

Knowledge sharing and absorptive capacity: interdependency and complementarity

Andrea Raymundo Balle, Mírian Oliveira and Carla Maria Marques Curado

Abstract

Purpose – This study aims to resolve contradictions in the literature regarding the relationship between knowledge sharing (KS) and absorptive capacity (AC). The authors analyze the reasons for which KS has been interpreted as an antecedent and those for which it has been seen as a consequent of AC.

Design/methodology/approach – The study uses a systematic review of the literature to identify the arguments supporting the relationships between the constructs and propose a model. Additionally, the hypotheses were tested using SEM to assess the proposed model.

Findings – The findings reveal the nature of the relationship between KS and AC. Suggesting AC is bi-dimensional, consisting of potential AC and realized AC, while the relationship between these two dimensions depends on KS.

Research limitations/implications – This study provides consistent theoretical grounds for future empirical research. The study findings demonstrate KS provides a real contribution towards AC, validating the previous literature on the impact of KS antecedents on realized AC. Additionally, the authors provide evidence to suggest knowledge donation is an output of the AC process, thus generating a debate on the nature of knowledge donation (requested vs unrequested), which raises interesting research questions to be addressed in the future. As a limitation, empirical data was only collected in the context of software development in two countries.

Practical implications – The results elucidate the central role of knowledge collection within AC. For managers, the importance of the role of knowledge collection to fully benefit from AC and exploit knowledge is highlighted.

Originality/value – The research design is original in that it combines a systematic and integrative literature review to the ground and propose hypotheses with empirically testing of the emerging model. The study clarifies the relationship between KS and AC, providing evidence to show knowledge donation is an output of the AC process. The benefits of this study can be seen at the team and firm-level.

Keywords Absorptive capacity, Knowledge sharing, Systematic literature review, Knowledge intensive teams

Paper type Research paper

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1. Introduction

Knowledge is a justified true belief (Nonaka and Takeuchi, 1995) that mixes experience, values, contextual information and experienced insight (Davenport and Prusak, 1998). It is a strategic organizational resource (Schultze and Leidner, 2002; Sher and Lee, 2004), as it improves organizational capacity (Nonaka, 1994) and is a source of organizational value creation (Mohanty, 2003). This is because knowledge can generate rare, valuable solutions that are hard to imitate and replace (Grant, 1996) and which can provide competitive advantage (Barney, 1991; Rua *et al.*, 2018).

Knowledge management (KM) is critical to organizations (Grant, 1996), being an organizational capacity (Alavi and Leidner, 2001; Prieto and Easterby-Smith, 2006) that

allows managers to create, retain, transfer and use knowledge (Cepeda and Vera, 2007). Knowledge sharing (KS) is a central element in the KM process (Liao *et al.*, 2007; Naim and Lenkla, 2016; Ramayah *et al.*, 2013) because it connects individual knowledge with organizational knowledge (Hendriks, 1999) and managers find it important in organizations (Bock and Kim, 2002). KS is a process in which units influence each other through their experiences (Argote and Ingram, 2000) to create new knowledge (Hooff and Ridder, 2004). Managing KS is one of the greatest challenges for managers today (Law, 2014), as it is key to improving organizational productivity, innovation and performance (Tseng, 2010).

While KS plays a key role in building the modern world (Naim and Lenkla, 2016), it is not the only factor that impacts organizational performance. Absorptive capacity (AC), which has been related both to performance (Easterby-Smith *et al.*, 2008; Todorova and Durisin, 2007) and KS (Ceccagnoli and Jiang, 2013; Van Wijk *et al.*, 2008), is important for companies because it influences their ability to create new organizational capacities (Pittz and Intindola, 2015), learning behaviour (Naim and Lenkla, 2016), the knowledge held by the company (Scott and Sarker, 2010), project performance (Ali *et al.*, 2018) and the capacity for innovation (Daghfous and Ahmad, 2015; Ritala and Hurmelinna-Laukkanen, 2013). A large AC also provides for better experiences with suppliers (Jordaan, 2013), improves the access to strategic resources (Rejeb-Khachloul *et al.*, 2011) and the better use of technology (Peng *et al.*, 2014).

There is growing interest in exploring the factors that determine the relationship between KS and AC (Ceccagnoli and Jiang, 2013; Naim and Lenkla, 2016; Paulsen and Hjertø, 2014; Szulanski, 1996; Van Wijk *et al.*, 2008). However, there is a puzzling ambiguity regarding the exact nature of the relationship. While some studies claim that AC is positively influenced by KS (Curado *et al.*, 2017; Peltokorpi, 2017; Supartha and Ratih, 2017), others find that AC influences the KS (Ai and Tan, 2017; Baker and Yousof, 2017; Berry, 2017). Such contradictions can be potentially damaging, especially when empirical research addresses data. Given that quantitative studies often propose directional hypotheses to be tested using dependency techniques, in this study, a literature review was undertaken to establish, which variables are dependent and which are independent (Hair *et al.*, 1998; Hair *et al.*, 2003). The ambiguity regarding, which variable in the relationship is the dependent on which means certain data analysis techniques cannot be applied, or, if applied, may compromise the results of data interpretation (Hair *et al.*, 1998; Hair *et al.*, 2016).

As previous studies have been unable to establish a unanimous position concerning this relationship, we propose to fill that gap by investigating the subject and offering solid grounds for future research. Therefore, this study aims to examine the reasons given for identifying KS as an antecedent and those given for identifying it as a consequent of AC and to test a model exploring the relationship between them. To do so, a two-phase study was carried out: firstly, a systematic review of the literature where articles dealing with the relationship between KS and AC were analysed; the secondly, a survey conducted amongst software development teams, an intensive knowledge context (Robillard, 1999; Solli-Sæther and Karlsen, 2014), and therefore, suitable for research into KS and AC.

The article is divided into the following sections: the literature review on the concepts of KS and AC and the relationship between KS and AC (Section 2); method (Section 3); quantitative analysis of the proposed research model (Section 4); and conclusions, limitations and suggestions for future research (Section 5).

