value of R^2 for attitude was 0.313, meaning that the model explained 31 % of the variance in attitude. With respect to intention, a R^2 value of 0.508 could be reached, i.e., 51 % of intention's variance was explained by the model.

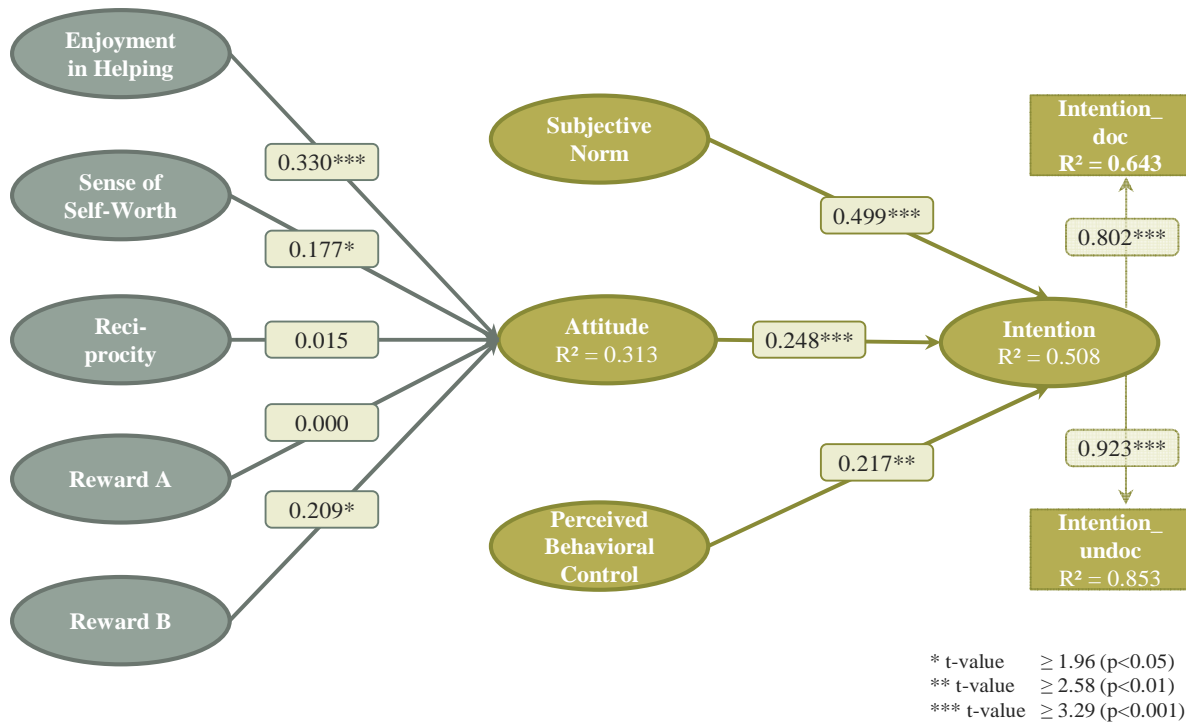


Figure 3 Results from PLS Analysis

As indicated in Table 9, all exogenous variables with a significant link to one of the two endogenous variables showed a mentionable effect size f^2 , if the interpretation is based on the cutoff values suggested by Chin (1998). With respect to predictive relevance, Table 9 shows that both exogenous variables had a Q^2 greater than zero, implying that the model appropriately predicted both constructs.

Table 9 Evaluation of Structural Model

Endogenous Variable	R ² _{incl.}	Q ² _{incl.}	Exogenous Variable	Path Coefficient	T-Value	f ²	q ²
Critical Value		> 0		> 0.2	≥ 1.96: p<0.05 ≥ 2.58: p<0.01 ≥ 3.29: p<0.001	> 0.02: small effect/degree > 0.15: medium effect/degree > 0.35: large effect/degree	
Intention	0.508	0.286	Attitude	0.248	4.293	0.114	0.050
			Subjective Norm	0.499	9.423	0.437	0.168
			Perceived B. Control	0.217	3.031	0.079	0.029
Attitude	0.313	0.140	Enjoyment in Helping	0.330	3.958	0.116	0.045
			Self-Worth	0.177	2.311	0.033	0.012
			Reciprocity	0.015	0.222	0.000	-0.001
			Reward A	0.000	0.006	0.000	-0.005
			Reward B	0.209	2.369	0.047	0.015

Blindfolding conducted with an OD of 8; bootstrapping conducted with 133 cases and 8,000 samples

6. Discussion

Attitude, subjective norm, and perceived behavioral control explained 51 % of intention's variance, verifying that these three factors significantly determine R&D employees' intention to exchange knowledge with external partners in OI-projects. Subjective norm possessed by far the strongest and most significant impact on the intention of the surveyed R&D employees and, thus, can be considered as dominant influencing factor in this sample. Furthermore, the results showed that social pressure caused by the CEO (SN1) and colleagues (SN3) had both a high absolute and relative importance (Hair, Ringle and Sarstedt, 2011). In contrast, subjective norm related to the immediate supervisor (SN 2) only had a significant absolute importance. Consequently, the marginal utility of social pressure caused by the immediate supervisor is lower than the marginal utility of social pressure caused by the CEO or colleagues.

