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Quality Management and collective mind: investigating university R&D from a group focus

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Abstract

This article analyzes how Quality Management (QM) practices moderate the relationship between collective mind (CM), and knowledge transfer (KT) and absorption in university research and development (R&D) groups. The data are taken from 257 R&D groups in different Spanish universities. The findings show that the relationship between CM and KT is significant when QM is included as moderating variable because QM permits better communication and fosters stronger ties between group members. In the case of knowledge absorption (KA), however, QM does not have a significant effect. The final section presents the study's conclusions and implications. As no studies have tested these effects empirically, our conclusions are highly relevant for academics and researchers.

Keywords: QM; Collective mind; Knowledge; R&D groups

1. Introduction

The theory of collective mind (CM) was proposed by Weick and Roberts (1993), who define it as a pattern of interrelations that are attentive to the actions in a social system. CM is a structure that is created within a group and that coordinates that group's activities (Ackerman et al., 2007). As a variable related to mental processes (Weick and Roberts, 1993), it appears in a group only when each member is responsible for a specific field and enables his or her field to interact with the fields of others and to develop by mixing with them.

Since CM is a construct that has received little study, gaps in knowledge of it exist in the scholarly literature. For example, the relationship between CM and knowledge-related variables requires more attention (Lin et al., 2014), and researchers recognize the need for research on antecedents that encourage the creation of dynamic capabilities related to knowledge. Our study contributes information to advance knowledge of these issues.

To achieve this goal, we focus on knowledge management, since knowledge is a continuous process of learning that permits the overcoming of individual limits (Nonaka et al., 2006; Lin et al., 2014). Knowledge originates and resides in people, is permanent and incremental, and serves as a guide to decide what to do at each moment and thus to improve the results of each individual's acts (Andreu and Sieber, 2000). Within knowledge management, we decided to study the variables of knowledge absorption and transfer because they play a key role in work groups' success (Rentsch et al., 2014) First, we relate CM to knowledge transfer (KT), defined as the process through which a unit, group, department, or division is affected by the experience of others (Argote and Ingram, 2000). Second, CM is related to knowledge absorption (KA), understood as a set of organizational routines and strategic processes through which knowledge is acquired, assimilated, transformed, and applied with the goal of creating an organizational dynamic capability (Zahra and George, 2002). Our study attempts to observe whether CM is an antecedent of such capabilities.

Research is currently being conducted on KT and KA, not only in the field of Business Administration but also in Psychology. This research permits analysis from a multidisciplinary perspective, enabling a theoretical foundation that situates knowledge transfer and absorption as key aspects in achieving competitive advantage (Babcock, 2004; Fritsch and Kauffeld-Monz, 2010; Lin et al., 2014). Our study adds to this line of research.

We include QM practices in our research because we believe that the relationships proposed can be strengthened by introducing QM practices as a moderating variable that facilitates the relationships between CM and knowledge absorption and transfer. We chose to investigate this moderating effect as a facilitator of the relationships due to many recent studies of the positive, significant impact of QM on organizational performance (Silá and Ebrahimpour, 2005; Jiménez and Martínez, 2009). Prior research supports the value of observing the behavior of the relationships discussed above in a QM work environment.

Our analysis focuses specifically on university R&D groups. We chose this sector primarily for two reasons. First, very few studies link QM to R&D; second, no studies link QM specifically to university R&D. The connection between the constructs R&D and QM is a young topic of research, and the most important studies have been developed by academics and researchers, such as Kumar and Boyle (2001) and Prajogo and Hong (2008). Further, QM is a construct that emerges in the business sector but that is currently spreading to non-business organizations.

University R&D groups are a particularly useful unit of analysis for testing the hypotheses proposed. First, they correspond precisely to theories related to knowledge management and QM. Second, a major function of university R&D is to contribute scholarly knowledge to the socioeconomic development of regions and countries (Landeta et al., 2004; Minguillo and Thelwall, 2015), and this knowledge is crucial to fostering the university's relationship with its environment (Landeta et al., 2004). Academic research is thus a very attractive base for organizations that use knowledge (Minguillo and Thelwall, 2015).

Further, the empirical studies performed show that using universities' academic knowledge is highly beneficial. The university generates new theoretical and technical perspectives and abilities that are difficult for other organizations to develop (Zucker and Darby, 2005). Since the university is the environment closest to new scientific advances (Hak Eun et al., 2006; Pries and Guild, 2007), society needs universities' knowledge and research. Indeed, many organizations have ceased internal R&D to focus more on joint research with networks of university researchers, as such research enables them to access more current knowledge (Lam, 2007). These studies confirm the importance of R&D, particularly in the university context.