2. Knowledge sharing and absorptive capacity

The concept of AC is linked to knowledge and KS, as it is an ability that allows a company to identify external knowledge, assimilate it and apply it for business purposes (Cohen and Levinthal, 1990). The following sub-sections deal with the concepts related to KS; present the concepts related to AC; and show the development of the hypotheses.

2.1 Knowledge sharing

KS is central to KM (Liao *et al.*, 2007; Naim and Lenkla, 2016). For Argote and Ingram (2000, p. 151), "KS in organizations is the process by which one unit (e.g. group, department or division) is affected by the experience of another". According to the knowledge-based view of the firm, the success of an organization depends on effective KS in the company (Ismail, 2012).

KS is a dynamic, interactive process (Bengoa and Kaufmann, 2014), which occurs when one individual wants to either donate knowledge or acquire that of other individuals to build skills (Naim and Lenkla, 2016) and new knowledge (Song, 2014). During KS, the knowledge held by the donor is transferred to the recipient through a variety of methods such as personal interaction, information systems and networks (Daghfous and Ahmad, 2015). Thus, to foster KS, it is necessary to promote social interaction between employees (Naim and Lenkla, 2016).

When sharing knowledge, the participating units influence each other's knowledge, facilitating the joint creation new knowledge (Van Wijk *et al.*, 2008). There is no standard measure for KS, which means it can be measured in several ways (Oliveira *et al.*, 2015; Wang and Noe, 2010). For Hooff and Ridder (2004), KS involves two processes, namely, knowledge donation and knowledge collection. When donating, intellectual capital is communicated to others, while when collecting, the intellectual capital of another individual is consulted.

2.2 Absorptive capacity

AC is the ability of the individuals within an organization to develop relevant knowledge bases, to recognize external information of value, to make appropriate decisions and to implement effective work processes and structures (Cohen and Levinthal, 1990). Cohen and Levinthal's (1990) original conceptualization limits AC to a function of the company's previous knowledge, which does not encompass the richness of the construct (Lane *et al.*, 2006). The research from Zahra and George (2002) expands on Cohen and Levinthal's (1990) work by viewing AC as a multi-dimensional construct that includes the acquisition, assimilation, transformation and exploitation of knowledge. Acquisition refers to the firm's ability to identify and obtain knowledge from external sources (Flatten *et al.*, 2011). Assimilation refers to the routines and processes that allow the firm to analyse, interpret and understand the information obtained from external sources (Szulanski, 1996). Transformation denotes the firm's ability to develop routines that facilitate the combination of existing knowledge with acquired knowledge (Zahra and George, 2002). Exploitation is based on routines that allow the firm to refine its knowledge and skills and use them for commercial ends (Lane and Lubatkin, 1998; Zahra and George, 2002).

The dimensions are grouped into two moments, namely, potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP) AC. The PACAP makes the firm receptive to acquiring and assimilating external knowledge, but does not guarantee that the knowledge will be exploited (Lane and Lubatkin, 1998; Zahra and George, 2002). The RACAP is a function of the similarities in the knowledge and similarities in the social-cognitive context (Kim *et al.*, 2015) and consists of the transformation of capacities, which allow the firm to develop new processes and introduce changes to existing processes (Flatten *et al.*, 2011). The RACAP facilitates the exploitation of knowledge and reflects the firm's ability to leverage the knowledge that has been absorbed (Zahra and George, 2002). The PACAP positively influences the RACAP (Montazemi *et al.*, 2012), moderating the social integration mechanisms that lower the barriers to sharing and raising the efficiency of knowledge transformation and exploitation (Zahra and George, 2002).

2.3 Hypotheses development

Interest in determining the nature of the relationship between KS and AC has grown and the approaches adopted in attempting to do so differ. Some authors see AC as a sub-process of KS routines (Dyer and Singh, 1998; Huber *et al.*, 2011; Miller *et al.*, 2016), while others consider KS as a process of AC (Omidvar *et al.*, 2017; Saraf *et al.*, 2013).

Some studies compute AC and KS as a single construct that is necessary for moving information around within the company (Mowery and Oxley, 1995; Welch and Welch, 2018) or as part of a dynamic capacity (Cepeda-Carrión *et al.*, 2017). While the above studies show different interactions or configurations involving the two constructs, most of the studies that deal with KS and AC tend to consider one to be an antecedent of the other (Ceccagnoli and Jiang, 2013; Naim and Lenkla, 2016; Paulsen and Hjertø, 2014; Szulanski, 1996; Van Wijk *et al.*, 2008). The two constructs are considered independent. There is a need for evidence regarding the nature of their relationship, which would enable greater progress in the field and empirically facilitate coherence amongst the studies. A systematic and integrative literature review was conducted to address the puzzling variety of relationships perceived to exist between the two constructs. The articles were identified and classified into three groups, namely, those in which AC is seen as an antecedent of KS (12 quantitative articles and 11 qualitative articles); those in which KS is seen as an antecedent of AC (nine quantitative articles and three qualitative articles); and finally those considering AC and KS to be related concepts and, therefore, present AC both as an antecedent and a consequent of KS (two quantitative articles and only one qualitative article). The 38 articles resulted from a search carried out in Web of Science and Scopus. Appendix 1 shows the articles organized into the three groups.

The justifications used to support the choice of relationship in each group of articles were analysed. This analysis shed light on the underlying logic of the authors in each group, which grounded the development of the research model presented later in this section.

Regarding the qualitative articles that consider KS an antecedent of AC, the key influencing argument is the presence of KS support practises that make shared knowledge relevant and, therefore, boost the AC. For both the reflexive practises identified by Elezi and Bamber (2016) and the pre-sharing decision algorithms identified by Daghfous and Ahmad (2015), the prior treatment of KS is the central element affecting the AC. This is in line with the literature review carried out by Lim *et al.* (2015), which shows that sharing must occur in certain emotional, psychological and timely environments in order for the AC of those involved to be affected that is if the sharing process is not well structured, there will be no effect on AC.

