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Absorptive capacity versus distributive capability

The asymmetry of knowledge transfer

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Abstract

Purpose – The purpose of this paper is to disentangle the role of the source and recipient of knowledge in supply chain collaboration by providing evidence that the distributive capabilities of a source, working in conjunction with the absorptive capacity (AC) of a recipient, have direct and significant effects on levels of collaborative engagement between supply chain partners and indirect and significant effects on collaborative operational outcomes.

Design/methodology/approach – This study utilises 310 surveys and structural equations modelling to provide empirical evidence to support the significance of the source of knowledge in collaborative activities.

Findings – The study provides evidence for source-based knowledge transfer constructs (distributive capabilities) in supply chain collaboration. Further, this research supports these capabilities working in conjunction with recipient AC both as necessary but insufficient requirements for successful knowledge transfer.

Practical implications – Firm interdependence within supply chains continues to grow. In today's environment of outsourcing and increasing levels of inter-firm activities, this research provides a parsimonious model of collaboration that allows firms to understand knowledge transfer better and how to more aptly manage these types of activities and complex relationships.

Originality/value – Earlier research in this domain has focussed on the abilities of a recipient firm to absorb knowledge in order to understand successful collaborative knowledge transfer. By solely focussing on the recipient firm, the role of the source of knowledge has been largely overlooked in this stream of research.

Keywords Absorptive capacity, Supply chain collaboration, Distributive capability, Distributive knowledge transmission

Paper type Research paper

1. Introduction

Faced with increasing environmental uncertainty and product complexity, firm interdependence is growing as companies work together towards supply chain innovation, process management and meeting diverse stakeholder expectations (Grant and Baden-Fuller, 2004; Teece *et al.*, 1997). Supply chain collaboration is a means by which firms are able to exploit the knowledge of both partners in order to manage and reduce uncertainty and address complexity (Patel *et al.*, 2012; Spring and Araujo, 2014). Ultimately, cooperation and collaboration allow supply chain partners to

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leverage an important intangible resource, supply chain knowledge (Boer *et al.*, 2001; Bessant *et al.*, 2003; Craighead *et al.*, 2009).

In its most basic form knowledge transfer requires a sender and receiver of knowledge in which knowledge moves from the sender to the receiver. Until fairly recently, research into knowledge transfer has primarily focussed on the knowledge receiver and its characteristics (Easterby-Smith *et al.*, 2008; Szulanski, 1996). One important such characteristic, absorptive capacity (AC) was first defined by Cohen and Levinthal (1990) as "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends". Despite strong theoretical support for AC, surprisingly much of the research on collaboration has not found a relationship between AC and collaboration (e.g. Hult *et al.*, 2004; Wagner, 2012; Zacharia *et al.*, 2011). This research seeks to show that AC was found to be insignificant in these tests because the role of the source of knowledge was not included in the research.

The roles of both the source and the recipient of knowledge have been blurred in the literature because organisations can perform both functions at the same time (Davenport and Prusak, 1998). However, it is important to bifurcate these characteristics, each from the other and understand how they work alone and together to better understand collaboration. Successful collaboration is dependent upon the abilities of each firm to the collaboration and, more specifically, each firm's-specific knowledge absorptive and transfer capabilities.

Although there is consensus regarding the importance of recipients of knowledge and their corresponding AC (Lane *et al.*, 2006), the source of knowledge has been largely overlooked in the literature. Further, when the source is acknowledged there is little consensus on the importance of their characteristics on knowledge transfer (Kuiken and Van der Sijde, 2011; Oppat, 2008). Waehrens *et al.* (2009) coined the term dispatching capacity as a counterpart to AC and argued that it consisted of five elements: identification, codification, reconfiguration of knowledge, motivation and pedagogical capacity of the sender. In 2010, Aarup *et al.* provided a working definition of dispatching capacity as "The ability of the firm to identify essential knowledge, prepare it for transfer and ensure that it is transferred in its entirety". Essential knowledge is the knowledge that must be located and transferred if the process is to perform at the required level. Preparing knowledge for transfer encapsulates the codification and reconfiguration elements presented by Waehrens *et al.* (2009). Large amounts of knowledge can be associated with a process, but the key to high-dispatching capacity is identifying and transferring what is vital and necessary (Aarup *et al.*, 2010). Even though dispatching capacity is insightful in understanding how knowledge needs to be packaged for better knowledge transfer there is little emphasis on the role of sender and receiver in the transfer process, which is the focus of this research paper.

Our research suggests the key to understanding the dynamic successful transfer of knowledge between the sender and receiver is to realise in addition to AC and dispatching capacity, there exists a distributive component. Expanding upon the model theorised by Zacharia *et al.* (2011), we propose a new dimension of knowledge transfer: distributive capability (DC). The ability of a knowledge source to transfer commercially relevant knowledge to a known recipient in order to effectuate positive performance outcomes. Our research finds that DC was ultimately composed of two distinct capabilities: the ability of the source to disseminate knowledge and the source's knowledge of their supply chain partner. For the purposes of this research, these

attributes are considered separate constructs and are referred to as distributive knowledge transmission (DKT) and distributive partner knowledge (DPK), respectively. We found both of these constructs to have statistically significant and direct influences on collaborative engagement (CE) and indirect and significant influences on operational outcomes (OO) in a collaboration. We make an empirical contribution to existing literature by addressing the following research questions:

RQ1. What characteristics define a source of knowledge in a successful knowledge transfer transaction in a commercial collaboration?

RQ2. Does the AC of a recipient of knowledge affect operating outcomes in supply chain collaboration?

RQ3. Does the DC of a source of knowledge affect operating outcomes in supply chain collaboration?

This paper is organised as follows. Section 2 establishes the theoretical basis for the paper, provides a literature review and establishes the proposed hypotheses. Section 3 describes the research methods and discusses the samples. Sections 4 and 5 provide the statistical analysis and results. Finally, Section 6 contains the discussion and managerial implications and Section 7 provides the limitations of this research and opportunities for future research.

2. Theoretical background and hypotheses

Supply chain collaborations represent vibrant and dynamic relationships between firms during which a two-way flow of knowledge is utilised to exploit current knowledge and create new knowledge (Minbaeva, 2007). It is important for supply chain managers to understand the knowledge transfer abilities of all parties in a collaboration in order to manage the process and maximise OO (Revilla and Knoppen, 2015).

Knowledge sharing is a process where organisations mutually trade or collectively create knowledge (Nagati and Rebolledo, 2012). De Vries *et al.* (2006) suggest that all knowledge sharing behaviour involves giving and receiving knowledge. This mutual exchange can lead to non-significant results if both of these actions are not considered simultaneously. The following articles did not find the hypothesised significance of AC when it was tested in relation to:

(1) CE (Zacharia *et al.*, 2011);

(2) the fuzzy front end in new product development (Wagner, 2012);

(3) the effects of e-purchasing tools on category performance (Kauppi *et al.*, 2013); and

(4) improved cycle time (Hult *et al.*, 2004).