The general goal of our research is to explain whether CM is an antecedent of knowledge transfer and absorption in the presence of QM practices. More specifically, we will determine whether QM practices, as a second-order variable measured through six practices, moderate the relationships between CM and knowledge absorption and transfer in R&D groups. The literature contains no prior studies of the relationships proposed.

The article is structured as follows: The literature review follows this introduction. We then describe the methodology and present the data analysis. Subsequently, we discuss the results and explain the main conclusions, limitations, and future lines of research.

2. Literature review and development of the hypotheses

Collective mind

Collective mind (CM) is defined as the cohesion created by the interrelation between members of a group (Huang, 2009). It is a social process that produces a set of personal interactions coordinated by the group's members. CM consists of three components: contribution, representation, and subordination. Contribution indicates what each member gives to the group and is assumed by others. Representation is

the understanding all members of the group composing the system possess of all actions contributed. Subordination is the interrelation of all of these actions (Lin et al., 2014).

Taking the foregoing into account, CM explains in depth how these interrelations function and thus helps the group's members to understand each other's knowledge (Faraj and Sproull, 2000; Yoo and Kanawattanachai, 2001). CM is only present in cohesive groups (Weick and Roberts, 1993; Dougherty and Takacs, 2004). It provides a advanced way of analyzing processes related to the mind and knowledge (Yoo and Kanawattanachai, 2001; Lin et al., 2014). More studies are needed to provide information on the processes that link CM to knowledge (Lin et al., 2014).

Collective mind as antecedent of knowledge transfer and absorption

The literature treats dynamic capabilities as a source of competitive advantage and indicates that organizations should possess certain attributes and characteristics to create and develop these capabilities. There are few studies, however, of the elements that foster creation of dynamic capabilities. Since the few existing studies of antecedents focus on very specific cases, the research on this topic is not only insufficient but scattered. For example, some antecedents of KT have been studied, the most widely recognized being trust (Chiu, et al., 2006; Renzl, 2008; Huang, 2009; McNeish and Singh Mann, 2010). One also finds studies of technological capability (Renzl, 2008), communication (Wang and Liu, 2007), transactive memory system (Akgun, 2006; Huang, 2009), and networks (Baggio and Cooper, 2010). As to KA, we find studies of previous knowledge and organizational mechanisms (Cohen and Levinthal, 1990), sources of external knowledge (Zahra and George, 2002), and training of employees (Mahnke et al., 2005; Liao et al., 2014). CM has not been studied as an antecedent, despite the fact that it could be a good antecedent due to its characteristics as a cognitive variable. We thus respond to the call in the literature for the need and relevance of studying these and other possible antecedents, and of validating them empirically, given the absence of research in this line (Joglar, et al., 2007; Liao et al., 2014).

Our study will focus on the antecedent CM, since the connection between CM and the constructs of KT and KA has not been sufficiently studied (Lin et al., 2014). As there is very little theoretical support for this connection, our results will contribute information to a theoretical framework supporting the concept. Although these variables have been analyzed independently in the literature, certain considerations lead us to believe there may be connections between them.

In recent years, there has been marked interest in the field of collective properties, particularly in the construct CM. We know that CM is a construct with powerful implications for group research, and of course for organizations in general.

CM is defined as the cohesion created by the interrelation between the members of a group. It develops as the members coordinate, share, distribute, and recombine individual knowledge (Brown and Duguid, 2001). This process enables continuous improvement, better connection between tasks, and development of encrusted knowledge among the members, facilitating the growth of internal attributes of the group and creating an atmosphere of trust and mutual knowledge. Because such circumstances develop in a previously created environment sustained by a culture or organizational attribute that encourages these variables, we believe that CM facilitates KT and KA. As Zhao and Anand (2009) suggest, certain structural and cultural attributes of an organization promote the acquisition and assimilation of new knowledge. In this case, the structural and cultural attribute would be the presence of CM.

According to Weick and Roberts (1993), all groups initially generate CM through interrelations among their members, but CM can be lost when interrelations begin to become routines. We believe that CM can be revived precisely through knowledge transfer and absorption, if these knowledge capabilities develop in a dynamic and continuous way so as not to disrupt the group's interrelations.

Such development involves a process of constant feedback, in which CM encourages transfer and absorption, which in turn strengthens CM. Knowledge transfer and absorption can aid in this process because such exchanges occur much more easily in a group whose members have interacted previously, enabling CM to continue to develop. Such dynamic exchange would not promote development of routines, since knowledge exchange would constantly enrich and alter behavior patterns as the group develops further due to the strong mutual influence, even dependence, established. Given the foregoing, the stronger the CM, the easier it will be for the members to transfer and absorb knowledge within the group.