With regard to the quantitative articles that consider KS an antecedent of AC, five articles argue that sharing increases the individual's or unit's knowledge and this increase in knowledge makes it easier to identify the value of new knowledge, thus influencing the AC (Curado *et al.*, 2017, p. 2017; Nodari *et al.*, 2016; Oliveira *et al.*, 2015; Peltokorpi, 2017; Supartha and Ratih, 2017). The studies from Costa and Monteiro (2016), Iyengar *et al.* (2015) and Wuryaningrat (2013) use a similar argument, that KS is a learning process, resulting in new knowledge. When analysing AC from the perspective of Zahra and George (2002), one can see that this perspective only covers the acquisition and assimilation of knowledge that is the PACAP. Hence, the influence would be incomplete because it does not cover the RAPAC. The argument presented by Lee *et al.* (2014) is unclear and makes a "circular reference", stating that when teams share knowledge, AC increases and that it is important because teams need knowledge. One may consider that, again, the argument used is that KS increases knowledge, thus it can be included in the same category as the other articles.

The point of convergence amongst the arguments regarding the qualitative articles that consider AC an antecedent of KS is that the AC guarantees the prior knowledge base

necessary for KS to occur effectively. [Ai and Tan \(2017\)](#), [Ishihara and Zolkiewski \(2017\)](#) and [Chang and Smale \(2013\)](#) explicitly make this argument, treating prior knowledge as a proxy for the unit's AC. Similarly, the literature review by [Khamseh and Jolly \(2014\)](#) concludes that AC is dealt with through prior knowledge, with the difference that the relation is only between the RACAP (i.e. the transformation and exploitation dimensions). The same reasoning guides the arguments from [Daghfous et al. \(2013\)](#), [Fongwa and Marais \(2016\)](#), [Brookes \(2014\)](#) and [Wendling et al. \(2013\)](#). Nevertheless, they all agree the cultural factor is extremely important and can potentially impair KS. This cultural factor can be understood as a lack of prior knowledge about the differences and peculiarities of different regions, thus, negatively affecting the AC. The study by [Béliveau \(2013\)](#), focussing on the knowledge of middle managers and that of [Battistella et al. \(2016\)](#), which refers to the need to understand knowledge, adopt the same approach of considering AC as a prior base to KS. A dissonant study is provided in the literature review conducted by [DeNisi and Sonesh \(2016\)](#) that uses Szulanski's (1996) concept of stickiness to associate AC to the recipient's motivation and ability.

Concerning the quantitative articles that consider AC an antecedent of KS, the central argument is that it facilitates the process of KS. The arguments supporting such a relationship highlight the need for the entity to have understood and made the knowledge its own prior to engaging in the process of KS. This can be done in several ways:

- through good practises ([Awang et al., 2013](#); [Paulsen and Hjertø, 2014](#));
- by learning to develop the knowledge base ([Junni and Sarala, 2013](#); [Tho, 2017](#); [Zapata and Arroyo, 2017](#));
- by identifying knowledge opportunities and advantages ([Baker and Yousof, 2016](#); [Baker and Yousof, 2017](#); [Grimpe and Hussinger, 2013](#); [Junni and Sarala, 2013](#); [Nair et al., 2016](#)); and
- by acceptance and understanding ([Antwi-Afari et al., 2016](#); [Junni and Sarala, 2013](#)).

Therefore, the articles support the idea that RACAP influences the process of KS. However, as the RACAP is preceded by the PACAP ([Todorova and Durisin, 2007](#); [Zahra and George, 2002](#)), the argument covers the AC as a whole.

Finally, we analyzed the arguments in the articles that consider the AC to be both an antecedent and consequent of KS. According to [Song's \(2014\)](#) qualitative, AC and KS are dynamic concepts that self-feed in feedback loops. Similarly, the central argument in [Kang and Lee's \(2017\)](#) article is that AC and KS are interrelated concepts that involve two connections, namely, the PACAP influences KS, which, in turn, influences the RACAP.

[Kang and Lee's \(2017\)](#) rationale has the advantage of encompassing the AC as a whole. The authors argue the accumulation of knowledge causes the individual to learn to share it more effectively and that sharing leads to the accumulation of knowledge. The resulting access to more varied knowledge can lead to a greater transformation and exploitation of knowledge. Similarly, the article by [Martelo-Landroguez and Cegarra-Navarro \(2014\)](#) considers KS a mediator between PACAP and RACAP, explaining the relationship in terms of the role of intra-organizational KS, which is fed by PACAP and essential for RACAP. Thus, the argument in the quantitative articles that consider KS a mediator between PACAP and RACAP can be summarized as follows: the acquisition and assimilation of knowledge makes KS more effective and sharing promotes the refinement of existing knowledge structures, which facilitates the transformation and exploitation of knowledge.

[Table 1](#) shows a summary of the central argument of each group of articles regarding the relationship between AC and KS.

The KS → AC argument in quantitative studies refers to the increase in knowledge within the unit. In the qualitative articles, the argument for the relationship is based on the relevance of

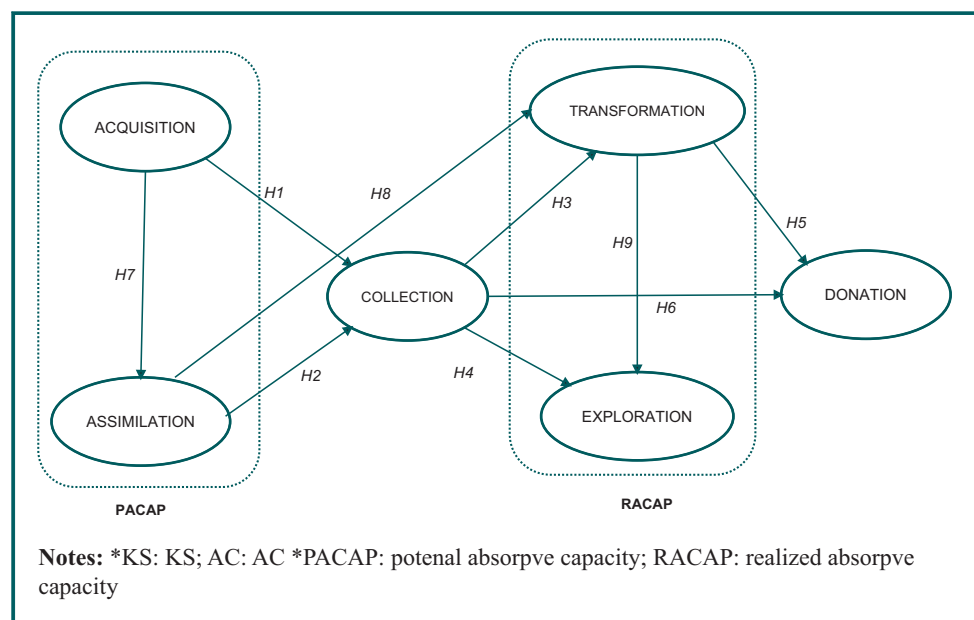
Table 1 Central arguments used to explain the relationship between KS and AC in each group