These results were surprising due to the strong face validity of the propositions and literature support. In each case, researchers tested AC without consideration of the DC of the partnering firms.

This research proposes a new construct DC as a complement to AC to allow researchers and managers to view the dyadic exchange of knowledge through a new lens. Additionally, it argues that the addition of DC into models of knowledge transfer will parse out the elusive significance of AC in models such as those listed above.

For clarity a naming convention is adopted in this paper to use "source" and "recipient". This paper defines these terms in the following manner:

(1) Sources are those organisations that have substantial specialised (rare, inimitable) commercial knowledge, based on expert knowledge and/or experience (Davenport and Prusak, 1998).

(2) Recipients are those organisations that are intentionally looking for specialised knowledge for commercial application. They have an identified need that must be filled by knowledge that is not available within their firm.

These terms are representative of those used in organisational theory regarding knowledge transfer and management (Cohen and Levinthal, 1990; Davenport and Prusak, 1998; Gupta and Govindarajan, 2000; Szulanski, 1996).

2.1 Theoretical foundations

The increasing importance of inter-organisational relationships has led to the development of a wide range of theories to explain the formation of collaborations. The knowledge-based view (KBV) of the firm suggests that organisations that are able to combine the knowledge of individuals in a synergistic manner promote sustainable competitive advantage (Grant, 1996). Individual knowledge is combined, coordinated, transformed and amplified by the collective and legitimised into organisational knowledge (Nonaka, 1994; Spender, 1996). The KBV provides bases upon which knowledge-based predictions can be made regarding organisational decisions (Grant, 1996). However, this theory has not yet provided guidance for managers on how to leverage this idea into significant tangible management techniques and routines (Priem and Swink, 2012).

This paper endeavours to help bridge, at least in part, the gap between theory and application by identifying and operationalising the characteristics of the source in supply chain collaboration. Research has identified that there is an imbalance in the research focus on the recipient vs the source (Oppat, 2008). However, it is theorised here that AC and DC are necessary but insufficient conditions for knowledge transfer and each moderate the effect of the other on knowledge transfer.

As Oppat (2008) argues there is a balancing act among the domains of the source and recipient that must be addressed to fully understand knowledge transfer. However, as this research will show there is another nuance to this balance as seen in Figure 1. DC and AC are complementary requirements for knowledge transfer and their asymmetry leads to necessary behavioural changes by either the source or the recipient or both suffer reductions in knowledge transfer success.

The DC characteristics of the source are often confused with those of the AC of the recipient in knowledge transfer situations. This simple distinction is clouded by the fact that an organisation can be both a sender and a receiver of knowledge in the same collaboration. In fact, this plurality of roles is common and causes difficulties for organisations and managers to differentiate the characteristics of the source and recipient.

This paper expands on the model of supply chain collaboration presented in Zacharia *et al.* (2011) by hypothesising the role of the source in supply chain collaborations. The constructs in the proposed model are grounded in the research presented in Zacharia *et al.* (2011), an extant literature review and a series of executive interviews. Figure 2 shows the proposed model of supply chain collaboration, which is the subject of this paper.

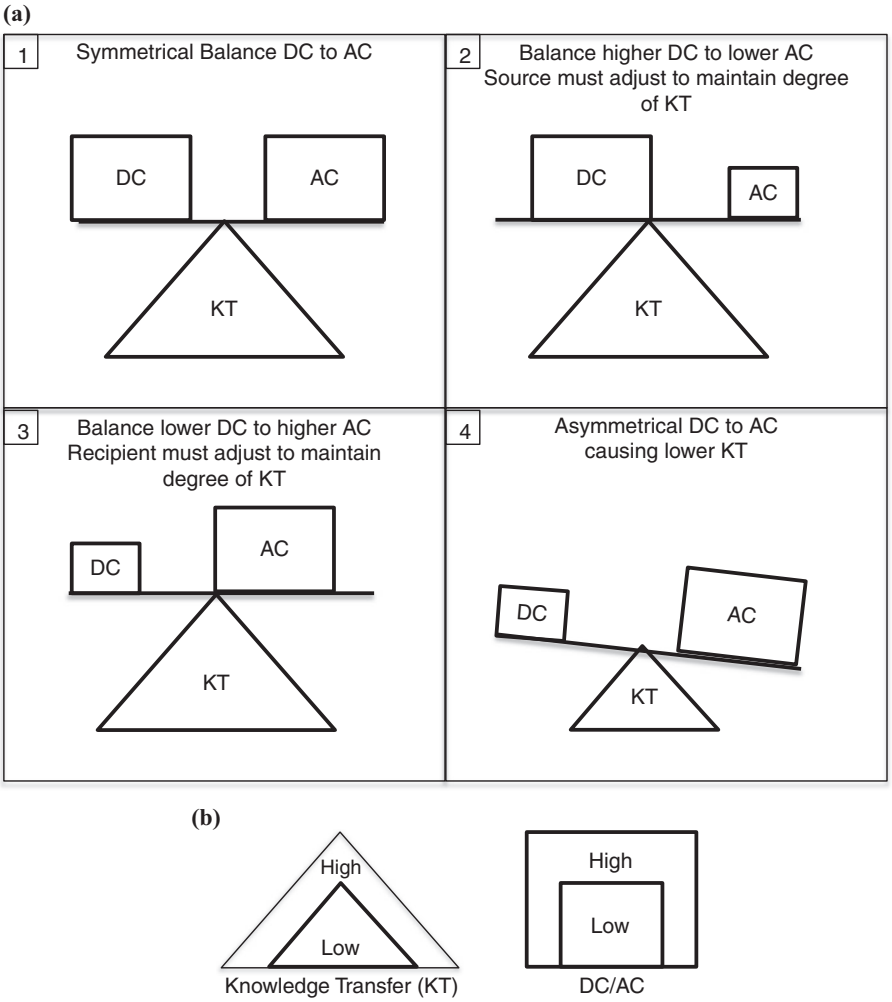

Figure 1.
Balancing DC and AC in knowledge transfer

2.2 Relational factors

Any collaborative relationship is primarily forged based on resources that are heterogeneous between organisations (Teece *et al.*, 1997). The need for resources that do not reside within the firm and shared goals are the pillars of inter-organisational collaborations. However, after the problem setting stage of collaboration, the level of CE between the parties is at least partially driven by the perceived interdependence (PI) between the firms (Stock and Tatikonda, 2000; Zacharia *et al.*, 2009). Firms often engage in collaborative activities because they believe that if they collaborate with another firm that has complementary resources and/or capabilities that they will achieve results that they would be unable to achieve alone (Eisenhardt and Schoonhoven, 1996). When firms believe that they are mutually dependent on one another, they engage more intensely in collaborative activities (Stock and Tatikonda, 2000). Therefore, the following relationship is hypothesised:

H1. The level of PI between firms is positively related to the level of CE.