This analysis shows great need for empirical research to support these relationships. Because these dynamic capabilities are easy to access in work groups, our research will test the hypotheses in university R&D groups. Knowledge exchange within teams is crucial to their functioning (Staples and Webster, 2008) and is recognized as one of the most fundamental characteristics enabling a research team to create and maintain competitive advantage (Liao, 2008). We thus formulate the following hypothesis:

H1a: CM is positively related to KT in R&D groups.

H1b: CM is positively related to KA in R&D groups.

Connection between QM practices when they moderate the relationship between CM and KT in university R&D groups

Prior studies that relate quality to R&D have been oriented fundamentally to the pharmaceutical and manufacturing sectors (Price, 1995; Kiella and Golhar 1997; Kumar and Boyle, 2001; Prajogo and Sohal, 2006; Prajogo and Hong, 2008). Studies of quality that analyze the world of the university, in contrast, revolve around training of professionals (Cantón, 1996; Buendía and García, 2000; Cong, 2008). Our study is important because we tackle the characteristic of quality in R&D as a variable that moderates and strengthens the relationships studied, a topic not previously analyzed. Further, in analyzing QM in university research, we cover all sectors of knowledge.

The effects of QM practices on research environments have received very little study (Prajogo and Hong, 2008). Our analysis uses the QM practices of leadership, strategic planning, customer focus, information and analysis, human resource management, and teamwork (see Appendix A for description).

The implementation and development of QM practices in Spanish universities is currently driven by the government, the Ministry of Education, and the universities themselves. This process has an external focus because policies in the environment demand the development of QM instruments and procedures in nearly all areas, including university R&D. Universities have quality policies, quality certification programs, accreditation, and a Strategic Plan for Research with a system to evaluate the quality of research generated by demand in the environment. The goal is to achieve quality parameters that permit Spain to integrate competitively into the European Higher Education Area.

The connection between CM and KT has been described above. Given the many attributes granted to the different QM practices, our aim in this section is to describe the facilitating effects of these practices on the relationship studied. We believe the impact should be favorable. For the last three decades of the 20th century, QM's emphasis on excellence produced a renaissance in the way organizations were managed (Camisón and Pérez, 2010). It is thus worth studying the use of these practices in connection with other elements. For example, leadership can strengthen the relationship because its fundamental responsibility is to ensure that all issues related to group management, functioning, and performance (Tarawneh and Ahmad, 2010) are developed properly.

The practice of customer focus is one of the most beneficial elements for helping groups to focus on their objectives. Customer focus is also a key to improving the relationship between CM and KT. Group focus on the customer requires, first, that the group identifies its customers, both external and internal, and, second, that it practices KT or attempts to develop it. Since customers' expectations are dynamic (Ahire et al., 1996), CM must be dynamic when linked to QM practices so that KT can also become dynamic. The practice of information and analysis is fundamental to the development of other QM practices. This practice contributes the data for decision making on any level of the organization, facilitating the relationship between CM and KT. Because these data are responsible for putting the organization's objectives and goals into practice, human resources can affect success or failure in multiple ways (Tarawneh and Ahmad, 2010).

The practice of teamwork plays an undeniable role in facilitating the relationship between CM and KT, since it involves all members of the group in the different processes. Teamwork is a good stimulant of this relationship due to the daily interrelations and affective and knowledge-related bonds team interaction can create.

Each QM practice described supports the conclusion that CM is a good antecedent of KT. Our analysis indicates that developing CM and KT in a quality environment sustained by the practices discussed will strengthen the relationship between the variables, as this relationship will benefit from dynamic, united groups. QM helps to enable such benefits (see Figure 1). The foregoing leads to formulation of the following hypothesis:

H2: QM practices positively moderate the relationship between CM and KT in R&D groups.

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Connection of QM practices when they moderate the relationship of CM and KA in university R&D groups

As explained above, KA has received less study than KT. How CM relates to KA has thus also received little study. We propose that the QM practices in this study positively moderate the relationship between the variables.

Husted and Michailova (2002) argue that people tend to resist using the knowledge they receive from others. It should be possible to facilitate KA, however, and the technique of quality can be used to foster and improve KA. Satyendra and Harsh (2011) suggest that applying QM in R&D can help university R&D organizations to grow and continue to be competitive in the current environment. Leadership is

crucial to the efficacy and effectiveness of work teams (O'Reilly et al., 2010; Gil et al., 2011), as it improves the relationship between CM and KA. Strategic planning is also used as a tool to improve group work, since it is responsible for formulating and implementing work goals. Leadership and strategic planning thus provide support by organizing and identifying the group's objectives and goals. Information and analysis permit accurate decision making in the presence of different perspectives that arise in the environment. Human resources management is important in R&D groups because human resources usually perform the mental processes and KA. Teamwork is undeniably important in strengthening the relationship between CM and KA; this QM practice alone tends to improve satisfaction levels of human resources (Boon et al., 2007) and encourage CM and KA in groups, as it recognizes not only individual but also coordinated group effort, which becomes even more important (Grover et al., 2006).