Relationship	Qualitative	Quantitative
KS → AC	KS support practises are necessary because they make shared knowledge relevant, and thus, boost the AC	KS increases the unit's knowledge, and therefore, influences the AC
AC → KS	AC guarantees the knowledge base necessary for effective KS to occur	AC facilitates KS, as it is necessary that the entity has previously understood and transformed the knowledge in its own to engage KS
AC ↔ KS	AC and KS are dynamic constructs that feed each other because shared knowledge is the basis for the AC, which, in turn, determines the degree of sharing of future knowledge	The acquisition and assimilation of knowledge makes KS more effective and sharing helps to refine the existing knowledge structures, which facilitates the transformation and exploitation of knowledge

shared knowledge. In both cases, the argument is centred on the availability of knowledge, which is relevant when it is available in larger amounts and suitably filtered through the KS support practises. The emerging knowledge will be integrated into the unit's knowledge base and will subsequently boost the AC.

The arguments used in AC → KS articles, both quantitative and qualitative, follow a similar rationale. Although the quantitative argument is based on several different drivers and practises, the expected result is thought to be facilitated by prior understanding and transformation. As in the qualitative articles, the argument in the quantitative articles considers the AC will guarantee the prior knowledge base necessary for KS.

The argument in the AC → KS articles forms a direct loop with that KS → AC articles. This sequence of events seems to show: AC guarantees the knowledge base necessary for sharing, which, in turn, increases the knowledge base required for the AC. This self-feeding cycle is basically the argument put forward in the AC ↔ KS articles, which can either close this loop through a literature review or try to circumvent it by separating AC into PACAP and RACAP, which makes it an antecedent and consequent of KS. Figure 1 shows the relationships between both concepts.

Figure 1 Relations between KS and absorptive capacity

The quantitative articles express the self-feeding loop between constructs by viewing KS as a mediator of the PACAP and RACAP. However, when analyzing the arguments for the groups $AC \rightarrow KS$, $KS \rightarrow AC$ and $AC \leftrightarrow KS$ along with KS perceived in terms of donation and collection, an alternative interpretation of the interaction of the constructs in the formation of the loop arises.

The $AC \rightarrow KS$ arguments state that AC facilitates the identification of knowledge and makes sharing more effective (Ai and Tan, 2017; Ishihara and Zolkiewski, 2017; Chang and Smale, 2013). As PACAP consists of the knowledge acquisition and assimilation capacities and knowledge collection is the act of consulting the intellectual capital of other units (Hooff and Ridder, 2004), this knowledge collection is facilitated by the identification, analysis and interpretation processes that occur within PACAP. Therefore, from such literature we suggest the following hypotheses:

- H1.* The capacity to acquire knowledge positively influences the collection of knowledge.
- H2.* The capacity to assimilate knowledge positively influences the collection of knowledge.

The $KS \rightarrow AC$ arguments show that sharing increases the quantity and the relevance of the knowledge held by a unit, which increases the AC (Curado *et al.*, 2017; Daghfous and Ahmad, 2015; Nodari *et al.*, 2016; Oliveira *et al.*, 2015; Peltokorpi, 2017; Supartha and Ratih, 2017), in addition to refining the existing knowledge structures, which is essential for the RACAP. The knowledge accumulated through the collection and the increase in the available knowledge allows more knowledge to be transformed and exploited for the business that is it enhances the capacities to transform and exploit, which form the RACAP. Thus, based on this rationale we propose the following hypotheses:

- H3.* Knowledge collection positively influences the knowledge transformation capacity.
- H4.* Knowledge collection positively influences the knowledge exploitation capacity.

Finally, we return to the $AC \rightarrow KS$ argument, according to which knowledge must be understood and transformed prior to being shared (Antwi-Afari *et al.*, 2016; Awang *et al.*, 2013; Berry, 2017; Junni and Sarala, 2013). In addition, the accumulation of prior knowledge and experience provided by the AC allows the individual to learn to share it more effectively (Ai and Tan, 2017; Chang and Smale, 2013; Ishihara and Zolkiewski, 2017; Kang and Lee, 2017). Khamseh and Jolly (2014) suggest prior knowledge is specifically concentrated in the RACAP, rather than in the AC as a whole. The capacity to transform knowledge, by allowing the development of new routines for the combination of existing knowledge and acquired knowledge (ZAHRA, GEORGE, 2002), enables the creation of new knowledge, properly understood beforehand by the unit. This ensures the prior knowledge base that is necessary for knowledge donation. The exploitation capacity because it is a capacity to use knowledge, would not bring about any expansion of the knowledge base and therefore, would not influence knowledge donation. So, following this line of reasoning we propose the following hypothesis:

- H5.* The capacity to transform knowledge positively influences knowledge donation.

In addition to the interactions between AC and KS the literature suggests the components of sharing influence each other: the more knowledge is collected, the more it will be donated (Hooff and Ridder, 2004). Consequently, the following hypothesis was formulated:

- H6.* Knowledge collection positively influences knowledge donation.