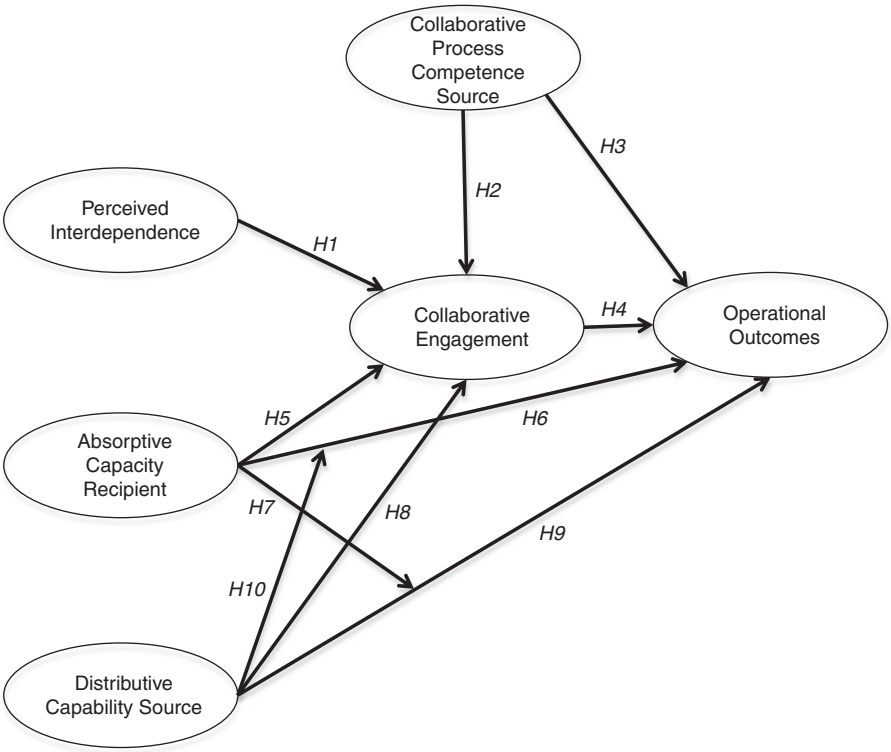

Figure 2. Theoretical model of supply chain collaboration

Collaborative process capability (CPC) is the ability to manage a knowledge transfer process. It is a combination of skills that reside within individuals that are ultimately coordinated and executed at the organisational level (Zacharia *et al.*, 2011). CPC "enables the process of sharing relevant information, managing conflict, assessing options, jointly making decisions and combining resources to accomplish objectives in a collaborative way" (Zacharia *et al.*, 2011).

CPC allows a firm to manage and monitor collaborative activities (Priem and Swink, 2012). By creating an environment that is conducive to partnering, promoting consensus, addressing challenges and breaking down barriers, firms can affect the levels of collaborative involvement engaged by all parties to the collaboration. It is suggested here that in order to promote efficiency and coordination, one firm is generally in charge of ensuring that the collaboration is managed well. Although, CPC can reside in either party to the collaboration, this research posits that CPC resides within the source. Based on the preceding description it is hypothesised that:

H2. The source's level of CPC is positively related to the level of CE in collaborative initiatives.

Cao and Zhang (2011) found a positive relationship between collaborative competence and performance outcomes in supply chain collaborations. These findings are in accordance with the assertions and earlier findings of

Zacharia *et al.* (2011) regarding the effect of CPC on OO. Based on this support, we further hypothesise that:

H3. The source's level of CPC is positively related to the OO of collaborative initiatives.

Zacharia *et al.* (2011) describe CE as the level of a "firm's involvement in a collaboration effort". CE can be strong or weak and is characterised high levels of commitment, knowledge transfer, consensus, frequency of interactions and relationships that create or change inter-organisational routines (Li *et al.*, 2012). Logsdon (1991) suggests that the stakes at hand for each firm drive levels of CE between firms. When the stakes are high, the collaborating firms will engage in more rigorous collective activity. Accordingly, this research proposes the following hypothesis:

H4. The level of CE between firms in collaborative initiatives is positively related to the OO of the collaboration.

2.3 Knowledge-based factors

2.3.1 AC. Organisational AC is loosely based upon an idea in macro-economic theory that talks to the ability of an economy to utilise and absorb external information and resources (Adler, 1990). A firm with high levels of AC is likely to recognise the value of new knowledge and understand how that new knowledge may be utilised within its routines and processes (Lane and Lubatkin, 1998). The ability to seek out new knowledge and exercise the four dimensions of AC is predicated on the firm's prior relevant knowledge (Cohen and Levinthal, 1990). This prior knowledge base not only consists of technical knowledge, but also knowing where knowledge resides within an organisation or in external resources (Zhang *et al.*, 2015). AC improves operational and relational outcomes (Patel *et al.*, 2012) and higher levels of AC have been associated with higher levels of spillover and relational rents from collaboration activities (Cao and Zhang, 2011). Accordingly, it is hypothesised that:

H5. The recipient's level of AC is positively related to the level of engagement in collaborative initiatives.

H6. The recipient's level of AC is positively related to the OO of collaborative initiatives.

Szulanski (1996) defined knowledge transfer in terms of a source and recipient – "a dyadic exchange of organisational knowledge between a source and a recipient unit in which the identity of the recipient matters". Acknowledging the role of the source in the transfer, the AC of the recipient is theorised to have a moderating effect on the DC of the source as found in the literature. Knowledge transfer, sharing and pooling are dependent on the characteristics of both the source and recipient (Easterby-Smith *et al.*, 2008; Grant, 1996; Gupta and Govindarajan, 2000; Oppat, 2008). The lack of AC, specifically the ability to absorb and apply knowledge, has been shown to moderate the effect of the source's ability and willingness to share knowledge on knowledge transfer outcomes (Chang *et al.*, 2012; Gupta and Govindarajan, 2000). Based on these assertions it is posited that:

H7. The recipient's level of AC has a moderating effect on the ability of the source's DC to positively affect the OO of collaborative initiatives.

2.3.2 DC. DC is theorised to include the intellectual capital of the firm and its ability to leverage that intellectual capital to benefit an external partner (Craighead *et al.*, 2009). This research proposes that when a partner is given access to needed intellectual capital there will be higher levels of CE between firms. Higher levels of CE can lead to richer communications, stronger relationship ties and better operating outcomes (Zacharia *et al.*, 2011).

DC is also theorised to include the ability of the firm to acquire, assess and apply partner knowledge to the selection, personalisation and transmission of knowledge to the recipient (Jasimuddin *et al.*, 2012; Oppat, 2008). Further, we propose that the more partner knowledge a firm has the more likely they are to vigorously engage in collaborative activities. Based on these three attributes of DC the following hypothesis is proposed:

H8. The source's level of DC is positively related to the level of engagement in collaborative initiatives.

The successful transfer of knowledge within collaborative activities is a necessary pre-requisite to the successful absorption and, ultimately, application of knowledge by a recipient (Revilla and Knoppen, 2015). As AC has been found to improve performance outcomes (Cao and Zhang, 2011; Patel *et al.*, 2012), it is proposed here that DC also has a direct effect on the OO. Based on these assertions it is hypothesised that:

H9. The source's level of DC is positively related to the OO of collaborative initiatives.