The three motivational factors significantly related to attitude (i.e., enjoyment in helping, sense of self-worth, and reward B) explained 31 % of attitude's variance, verifying that these three factors considerably determine the attitude of R&D employees toward their knowledge exchange with external partners in OI-projects. Contrary to our expectation, reciprocity was not positively related to attitude. A follow-up group discussion with R&D managers about the results and a closer look at the literature offered an explanatory approach, which is related to Herzberg's motivation-hygiene theory (Herzberg, Mausner and Snyderman, 1959; Herzberg, 1968, 1974). The managers suggested that reciprocity in the context of interorganizational knowledge exchange represents a hygiene factor rather than a motivator. R&D employees take a balanced give-and-take relationship for granted, particularly because reciprocity is institutionalized and best possibly regulated through the contractual framework of the OI-project. Furthermore, the R&D employees rely on the management and its attempt to only select OI-partners willing to enter a balanced give-and-take relationship. Consequently, the absence of reciprocity cause dissatisfaction, but the presence of it does not satisfy or motivate

the R&D employees. This outcome supports the differentiation between job context-related, rather extrinsic factors (hygiene factors) and job content-related, rather intrinsic factors (motivators) suggested by Herzberg. Reward A and reciprocity, which did not show a positive influence on R&D employees' attitude, could be classified as hygiene factors in our sample. Enjoyment in helping and especially sense of self-worth and reward B are typical motivators according to the motivator-hygiene theory.

6.1 Implications for Academic Research

Our study significantly contributes to OI-research, because it is the first empirical study with a clear focus on R&D employees working in OI-projects and the first time that the TPB was applied in an OI-context. Additionally, the study links open innovation to other research fields such as knowledge management and motivation theory. In so doing, it broadens the view on open innovation and substantially contributes to the current OI-understanding as well as to knowledge exchange and motivation research. For instance, the vast majority of studies considered in our literature review (Table 2) were conducted in Asian countries. Consequently, this study contributes to knowledge exchange research by adding an analysis conducted primary in Europe. Furthermore, our findings showed that motivational factors derived from the knowledge exchange literature have a significant impact on employees' attitude towards knowledge exchange in OI-projects, confirming the connection between open innovation and knowledge exchange. With respect to motivation research, the findings of this study strongly support Herzberg's (1968; 1974) motivation-hygiene theory. Since the distinction between motivators and hygiene factors is hardly considered in the knowledge exchange and/or OI-literature, this work makes a contribution by broadening the scope of this motivation theory's application. Furthermore, the results confirm that it is important to distinguish different kinds of rewards – particularly in the context of knowledge exchange in OI-projects – and to operationalize the reward construct(s) accordingly. Lastly, our study

makes a contribution by introducing a new, albeit developable reward construct (reward B), which entails rather intrinsic elements and was established with R&D employees during the pretest.

6.2 Managerial Implications

Managers of both OI-active companies and OI-newcomers can benefit from this study, because its findings indicate how to leverage R&D employees' intention to exchange their knowledge in OI-projects. The results showed that employees' intention is heavily dependent on subjective norm. However, employees can only act according to the interests of important others, if these interests are known. In order to minimize the gap between perceived and existent interests and avoid a "misdirection" of subjective norm, a clear and consistent communication is required. Since a misdirection is often due to insufficient feedback (Gecas, 1982), it is crucial to frequently give employees feedback. Positive feedback can encourage employees' knowledge exchange, while negative feedback can help to control the quality of employees' contributions (Cabrera and Cabrera, 2002). Notwithstanding the importance of subjective norm in this sample, also attitude and perceived behavioral control showed a significant positive impact on intention. Since attitude considerably develops from past experiences (Fishbein and Ajzen, 1975), it is critical to know which aspects or conditions might have transferred employees' past engagements in OI-projects into a positive and negative experience, respectively. It is, therefore, advisable to track employees' OI-experience and to identify disruptive factors, e.g., through (anonymously) surveys or "lessons learned" sessions after every OI-project. Furthermore, managers should evaluate the need for special trainings on a regular basis in order to positively influence R&D employees' perceived behavioral control. Lastly, our study revealed that employees are not interested in extrinsic incentives (e.g., higher salary, bonus), but rather prefer to broaden their horizon, to add value for their company and to be helpful. Consequently, it is advisable to establish

conditions stimulating intrinsic motivation, e.g., by setting employees' engagement in a broader context.

6.3 Limitations and Further Research

As this was the first study focusing on open innovation in R&D departments and on R&D employees exchanging their knowledge with external partners in OI-projects, further comparable analyses need to follow and confirm our findings. The survey sample was compiled among R&D employees of four manufacturers with global business, headquartered in Germany, active in the B2B market, operating in the fields of chemistry, automation and steel treatment, and publicly stating the application of the OI-approach. Even though this given mix of characteristics might be representative for several (high-tech) industries and companies, our findings should be interpreted in the described context and with the awareness that other characteristics might implicate different results. Further studies in different contexts (e.g., FMCG, B2C market, American companies) are required to analyze which findings are independent from these parameters and which are specific. A second limitation might be seen in the sample size. The number of usable responses was adequate for testing the research model and related hypotheses. However, the generalization of our results might be limited. Another limitation originates from the fact that the behavior construct of the TPB was not part of my research model. Future research could, therefore, investigate the relationship between intention and behavior and explore the stability of this connection in the context of knowledge exchange in OI-projects. Lastly, our study concentrated on knowledge exchange. However, we did not assess whether employees were able to absorb the knowledge from outside. Future studies could investigate the absorption of external knowledge and its integration in the internal innovation process.

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