There are also relationships within AC components. Zahra and George (2002) suggest the PACAP influences the RACAP. As PACAP and RACAP are second-order constructs (Costa and Monteiro, 2016; Martelo-Landroguez and Cegarra-Navarro, 2014), the variables that compose them are also related to each other. Following the logical order of the variables that comprise RACAP and PACAP resulting in AC, the following hypotheses are proposed:

- H7. The capacity to acquire knowledge positively influences the knowledge assimilation capacity.
- H8. The knowledge assimilation capacity positively influences the knowledge transformation capacity.
- H9. The knowledge transformation capacity positively influences the knowledge exploitation capacity.

Figure 2 shows the proposed research model.

Next, the method adopted in this investigation will be described.

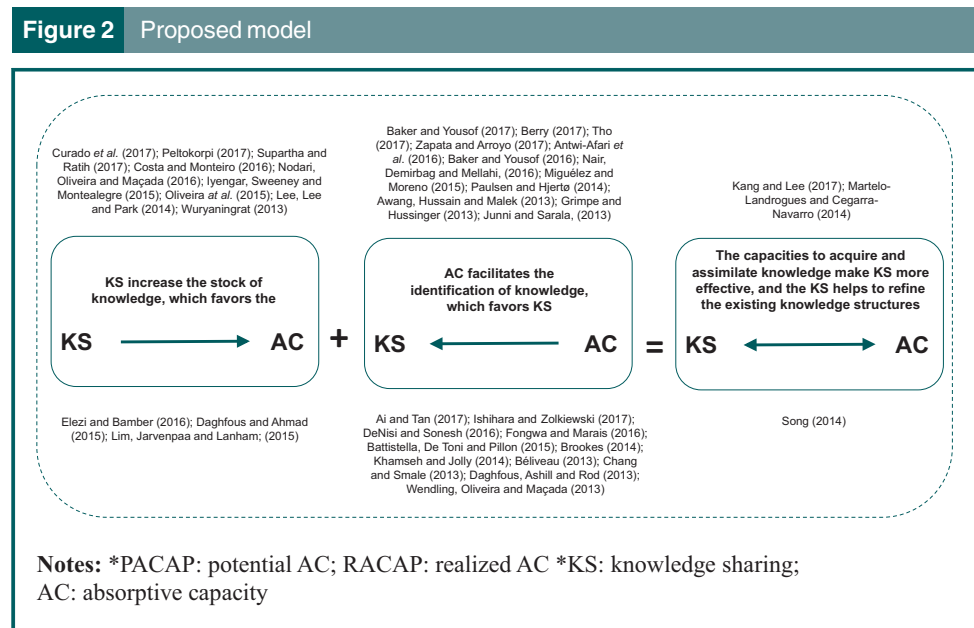
3. Method

To accomplish the proposed objective, the study was carried out in two phases, namely, in the first, described in Section 3.1, a systematic literature review was carried out with the purpose of constructing a research model relating KS to AC; in the second, presented in Section 3.2, a survey was conducted to test the model.

3.1 Systematic review of the literature

The systematic review of the literature was based on the principles described by Wolfswinkel *et al.* (2013). Searches were carried out in the Web of Science and Scopus databases in November 2019. The terms searched for in the abstracts, keywords and titles of the articles were combinations of “KS”, “knowledge transfer”, “knowledge dissemination”, “knowledge flow”, “knowledge collection”, “knowledge donation” and “AC” in scholarly, peer-reviewed articles written in English and published between 2013 and 2019.

Altogether, 506 articles were initially identified. However, most of the retrieved articles did not directly address the subject and were eliminated. Most of the articles (468) were eliminated because they did not deal with KS or with AC and did not relate the concepts in any way to the model, propositions or conclusions. Thus, 38 articles were deemed fit for analysis. Once selected, the articles were analyzed according to the principles of



Grounded Theory adapted for literature reviews, as recommended by [Wolfswinkel et al. \(2013\)](#) in conjunction with the of content analysis technique described by [Bardin \(2009\)](#).

The articles were separated into three groups, namely, those in which AC is seen as an antecedent of KS – with 12 quantitative articles and 11 qualitative articles; those in which KS is seen as an antecedent of AC – with nine quantitative articles and three qualitative articles; and finally those that consider AC and KS to be related concepts and, therefore, present AC as an antecedent and a consequent of KS – with two quantitative articles and only one qualitative article.

Based on the analysis of the articles, a number hypotheses were proposed and a model was generated. Below, the procedures involved in the second phase of the research are detailed.

3.2 Quantitative phase

To accomplish the proposed objective, a survey was conducted to test the relationships between the constructs of AC and KS proposed in the [Figure 2](#). The respondents were members of software development teams from companies in Brazil and Portugal. The sample was chosen because:

- software development is a knowledge-intensive activity ([Karagoz et al., 2016](#)) and
- Brazil and Portugal are countries with similar cultural characteristics ([Hofstede et al., 2010](#)) that have experienced undergone rapid technological expansion in recent years ([Dutta, Lanvin and Wunsch-Vincent, 2018](#)).

The questionnaires included sociodemographic questions and scales with questions about the constructs, adapted from the literature – the scale used to measure the AC was from [Lowik et al. \(2016\)](#), while that used to measure KS was from [Vries et al. \(2006\)](#). A seven-point Likert-scale was used to measure the items. Questionnaires were applied in Brazilian and European Portuguese. The scale items (reverse translated to English) are provided at [Appendix 2](#).

To refine the instrument, the scales underwent reverse translation, with the help of bilingual translators and academics, followed by content and face validation with the help of academics and software development professionals. In addition, where deemed appropriate, the vocabulary was adapted to include terms specific to the Portuguese language of Brazil and Portugal, with the help of native scholars from both countries. The questionnaire was administered with the support of the Qualtrics® tool. The survey sample made up of software development teams in information technology companies and the respondents are the members of those software development teams in Brazil and Portugal, who were accessed through databases with company emails, using non-probabilistic sampling by judgement.