H10. The source's level of DC has a moderating effect on the ability of the recipient's AC to positively affect the OO of collaborative initiatives.

3. Research method

3.1 Measure development and pretesting

The fieldwork began with interviewing 43 executives to establish a scale for the newly proposed construct DC and reinforce the scale for CPC. Scale development followed procedures and guidelines recommended by Churchill (1979) and Anderson and Gerbing (1988). For established factors, we adopted pre-existing scales directly or modified to measure each of the constructs (see Table AI). A survey was written utilising both the scales from the executive interviews and the related literature. We then sent the survey to a small sample of executives and academics who provided feedback that enabled us to refine the survey. We conducted a pilot test of the survey by sending an e-mail with an electronic link to the survey to 75 executives who agreed to participate in the survey. Using principal factor analysis reliability analyses it was determined that all the items loaded correctly on their respective constructs and all measures were reliable for a Cronbach's α of over 0.70.

3.2 Sample frame and response rate

The target sample frame included experienced supply chain managers who had recently been personally involved in an inter-firm collaboration. We obtained a list of 5,000 randomly selected purchasing managers from Dun and Bradstreet. The only the criteria we used were that the company SIC code was manufacturing and that they were based in the USA. We mailed letters to each of these managers asking that they participate in our online survey.

Letters were sent to purchasing managers without prior knowledge about whether the individuals were recently and personally involved in an inter-firm collaboration. Self-selection was relied upon for respondents to choose to participate. In total, 506 managers responded by visiting the survey website. In all, 109 of these respondents did not proceed past the consent document that reiterated the necessity for personal and recent experience in collaborative activities. There was a net yield of 397 responses from this group providing a response rate of 78.4 per cent of the original set of self-selected respondents.

A second group of respondents was also asked to participate in this survey. In total, 300 randomly selected purchasing managers from state and local government were contacted via e-mail (with an electronic link to the survey). The survey information was captured under a separate survey website address so that the responses could be differentiated from the first set of respondents. These governmental responses yielded a response of 92 website hits. Again, each participant was asked to read an informed consent that reiterated the requirement for participation in inter-firm collaboration. In total, 32 respondents proceeded past the informed consent page and completed the survey. The request netted 32 usable survey responses providing a net 34.7 per cent response rate for this group.

Ultimately, 429 responses were received for a response rate of 71.7 per cent. After the elimination of surveys with greater than 10 per cent missing data (113) or were determined to be outliers (6) the net number of usable surveys was 310 or 51.8 per cent of the total self-selected responses to our survey request. Table I includes the respondent demographic information.

The potential for non-response bias was tested by comparing early responses (the first 100) to late responses (last 100) for all of the constructs using ANOVA (Armstrong and Overton, 1977) with no bias identified. An ANOVA test also failed to find any statistically significant differences ($p \leqslant 0.05$) between the two waves for demographic data such as industry type, number of employees, annual sales and organisational type.

	Frequency	%		Frequency	%
Titles			*Organisation type*		
C-level	46	19.35	Manufacturer	144	46.45
Director	53	22.58	Service company	60	19.35
VP	35	30.32	Government	36	11.61
Manager	154	13.23	Retailer	27	8.71
Not disclosed	12	11.61	Other	29	9.35
Other	10	2.90	Blank	14	4.52
Total	310	100.00	Total	310	100.00
Organisation size (employees)			*Organizaiton sales (US dollars)*		
< 100	62	20.00	< 10 million	60	19.35
101-500	68	21.94	10-99 million	70	22.58
501-1,000	30	9.68	100-999 million	94	30.32
1,001-5,000	64	20.65	1-5 billion	41	13.23
5,001-10,000	14	4.52	5 billion	36	11.61
10,001 or more	59	19.03	Blank	9	2.90
Blank	13	4.19			
Total	310	100.00	Total	310	100.00

Table I. Survey respondent demographic statistics

4. Analysis

Part of this research is considered exploratory especially with several new items associated with DC. Accordingly, an EFA was run using the sample data in order to determine if the proposed measurement items would group into categories that support the proposed constructs (e.g. Blome *et al.*, 2014).

4.1 Exploratory factor analysis

The EFA supported the unidimensionality of seven constructs. These constructs are similar to, but yet interestingly different, from the constructs that were proposed in the original structural model. Most notably, DC did not load as a single factor in the EFA. Instead, the measurements included within the originally proposed construct DC clearly loaded as two separate and distinct constructs. The first one includes measurement items that support the ability of a firm to distribute knowledge or transfer knowledge (DKT) to a known collaborative partner and the second construct supports the ability of a firm to understand its collaborative partner(s) or DPK.

Convergent validity for the resulting seven factors is supported by standardised loadings that range from 0.482 to 0.867. The lowest loading 0.482 was associated with the construct CE. It was considered acceptable because it is established and supported in current literature (Zacharia *et al.*, 2011). The constructs also had strong Cronbach's α values ranging from 0.733 to 0.953. Additionally, the EFA model resulted in a KMO of 0.915, $\chi^2 = 7{,}932.199$, df = 666 and $pr \leqslant 0.0000$.

The resulting seven factors included five of the proposed constructs: AC, PI, CPC (source), CE and OO. Additionally, two constructs, as described above, were included to represent two elements of DC. The EFA results suggest that the identified indicators support the constructs as shown in Table II (Hair *et al.*, 2010).

4.2 Structural equations modelling

We used confirmatory factor analysis (CFA) and structural equation modelling (SEM) to test and measure our conceptual framework using survey data. We conducted CFA and SEM analyses using Lisrel (8.8) and descriptive analyses using SPSS (12.1). We then used Anderson and Gerbing's (1988) two-step approach to analyse the data.

4.2.1 Convergent validity. Items that exhibited low item-to-scale total correlations as well as items that did not load significantly to the appropriate constructs in the CFA were removed. Table AI notes which items were removed. The average variance extracted (AVE) was examined for each construct to determine if they were above 0.5 as suggested by Hair *et al.* (2010) (See Table III). One construct resulted in an AVE of 0.4126. This was included since the construct was assumed to have convergent validity because:

(1) this construct is established in the literature with measurement items that were used in this research (Zacharia *et al.*, 2011);

(2) this construct resulted in factor loadings that exceeded 0.6 for each empirical indictor; and

(3) the EFA resulted in a Cronbach's α of 0.733 and it further passed the tests of construct reliability (0.74) and discriminant validity that will be described in the next sections.