The collection period was determined by the number of responses reached. [Hair et al. \(1998\)](#) recommends a sample should have at least five respondents for each item in the questionnaire. In total, 514 questionnaires were answered, which means the sample has 23.3 respondents per item. Following collection, the data were subject to cleaning procedures and analysis using SPSS software (statistical package for social sciences) and SmartPLS (smart partial least squares) version 3. After eliminating incomplete questionnaires and those in which the same alternative was chosen in more than 80% of the items, there remained 479 questionnaires in total.

To begin, the distribution of normality and linearity were analyzed using the Kolmogorov-Smirnov tests and asymmetry and kurtosis scores, as suggested by [Hair et al. \(1998\)](#). Reliability was checked using Cronbach's Alpha and the scales verified by calculating the corrected item-total correlation, as recommended by [Hair et al. \(2003\)](#). After which,

exploratory factor analysis (EFA) was performed following the procedures described to [Hair et al. \(1998\)](#) and [Koufteros \(1999\)](#). Then, for the structural equation modelling (SEM), the PLS method was used because the data do not follow a normal distribution and the PLS does not require any specific distribution, as it is a non-parametrized method ([Hair et al., 1998](#)). PLS is especially suitable for large and complex models with latent variables ([Ghasemy et al., 2020](#); [Richter et al., 2016](#)). Also, “PLS-SEM is particularly appealing when the research objective focusses on prediction and explaining the variance of key target constructs by different explanatory constructs” ([Hair et al., 2012](#), p. 321) and, as the analysis focusses on confirmatory modelling, the PLS approach is considered appropriate ([Richter et al., 2016](#)). [Ghasemy et al. \(2020\)](#) also considers PLS adequate for studies where structural model is complex, including many constructs, indicators and relationships.

4. Findings from testing the research model

The distribution pattern of the sample ([Hair et al., 1998](#)) influences the procedures adopted in the measurement tests. Thus, to detect the normality of the sample the asymmetry, kurtosis and the Kolmogorov–Smirnov value of the variables were checked. As the data presented non-normal distribution in all the tests, adjustment using PLS-SEM was recommended ([Hair et al., 2016](#)).

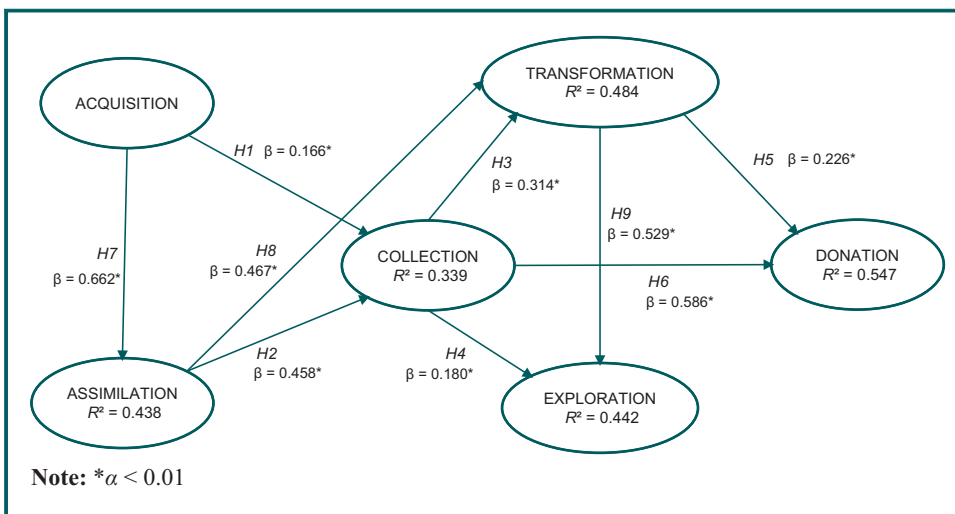
Reliability was tested using Cronbach's Alpha and all the constructs presented values above 0.6, as recommended by [Hair et al. \(1998\)](#). EFA was performed with principal component analysis (PCA), applying the varimax orthogonal rotation method, as described by [Hair et al. \(1998\)](#). When performing the analysis without restricting the number of factors, two components were identified in the rotated matrix: one with all the KS items and another with all the AC items. Although finding two factors might seem natural because of the fact two constructs are under study, multiple scales are used to measure each construct. Accordingly, KS is split into knowledge donation and collection and AC is split into acquisition, assimilation, absorption and exploitation. Moreover, the constructs that constitute KS and AC share common meanings, for which reason the result of two factors in the PCA is not surprising. Nonetheless the scales adopted are multiple (two factors for KS and four factors for AC) and for that reason, to continue the analysis, the number of factors were set at 6. The score of the Kaiser–Meyer–Olkin test was 0.940 and the Bartlett sphericity test had a significance of 0.000, both suitable values. One item in the construct transformation was deleted because it was the only item grouped into a factor other than its own. The exploratory factorial analysis was recalculated and all the items were correctly grouped into their respective factors.

To analyse the convergent validity, the average variance extracted (AVE) analysis and composite reliability (CR) were used, both of which had adequate scores according to [Hair et al. \(1998\)](#). The discriminant validity was examined according to the [Fornell and Larcker \(1981\)](#) criteria, which evaluates whether the square root of the AVEs is larger than the correlations between the constructs and is suitable for all the constructs. The scores for the variance inflation factors of the items are less than 5.00, which indicates a lack of collinearity, according to [Hair et al. \(1998\)](#). [Table 2](#) shows the Cronbach's alpha, AVE, CR and of Fornell and Larcker (1981) criteria scores.

The significance of the relationships was evaluated using the student's *t*-test, combined with the bootstrapping algorithm, using 1,000 subsamples. [Figure 3](#) shows the structural model and the results from testing the hypotheses. All the relationships are highly significant ($\alpha < 0.01$). However, the values of the relationships vary. For example, the strongest association in the model is that between Acquisition and Assimilation ($H7: \beta = 0.662$), revealing a solid association of variables within PACAP. On the other hand, the most fragile relationship is the one between Acquisition and Collection ($H1: \beta = 0.166$).