4.2.2 Discriminant validity. Each of the constructs passed tests for discriminant validity since all of the constructs have an AVE higher than any squared correlation with any other construct in the model (Hair *et al.*, 2010). The CFA provided evidence of

Item	Loadings	Cronbach's α	Mean
Absorptive capacity recipient			
AC6	0.867	0.953	33.76
AC3	0.865		
AC2	0.866		
AC1	0.864		
AC5	0.853		
AC4	0.836		
Collaborative process competence source			
CPC4	0.798	0.902	32.98
CPC5	0.785		
CPC2	0.667		
CPC3	0.689		
CPC1	0.673		
CPC6	0.704		
Operational outcomes			
OO1	0.714	0.872	31.95
OO3	0.742		
OO2	0.720		
OO7	0.685		
OO6	0.685		
OO5	0.665		
Distributive knowledge transmission			
DC3	0.716	0.850	28.05
DC1	0.667		
DC2	0.696		
DC5	0.607		
DC4	0.601		
Distributive partner knowledge			
DC16	0.832	0.839	21.34
DC17	0.820		
DC18	0.810		
DC19	0.584		
Perceived interdependence			
PI1	0.764	0.733	23.49
PI2	0.730		
PI3	0.707		
PI4	0.661		
Collaborative engagement			
CE1	0.482	0.853	31.52
CE6	0.682		
CE3	0.644		
CE7	0.593		
CE5	0.509		
CE4	0.577		

Notes: Extraction method: principal component analysis; rotation method: varimax with Kaiser normalisation. Rotation converged in six iterations. Please refer to Table AI for full descriptions of the items

Table II. Exploratory factor analysis

Item	Loading	CR	AVE
Perceived interdependence			
PI1	0.625	0.74	0.413
PI2	0.651		
PI3	0.639		
PI4	0.654		
Collaborative engagement			
CE1	0.673	0.86	0.503
CE3	0.714		
CE4	0.605		
CE5	0.716		
CE6	0.790		
CE7	0.744		
Distributive knowledge transmission			
DC1	0.644	0.86	0.544
DC2	0.728		
DC3	0.825		
DC4	0.774		
DC5	0.704		
Distributive partner knowledge			
DC16	0.796	0.85	0.579
DC17	0.781		
DC18	0.820		
DC19	0.633		
Collaborative process competence source			
CPC1	0.727	0.90	0.611
CPC2	0.742		
CPC3	0.712		
CPC4	0.805		
CPC5	0.846		
CPC6	0.847		
Operating outcomes			
OO1	0.625	0.87	0.537
OO2	0.788		
OO3	0.716		
OO4	0.765		
OO5	0.768		
OO6	0.724		
Absorptive capacity			
AC1	0.850	0.95	0.773
AC2	0.865		
AC3	0.907		
AC4	0.877		
AC5	0.891		
AC6	0.885		

Notes: CR, composite reliability; AVE, average variance extracted. Please refer to Table AI for full descriptions of the items. All loadings are significant at $p < 0.01$ level

Table III. Confirmatory factor analysis

an acceptable overall model fit to the data ($\chi^2 = 1{,}588.805$, df = 608, $p < 0.000$, GFI = 0.781, CFI = 0.960, NNFI = 0.957 and RMSEA = 0.0721). Table IV shows the correlations between the constructs.

4.2.3 CMV tests. CMV can have a serious effect on empirical results (Podsakoff and Organ, 1986). The survey development process took traditional steps to avoid common method bias such as prequalifying potential respondents to ensure the informants were mid to senior-level managers with high levels of relevant knowledge and assuring informants their responses would remain anonymous (Fugate *et al.*, 2009). Reverse coding was used for various questions to break up the similarity between answers to questions and questions were also broken into blocks such that they had different instructions and they were segregated so that they were not seen on the same screen in the online survey.

A common latent factor was added to the CFA model and a path was added from that factor to each measurement item to test CMV (Podsakoff *et al.*, 2003). All paths were constrained to be equal. The variance in the common latent factor was constrained to have an error equal to one. The resulting loadings from each of the measurement items to the common latent factor resulted in a value of 0.35. The loading value of 0.35 was squared in order to get the CMV value of 12.25 per cent, an acceptable level per Podsakoff *et al.* (2003). To confirm further that CMV was not an issue in the sample, we used a theoretically unrelated marker variable to test CMV (Lindell and Whitney, 2001). Control variables for type of company and how long ago the engagement took place were added to the model. The model without these variables had a better fit except for these paths. All paths were significant at $p < 0.005$ or better except these paths with $p < 0.421$ and $p < 0.342$, respectively. This result is yet another indicator that CMV is not an issue in this sample.

4.2.4 Testing model fit. Testing the fit of a structural model is the second step in a two-part analysis where the first step is assessing the unidimensionality of the constructs and then the sufficiency of the model fit to the data (Anderson and Gerbing, 1988). Testing the original proposed structural model necessitated that DKT and DPK, the two DC constructs suggested by the EFA, be combined into a single first-order construct. Although, the early analysis provided evidence that DC was not a single functioning latent construct it was necessary to test the original model to confirm the initial analysis that the model would not have a good fit to the data.

Table IV. Correlations, means and standard deviations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Perceived interdependence	*0.642*						
(2) Collaborative engagement	0.593**	*0.709*					
(3) Distributive knowledge transmission	0.227**	0.665**	*0.738*				
(4) Distributive partner knowledge	0.192**	0.512**	0.565**	*0.761*			
(5) Collaborative process competence	0.292**	0.625**	0.726**	0.447**	*0.782*		
(6) Operating Outcomes	0.314**	0.622**	0.630**	0.469**	0.650**	*0.733*	
(7) Absorptive capacity	0.216**	0.559**	0.447**	0.246**	0.476**	0.471**	*0.879*
Mean	5.873	5.225	5.610	5.335	5.497	5.325	5.627
SD	1.203	1.389	1.055	1.367	1.200	1.433	1.135

Notes: The square root of the average variance extracted (AVE) is shown on the diagonal in italics. The inter-construct correlation is shown off the diagonal. **Correlation is significant at the $p < 0.01$ level

The original model that includes DC as a single first-order construct and interaction between DC and AC was tested. The model provided an acceptable fit with the data ($\chi^2 = 876.67$, df = 387, $p < 0.000$, GFI = 0.817, CFI = 0.967, NNFI = 0.963 and RMSEA = 0.0688), however, the proposed interaction was found to be insignificant. Additionally, the path AC to OO was insignificant. We rejected this model despite the acceptable fit statistics as we determined the model to be an unacceptable representation of the data. Accordingly, the hypotheses related to the interaction of AC and DC were rejected (*H7* and *H10*).

We examined a second competing model without the proposed interaction and DC was treated in the model as a second-order latent construct DC all (DCALL) made up of DKT and DPK. The resulting model reduced the fit statistics (e.g. RMSEA increased to 0.089) and DCALL had a negative relationship to CPC. Additionally, other proposed structural paths were found to have low or negative standardised loadings and the paths from CE to OO, CPC to OO and AC to OO were shown to be insignificant.