Table 2 Reliability, convergent validity and discriminant validity of the constructs

Construct	Acquisition	Assimilation	Collection	Donation	Exploration	Transformation
Collection	0.861					
Donation	0.662	0.902				
Acquisition	0.470	0.568	0.851			
Assimilation	0.440	0.551	0.717	0.872		
Transformation	0.730	0.669	0.486	0.434	0.904	
Exploration	0.602	0.646	0.580	0.565	0.633	0.847
# items	4	3	4	4	3	3
AVE	0.741	0.813	0.724	0.760	0.818	0.717
Cronbach's α	0.883	0.885	0.872	0.894	0.889	0.803
CR	0.919	0.929	0.913	0.927	0.931	0.883

Figure 3 Structural model and the results from the hypotheses tests

All the relations in the proposed model were supported. Table 3 summarizes the results of the hypotheses tests.

Based on the R^2 value, one can see that the model explains 33% of the variance in the collection, 54% of the variance in donation, 43% of the variance in assimilation, 48% of the variance in transformation and 44% of the variance in the exploitation of knowledge. All

Table 3 Hypothesis test results

Hypothesis	Path	Path coefficient	t value*	Status
H1	Acquisition \rightarrow collection	0.166	2.943	Supported
H2	Assimilation \rightarrow collection	0.458	8.486	Supported
H3	Collection \rightarrow transformation	0.314	6.855	Supported
H4	Collection \rightarrow exploration	0.180	3.640	Supported
H5	Transformation \rightarrow donation	0.226	5.343	Supported
H6	Collection \rightarrow donation	0.586	14.290	Supported
H7	Acquisition \rightarrow assimilation	0.662	22.476	Supported
H8	Assimilation \rightarrow transformation	0.467	10.611	Supported
H9	Transformation \rightarrow exploration	0.529	13.053	Supported

Note: *t values over 1.96 signify $p < 0.05$

the constructs have values of $Q^2 > 0$, which indicates the model's predictive relevance. The f^2 value, which determines the relative predictive accuracy, is small ($f^2 > 0.02$) for $H1$, $H3$ and $H4$, medium ($f^2 > 0.15$) for $H2$, $H6$ and $H8$ and large ($f^2 > 0.35$) for $H5$, $H7$ and $H9$.

All the hypotheses were supported. The results are interesting because they are both consistent with some previous studies (Martelo-Landroquez and Cegarra-Navarro, 2014) and challenge some earlier (Dyer and Singh, 1998; Saraf *et al.*, 2013). Overall, our findings can be said to support the reconceptualization of AC (Zahra and George, 2002) and the conceptualization of the knowledge collection and donation as dimensions of KS (Hooff and Ridder, 2004).

5. Conclusions

This article offers a clear understanding of the relationship between KS and AC by undertaking a systematic and integrative literature review and grounding and testing the resulting proposed model. The arguments used to consider $AC \rightarrow KS$ form a feedback loop with the arguments for $KS \rightarrow AC$ and both suggest complementarity. This loop, in turn, is used to explain the relation established in the $AC \leftrightarrow KS$ articles, assuming interdependency. AC is a construct with several dimensions, thus we consider PACAP as an antecedent of KS and RACAP as its consequent. This dynamic is found to be the most appropriate way of approaching the relationship between the two concepts, based on the results of the systematic literature review.

AC and KS are complex constructs, accordingly the relationship between them can only be fully understood when the interaction between their respective dimensions are considered. KS is formed from two constructs, namely, the related processes of knowledge collection and knowledge donation. AC consists of four variables, namely, acquisition, assimilation, transformation and exploitation, which are also related. They compose two second-order constructs, namely, PACAP and RACAP. In addition, it is necessary to consider, which variables of AC are related to which KS processes. Addressing the relationship between AC and KS allows us to determine the influence one has over the other.

The proposed research model and the results from testing it shed light on the nature of the relationship between KS and AC. The present study shows that although AC and KS have previously been studied together empirically, our research model provides a better understanding of their relationship. This study confirms the argument put forward by Zahra and George (2002) that the AC four variables can be grouped into the two components, namely, PACAP and RACAP.

5.1 Theoretical implications

The paper proposes an understanding of the relationship between KS and AC. The results seem to point to the existence of a real contribution of KS to AC and, consequently, the literature regarding the KS antecedents can be considered to impact the RACAP. Therefore, the results of this research further enrich the reconceptualization of AC (Zahra and George, 2002) and the KS approach in the collection and donation dimensions (Hooff and Ridder, 2004).

While some studies claim that AC is positively influenced by KS (Curado *et al.*, 2017; Peltokorpi, 2017; Supartha and Ratih, 2017), others find that AC influences the KS (Ai and Tan, 2017; Baker and Yousof, 2017; Berry, 2017). Our findings go some way to resolve previously unaddressed contradictions. We explored the relationship between KS and AC and provide evidence to show, which construct influences the other. This is particularly useful as it provides a consistent theoretical grounding for future empirical research.

Considering the quantitative research, our results clearly establish, which variables are dependent and which are independent, and thus, help researchers to define their

hypotheses (Hair *et al.*, 1998; Hair *et al.*, 2003). We believe our results clarify pre-existent ambiguity, making it clear, which variable is dependent in the relationship, allowing certain traditional quantitative statistical methods to be applied and supporting data interpretation (Hair *et al.*, 1998; Hair *et al.*, 2016).

Considering the qualitative research, our findings suggest there is a need to explore the content analysis of data when guiding the coding process (Bryman and Bell, 2003, p. 586) or applying qualitative comparative analysis to generate alternative configurations of causal conditions leading to the outcome of interest (Fiss, 2007). We believe our results offer a relevant theoretical contribution not found in previous studies.

Additionally, we provide evidence to show knowledge donation is an output of the AC process. This finding should invite debate on the nature of knowledge donation (requested vs unrequested). The issue of knowledge protection also begs an interesting question for future research: Given that AC involves organizational resources, what mechanism can prevent unrequested knowledge donation from occurring? The theoretical developments that follow this study should clarify the intentionality of the process, specifically when it comes to knowledge donation.