A third competing model was also examined to test the possibility that DCALL was an appropriate construct in the model. This model was built without direct effects from DCALL and AC on OO. That is, it was proposed in this model that AC and DCALL were fully mediated as to their effect on OO. All path weights were found to be significant. The fit statistics were: ($\chi^2 = 1{,}720.72$, df = 620, $p < 0.000$, GFI = 0.765, CFI = 0.956, NNFI = 0.952 and RMSEA = 0.0757) There is strong evidence from the early analysis that DC is not a single construct. Accordingly, the remaining hypotheses that suggested the existence of a single construct for DC were also rejected (*H8* and *H9*).

A final model was tested utilising two unique single order latent constructs (DKT and DPK). Additionally, as suggested by the earlier competing models, this model eliminated any direct effects from AC or DKT/DPK to OO. The model provided a good fit to the data ($\chi^2 = 1{,}620.19$, df = 616, $p < 0.000$, GFI = 0.777, CFI = 0.960, NNFI = 0.956 and RMSEA = 0.0725). Additionally, all of the proposed structural paths were found to be significant. This model provided support for the remaining hypotheses: *H1-H5*. All of these hypotheses are supported at the $p < 0.001$. See Table V for a summary of the competing models results.

The final model provides the best fit among the competing models and provides strong evidence to suggest the importance of the source in supply chain inter-firm collaboration. The results of the final model are discussed in more detail in the next section.

5. Results

Prior research tells us that knowledge transfer activities many times do not meet organisational goals (Gupta and Govindarajan, 2000; Oppat, 2008). Our research findings show that this may be caused, at least in part, by a lack of understanding and management of two elements of knowledge transfer, specifically, the abilities of the recipient (AC) and source (DKT and DPK). The hypotheses in this research suggest that the addition of factors associated with the role of the source to the structural model of supply chain collaboration are necessary to better understand collaboration. The final structural model produced the following fit values: ($\chi^2 = 1{,}620.19$, df = 616, $p < 0.000$, GFI = 0.777, CFI = 0.960, NNFI = 0.956 and RMSEA = 0.0725). Figure 3 shows the resulting structure along with standardised regression weights. The results of the tests of hypotheses are shown in Table VI.

Table V. Competing models

	Proposed model fully mediated Model 1	Hypothesised model DCALL as a first-order construct – Model 2	Rival model DCALL as a second-order construct – Model 3	Rival model DCALL as a second-order construct – Model 4
PI to CE	0.41^{***}	0.44^{***}	0.32^{***}	0.55^{***}
AC to CE	0.26^{***}	0.29^{***}	0.18^{***}	0.45^{***}
DPK to CE	0.16^{**}			
DKT to CE	0.39^{***}			
DKT to CPC	0.76^{***}			
CE to OO	0.39^{***}	0.23^{**}	0.08^{ns}	0.35^{***}
CPC to OO	0.43^{***}	0.34^{***}	-0.18^{ns}	0.50^{***}
AC to OO		0.09^{ns}	0.08^{ns}	
DCALL to CE		0.41^{***}	0.60^{***}	
DCALL to OO		0.18^{**}	0.57^{***}	
DCALL to CPC			-0.81^{***}	0.85^{***}
DCAC to CE		-0.05^{ns}		
DCAC to OO		-0.07^{ns}		
Model fit statistic				
χ^2	1,620.19	876.67	2,134.77	1,720.72
df	616	387	617	620
CFI	0.960	0.967	0.939	0.956
NNFI	0.956	0.963	0.934	0.952
RMSEA	0.0725	0.0688	0.089	0.0757
PNFI	0.866	0.839	0.849	0.868
AIC	1,750.19	1,006.67	2,264.77	1,850.72
CAIC	2,058.07	1,314.55	2,572.64	2,158.60

Notes: ^{ns}Non-significant. **,***t-values significant at $p \leqslant 0.01$, $p \leqslant 0.001$, respectively

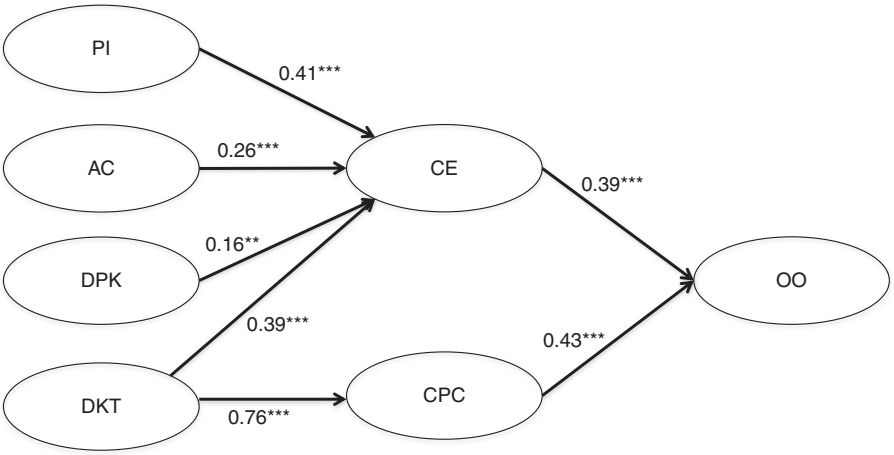

Figure 3. Final structural model representing supply chain collaboration

Notes: **,***t-values significant at $p<0.01$, $p<0.001$, respectively

The data in this research supports *H1*, the direct effect of PI to CE, as PI increases the level of CE also increases.

The original hypothesised model predicted a direct influence on CE by CPC. This was not supported by the results, therefore, *H2* is rejected. Additionally, CPC was

Hypothesis		Outcome
H1	The level of perceived interdependence between firms is positively related to the level of collaborative engagement	Supported
H2	The source's level of CPC is positively related to the level of CE in collaborative initiatives	Rejected
H3	The source's level of CPC is positively related to the operational outcomes of collaborative initiatives	Supported
H4	The level of CE between firms in collaborative initiatives is positively related to the operational outcomes of the collaboration	Supported
H5	The recipient's level of AC is positively related to the level of engagement in collaborative initiatives	Supported
H6	The recipient's level of AC is positively related to the operational outcomes of collaborative initiatives	Rejected
H7	The recipient's level of AC has a moderating effect on the ability of the source's DC to positively affect the operational outcomes of collaborative initiatives	Rejected
H8	The source's level of DC is positively related to the level of engagement in collaborative initiatives	Rejected
H9	The source's level of DC is positively related to the operational outcomes of collaborative initiatives	Rejected
H10	The source's level of DC has a moderating effect on the ability of the recipient's AC to positively affect the operational outcomes of collaborative initiatives	Rejected

Table VI. Results of hypotheses tests

theorised to have a significant direct effect on OO. This was indeed confirmed in our results and *H3* is supported. Surprisingly, however, CPC is a mediator between DPK and OO. In this research, it was hypothesised that CPC resides in the source. The results suggest that higher levels of DPK improve the CPC of the source and, in that way, influences OO.

Four distinct constructs are shown to have significant statistical influence on the levels of CE within supply chain collaboration (PI, AC, DKT and DPK). CE has been shown in the literature to increase OO within these types of CEs (Zacharia *et al.*, 2011). The data in this research confirm prior results and show CE to have a significant influence on OO. Accordingly, *H4* the hypothesis regarding the influence of CE on OO is supported.

Viewing the supply chain through the lens of knowledge-based organisational skills (Priem and Swink, 2012), this research proposed that AC has a direct effect on the levels of CE within inter-organisational collaboration. The data support this *H5* specifically that as AC increases the level of CE increases. This is different than the results of Zacharia *et al.* (2011), whereas in their study the authors found no significant direct effect to support the proposed influence of AC on CE. It is proposed that AC is found to be significant in this data as a result of disentangling AC from the effects of the source on the collaboration by introducing DKT And DPK in the model. Additionally, this result shows AC to have a significant indirect effect on OO through a path fully mediated by CE.

AC was also hypothesised to have a direct effect on OO. This hypothesis was not supported by the data and *H6* was rejected. Additionally, AC was hypothesised to have interactive effects with DC within the model, as AC would influence the level of DC on OO. This *H7* was also not supported in the model and was therefore rejected.

DC was introduced in this research as an accumulation of abilities associated with a source to transfer knowledge to a known recipient (Cohen and Levinthal, 1990; Dyer and Singh, 1998; Szulanski, 1996). In this research, DC is hypothesised to be a single first-order latent construct. The results of our tests indicate that DC is not a single construct and therefore the related hypotheses were rejected: *H8-H10*. However, the data suggest that the abilities of the source to transfer knowledge to a known recipient are represented by two distinct constructs, namely, DKT and DPK. The results of these tests indicate that although DC itself is not significant in the model DKT and DPK are significant.

The final proposed model indicates significant paths from DPK to CE, DKT to CE and CPC. This is a clear indication that the characteristics of the source in supply chain collaboration are important to levels of CE and CPC. Additionally, this also implies that DKT and DPK have fully mediated indirect effects on OO as CE and CPC are both shown to have significant roles in increasing OO.

6. Discussion

The collaborative process is an opportunity for organisations to work together towards outcomes that far exceed what each firm can achieve alone (Patel *et al.*, 2012). This research suggests that this type of synergy is created when the symmetry of the abilities of the recipient (AC) and those of the source (DKT and DPK) in a collaboration is improved. The resulting significance of AC, DKT and DPK in the model suggests that improving the symmetry between the firms may expand supply chain collaboration performance frontiers (Schmenner and Swink, 1998) beyond the current operations frontier, perhaps even moving it.

This research theorises and demonstrates the importance of the source of knowledge in supply chain collaboration. It is clear that a firm can play both the role of the giver and receiver of knowledge in a collaboration suggesting it is important to isolate the functions of giving and receiving knowledge. Successful collaboration is dependent on the firms to execute both the roles of the source and recipient.

Based on the data analysis the characteristics of the source cannot be represented by a single construct as hypothesised, but rather there are two distinct constructs (DKT, DPK). DKT represents the abilities of the source to transmit knowledge to a known recipient and DPK represents the level of knowledge a source has about the recipient. Each of the constructs: AC, DKT and DPK represent characteristics that are necessary, but not sufficient, to support positive knowledge transfer outcomes.

6.1 Implications for research

The KBV provides a theoretical basis that improved knowledge transfer abilities can increase operating outcomes in collaborative activities between supply chain partners. However, collaboration research steeped in KBV has found non-significant results (Hult *et al.*, 2004; Kauppi *et al.*, 2013; Wagner, 2012; Zacharia *et al.*, 2011) as it pertains to AC. Additionally, this paper recreated the model tested by Zacharia *et al.* (2011) who originally found no significance for AC in their collaboration model, and found significance not only for AC but also for the knowledge transfer abilities of the source (DKT and DPK). Based on this research the non-significance of AC in previous research can be the result of not including the DC of the source of knowledge.

The findings in this paper significantly contribute to the research literature by:

(1) providing evidence that the source of knowledge is important to the success of supply chain collaboration;

(2) showing that the knowledge source abilities are best reflected in two distinct constructs DKT and DPK; and

(3) supporting a model where AC is significant to supply chain collaboration.

These findings help us better understand the asymmetrical nature of the recipient and source in knowledge transfer. Additionally, the introduction of two new constructs enables researchers to characterize and operationalise the source of knowledge in collaborative activities.

6.2 Implications to practice

A very important implication for managers when considering or planning to collaborate with other firms, is the need to have a clear understanding of what role they expect to play in the collaboration and to also set their expectations for their partner. If a firm expects to be on the receiving end of knowledge, they need to ascertain their level of AC. This study shows that higher levels of AC are associated with higher levels of CE which leads to improved OO. If they desire to increase their AC they can manage it proactively selecting team members so that they have the right amount of expertise on the team in order to be able to understand the impact of new knowledge. Additionally, they need to be flexible so that they can take advantage of new knowledge to change processes and improve performance.

Receiving firms' managers should understand the DPK and DKT of their partner. This research shows that sources of knowledge are more effective in transferring knowledge when they understand their partner by getting to know their organisational culture, strengths, weaknesses, long-term goals and objectives for the collaboration. If a potential partner does not seek out this information, the receiver should question why and whether this is the right partner for the project. If the partner has specific intellectual capital that the receiver needs, they can balance this asymmetry by proactively providing this information to enhance the DPK of their partner.

The receiver should also investigate the DKT of their potential partner. This research shows that sources are more successful in collaboration when they are able to express ideas in a language that is easy to understand, provide multiple perspectives, make clear presentations of complex knowledge, select the best method to share, accept and respond to feedback and provide insight into possible future outcomes. When choosing a partner the receiver should explore these characteristics of potential partners and use this information to select the organisations that best complement their internal AC.

Conversely, managers within firms that are the primary source of knowledge in supply chain collaboration should consider the aspects of the receiver's AC and make any necessary adjustments to their choice of delivery method, expression of complex knowledge, perspective or even language in order to improve knowledge transfer. This research suggests that the best sources of knowledge will understand their partner's DPK and consequently the AC of the receiver thus helping equip them to accept and apply the knowledge that is being shared. Additionally, managers should take account of their own DPK and DKT. Are they adequately knowledgeable about their partner? Are they equipped to provide high levels of DKT? These questions will allow the source to explore and better prepare themselves and their partners to experience successful collaborative outcomes.

7. Summary and conclusions

The goal of this research was to study the knowledge-based abilities that support successful supply chain collaboration. This study validated a model of supply chain collaboration that includes both the characteristics of the recipient (AC) and the characteristics of the source (DKT) and (DPK). The three research questions posed at the beginning of the paper were also answered in that DKT and DPK characterises the source of knowledge and the AC of the recipient and the DC of a source of knowledge both affect the OO in a SC collaboration.

This study contributes to the collaboration literature by refining our understanding of the source of knowledge in collaborative activities in the supply chain domain. Building upon knowledge-based organisational strategy literature, this research proposed a complement to AC in the recipient, namely, DC in the source. This research further demonstrated that DC is not a single construct, but two separate constructs, DKT and DPK.