5.2 Managerial implications

From a managerial point of view, our results contribute to spotlight the central role of knowledge collection in AC. Team-level managers can use the proposed research model as a guide to increase AC and KS by following a sequential approach to PACAP, knowledge collection, RACAP and, finally, knowledge donation. Strategic-planning level managers can use the results to elaborate global actions to encourage and facilitate inter-team KS; create an environment for the development of team PACAP, so that it triggers KS and RACAP. Using PACAP generates benefits not only for the team but also influences inter-team sharing, spreading knowledge to other parts of the company.

Consequently, benefits should become apparent at the firm level, leading to the adoption of processes and technological solutions that support knowledge collection. Apart from the investment options such decisions imply, the workforce needs to be motivated and engaged to adopt knowledge collecting behaviours. Therefore, the challenges for managers involve the use of technological and non-technological mechanisms. The extent to which managers will dedicate themselves to explore the dynamics we present with the model presented here can be enlarged by considering organizational contingencies such as:

- The organizational culture (the artefacts, the beliefs and the values and the premises reflected in shared behaviour and shared attitudes).
- The organizational leadership (the actions, the words, the ethics and the examples that leaders set).
- The organizational interest in organizational learning (the priority given to and the efforts made in support of organizational learning).
- The organizational knowledge processes (the use of information and KS mechanisms, tacit and explicit knowledge exchange and organizational communication).
- The organizational structure (the hierarchy, the communication, the workflows, the geographical location and the workspace distribution).
- The organizational technological infrastructure (the hardware and software components used in the communication and in the collaboration between organizational members).

- The existence of a chief knowledge officer (an element in the firm that would coordinate organizational learning).

5.3 Limitations and future research

Limitations may apply because of the small number of articles analysed (38 articles), the databases used and the terms searched for in the abstracts, keywords and titles of the articles. A greater number of articles might lead to differences in the content analyses, but there is no such guarantee, as theoretical saturation may occur with the addressed sample and only trivial improvements might result from expanding the number of articles in the study. Nevertheless, in an attempt to ensure the rigour of the research, we followed a validated described method (Wolfswinkel *et al.*, 2013). The fact the empirical data were collected in the context of software development in two countries might be thought to present a limitation. Future studies might test the proposed research model in different contexts and countries. Considering the intra and inter-organizational nature of KS, future developments of Zahra and George's (2002) AC model should consider context dimensions, namely, the influence of participation in KS networks and partnerships and, consequently, in the RACAP. On the other hand, the contribution of the formal and informal KS mechanisms in AC should be investigated and the effect of obstacles to KS in the implementation of the AC. Finally, in the future a longitudinal investigation about the contribution of KS towards the integration of the two dimensions of AC should be conducted because the dimensions of AC occur at different moments.

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Appendix 1

Table A1 Articles analysed in this research		
<i>Group</i>	<i>Qualitative articles</i>	<i>Quantitative articles</i>
AC as antecedent of KS	Ai and Tan (2017), Ishihara and Zolkiewski (2017); DeNisi and Sonesh (2016), Fongwa and Marais (2016); Battistella, De Toni and Pillon (2016); Brookes (2014), Khamseh and Jolly (2014); Béliveau (2013); Chang and Smale (2013), Daghfous <i>et al.</i> (2013); Wendling <i>et al.</i> (2013)	Baker and Yousof (2017), Berry (2017); Tho (2017), Zapata and Arroyo (2017); Antwi-Afari <i>et al.</i> (2016), Baker and Yousof (2016); Nair <i>et al.</i> (2016); Miguélez and Moreno (2015); Paulsen and Hjertø (2014); Awang <i>et al.</i> (2013), Grimpe and Hussinger (2013); Junni and Sarala (2013)
KS as antecedent of AC	Elezi and Bamber (2016), Daghfous and Ahmad (2015); Lim <i>et al.</i> (2015);	Curado <i>et al.</i> (2017), Peltokorpi (2017); Supartha and Ratih (2017), Costa and Monteiro (2016); Nodari <i>et al.</i> (2016), Iyengar <i>et al.</i> (2015); Oliveira <i>et al.</i> (2015), Lee <i>et al.</i> (2014); Wuryaningrat (2013)
AC as antecedent and consequent of KS	Song (2014)	Kang and Lee (2017), Martelo-Landroguez and Cegarra-Navarro (2014)

Appendix 2

Table A2 Scale items			
<i>Construct</i>	<i>Variables</i>	<i>Items</i>	<i>Source</i>
KS	<i>Donation</i>	My team members communicate to members of other teams when they learn something new	<i>Vries et al. (2006)</i>
		My team members share information they have with members of other teams	
		My team members think it is important for members of other teams to know what they are doing	
		My team members regularly communicate to members of other teams what they are doing	
	<i>Collection</i>	My team members ask members of other teams about knowledge they need	<i>Vries et al. (2006)</i>
		My team members like to be informed about what members of other teams know	
		My team members ask members of other teams about their abilities when they need to learn something	
Absorptive capacity	<i>Acquisition</i>	When a member of another team is good at something relevant to the work of my team, my team members ask if he can teach them	<i>Lowik et al. (2016)</i>
		My team members are always actively seeking new knowledge for our work	
		My team members intentionally seek out knowledge in many different domains, to look “out of the box”	
		My team members are good at distinguishing between valuable and not-so-valuable opportunities and information	
	<i>Assimilation</i>	My team members easily identify, which new knowledge is most valuable to us	<i>Lowik et al. (2016)</i>
		My team members frequently share their new knowledge with colleagues to establish a common understanding	
		My team members explain new knowledge in such a way that my colleagues understand what they mean	
	<i>Transformation</i>	The members of my team communicate newly acquired knowledge that may be of interest to our team	<i>Lowik et al. (2016)</i>
		My team members usually sit together with colleagues to have good ideas	
		My team members attend meetings with people from different teams to come up with new ideas	
		My team members develop new insights from the knowledge that is available within our company	
	<i>Exploitation</i>	My team members transform existing knowledge into new ideas	<i>Lowik et al. (2016)</i>
		My team members often apply newly acquired knowledge to our work	
My team members exploit new knowledge to create new products, services or work methods			
		My team members are constantly thinking about how they can apply new knowledge to improve our work	

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