The source of knowledge has been largely overlooked in the literature and where it is acknowledged there is little consensus on its role as a dimension of knowledge transfer (Oppat, 2008). By theorising and evidencing the importance of the source, this research bridges the theoretical gap that separates the concepts of AC, disseminative capacity, collaborative process competence and organisational knowledge transfer. As such AC was found to have a direct and significant influence on CE in direct contrast to previous research that did not find such relationships (Zacharia *et al.*, 2011; Hult *et al.*, 2004; Kauppi *et al.*, 2013; Wagner, 2012). These results suggest that in collaboration research AC and the distributive capabilities of the source (DKT and DPK) should be studied in unison.

7.1 Research limitations and future directions

This research has limitations that could be addressed in future research. First, this research focussed the survey responses of a single firm instead of surveying both members of the collaboration. The utilisation of dyads in this area of research would give researchers added dimensions with which to study the interactions of knowledge-based constructs such as AC, CPC (source and recipient), DKT and DPK.

Second, this research did not capture the CPC of the recipient, instead focussing on the CPC of the source. This study theorised that CPC is primarily a contribution of the source of knowledge in collaboration. CPC should be the subject of future research to further differentiate between the CPC of the source and recipient.

Finally, this research did not capture the type of knowledge that was being transferred. By capturing the type of knowledge (tacit vs explicit) and perhaps the stickiness of the knowledge, these knowledge transfer constructs might have different results as the role of the source and the recipient may vary greatly depending on the type of knowledge being transferred.

This research lends itself to many areas of future research. The scales that have been developed as part of this research for DKT and DPK allow these distributive capabilities to be generalised to other areas of operations management research. Testing the role of the source in other domains would add to our understanding of how knowledge-based theory can improve supply chain and operational results. Acknowledging and supporting the role of the source in knowledge-based transactions can also be studied in organisational theory.

While AC and its role in supply chain collaboration have been studied extensively there has been scant research that focussed on the DC of the source. Thus this research

serves to fill a gap in the collaboration literature by validating the role of two distinct constructs, DKT and DPK and their effect on the OO of a collaboration. This research provides valuable insights to help managers and researchers get a better understanding of the factors that enhance the knowledge transfer process in supply chain collaboration.

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Appendix

Item	Label		Development
The organisations involved			
Were dependent on each other for an effective solution	PI1		Zacharia *et al.* (2011)
Needed knowledge the other possessed	PI2		Zacharia *et al.* (2011)
Needed skills the other possessed	PI3		Zacharia *et al.* (2011)
Needed each other to reach their goals	PI4		Zacharia *et al.* (2011)
Make joint decision on most issues	CE1		Zacharia *et al.* (2011)
Jointly set goals	CE2		Zacharia *et al.* (2011)
Used intensive collaborative planning	CE3		Zacharia *et al.* (2011)
Met often	CE4		Zacharia *et al.* (2011)
Throughout the collaboration			
There was a free flow of useful ideas	CE5		Zacharia *et al.* (2011)
There was a free flow of novel ideas	CE6		Zacharia *et al.* (2011)
There was an openness to new ways of thinking	CE7	X	Zacharia *et al.* (2011)
There was an openness to discovering new knowledge	CE8	X	Zacharia *et al.* (2011)
In general our partner had the ability to			
Express ideas in language that was easy for us to understand	DC1		Simonin (1999)
Provide multiple perspectives	DC2		Simonin (1999)
Make clear verbal presentations of complex knowledge	DC3		Simonin (1999)
Clearly express complex ideas in writing	DC4		Simonin (1999)
Select the best method to share knowledge	DC5		Ko *et al.* (2005)
Share knowledge with us both formally and informally	DC6	X	Ko *et al.* (2005)
Accept and respond to feedback	DC7	X	Ko *et al.* (2005)
Provide insight into possible future outcomes	DC8	X	Ko *et al.* (2005)
During the collaboration our partner's organisation			
Experienced employee turnover (reverse coded)	DC9	X	Inkpen and Tsang (2005)
Had the ability to attain 3rd party expertise when needed	DC10	X	Inkpen and Tsang (2005)
Exhibited high levels of technical expertise	DC11	X	Ko *et al.* (2005)
Was credible	DC12	X	Ko *et al.* (2005)
Was willing to share their knowledge with us	DC13	X	Ko *et al.* (2005)
Was protective of its intellectual capital (reverse coded)	DC14	X	Simonin (1999)
Was positive about sharing its expertise with us	DC15	X	Simonin (1999)
Our partner asked for or otherwise acquired information about our			
Organisation	DC16		Cao and Zhang (2011)
Organisational culture	DC17		Cao and Zhang (2011)
Strengths and weaknesses	DC18		Cao and Zhang (2011)
Long-term goals	DC19	X	Cao and Zhang (2011)
Objectives and expectations for the collaboration	DC20		Cao and Zhang (2011)
In general our partner had the ability to			
Establish processes to monitor and manage collaboration efforts	CPC1		Spekman *et al.* (1997)
Manage frequent interactions with our firm	CPC2		Interviews
Abide by an agreed timeline	CPC3		Interviews
Manage our expectations	CPC4		Spekman *et al.* (1997)
Recognise and resolve conflicts as they arise	CPC5		Spekman *et al.* (1997)
Positively influence cooperation between our organisations	CPC6		Spekman *et al.* (1997)

Table AI.
Empirical measures

(*continued*)

Item	Label	Development
In general our company has the ability to		
Identify and adopt new and useful ideas	AC1	Cohen and Levinthal (1990)
Seek out new and useful knowledge	AC2	Cohen and Levinthal (1990)
Take advantage of new knowledge to improve performance	AC3	Cohen and Levinthal (1990)
Understand the impact of new knowledge	AC4	Cohen and Levinthal (1990)
Change processes based on new knowledge	AC5	Cohen and Levinthal (1990)
Use new knowledge in response to competitive changes	AC6	Cohen and Levinthal (1990)
This collaboration resulted in our two organisations having		
Greater commitment to each other	RO1	Zacharia *et al.* (2011)
An improved level of trust	RO2	Zacharia *et al.* (2011)
More open sharing of information	RO3	Zacharia *et al.* (2011)
An enhanced commitment to work together in the future	RO4	Zacharia *et al.* (2011)
A feeling of partnership and solidarity between us	RO5	Zacharia *et al.* (2011)
This collaboration resulted in our company experiencing		
Lower costs	OO1	Zacharia *et al.* (2011)
Improved quality	OO2	Zacharia *et al.* (2011)
Better customer service	OO3	Zacharia *et al.* (2011)
Better safety, environmental or regulatory performance	OO4	Zacharia *et al.* (2011)
Improved value to its customers	OO5	Zacharia *et al.* (2011)
Overall improved organisational performance	OO6	Zacharia *et al.* (2011)
Improved profitability	OO7 X	Zacharia *et al.* (2011)

Note: X, items that were removed from the final model based on EFA and CFA analysis

Table AI.

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