QM practices encourage generation of group ideas, facilitate creativity, and improve the efficacy and efficiency in exchange of intellectual information and abilities. They also promote creation of an environment in which knowledge flows with fewer restrictions, improving the relationship in a positive way. We therefore establish the following hypothesis (see Figure 1):

H3: QM practices positively moderate the relationship between CM and KA in R&D groups.

Insert Figure 1

3. Research design

Description of the sample

We chose to study university R&D groups for various reasons. First, they are units for organization and management of research activity and where—because they have stable in their objectives, infrastructure, and shared resources—a set of researchers comes together and is organized in teams with the full ability to develop the research activity. Second, R&D groups have begun to acquire a crucial role in universities as generators of knowledge through research (Bayona et al., 2002). Third, these groups are pillars that currently sustain the prestige and recognition of universities, making it important to improve their processes. Finally, fostering and supporting R&D groups is one of the priority goals of European universities. The universities' scholarly production is performed through these groups, which also bear responsibility for generating knowledge and innovation that can be transferred to companies to make them are successful and increase their competitiveness (Bayona et al., 2004; Montro et al., 2006;

Minguillo and Thelwall, 2015). For these reasons, we believe that university R&D groups are a particularly useful unit of analysis for testing the hypotheses proposed. These groups correspond perfectly to the theories analyzed, and their results aid in management of the groups. The relationships analyzed can be tested in other contexts, as long as work is done in groups, knowledge is an essential element, and the group has a context that promotes QM.

Spanish university R&D is composed of research groups housed in different university faculties, research centers, laboratories, etc. These groups' fundamental goal is to perform research and transfer knowledge to society. The groups are usually composed of university professors, research assistants, and, in some cases, professionals in related sectors. The groups are usually managed by university professors.

To obtain the sample, we first created a database of the study population, composed of 12,434 groups. To belong to the population, the group had to be located in a Spanish university and provide contact information on the web. A sample of 3000 groups was selected through simple random sampling. We used random sampling so that each sample would have the same probability of being chosen. Making chance the only factor that endangers representativeness (Onyeka et al., 2013) ensured that each group was highly representative of the population. This method also eliminated systematic bias (Moore and McCabe, 2006). The sample was composed of Spanish university R&D groups from all areas of knowledge, regardless of size, region, age of group, or discipline. Choosing a sample of firms located in a relatively homogeneous geographic, cultural, legal, and political area minimizes the impact of variables that cannot be controlled in the empirical research (Alder, 1983). We contacted each group's research director and obtained 257 questionnaires, giving a response rate of 8.57% and a sampling error (taking an infinite population) of 6.1% with a confidence level of 95%.

The largest number of surveys was from R&D groups in the humanities, which composed 21% of the sample, followed by economics, social sciences, and law (18%), bio-health sciences (13%), and physics-chemistry-mathematics and health technology (11% each). Next in order were groups from natural resources and ecology (10%), agro-food (7%), information and communication technologies (5%), and production technologies (4%). Of the universities, 12.45% belonged to Andalusia, 12.06% to the Community of Navarre, 8.17% to the Community of Madrid, and 67.32% to other regions of Spain. Table 1 describes the sample to provide an overview of R&D in the Spanish university by group size, university, and discipline.

Insert Table 1

Measurement

The data were collected using an email questionnaire. All scales (see Appendix B) were accompanied by a seven-category Likert scale (1 disagree completely to 7 agree completely).

QM practices: To measure the QM practices, we adopted the scale developed by Prajogo and Sohal (2006), which has been validated for Australian and Korean organizations in the R&D sector. All Cronbach's alpha values for the scales were above 0.75, demonstrating the reliability of the scale for this environment. We also included teamwork, adapting the scale of Flynn et al. (1995) because it was perfectly adapted to the sector studied and because working in teams has advantages for performance in university R&D. The measurement scale was therefore composed of six variables: leadership, strategic planning, customer focus, information and analysis, human resources management, and teamwork.

Collective mind (CM): We adopted the scale proposed by Yoo and Kanawattanachai (2001), which has been validated using research groups (Huang, 2009).

Knowledge transfer (KT): We adapted the scale proposed in the study by Bock et al. (2005), who performed a field study with 154 managers to examine the relationship of attitudes and subjective norms to knowledge exchange.

Knowledge absorption (KA): We decided to adapt the scale proposed by Szulanski (1996), due to general acceptance of this scale and the ease of adapting it to the sector studied. (In our paper, KA refers to absorptive capacity.) We chose the scale from Szulanski (1996) because it analyzes the variable from an internal point of view by measuring the ability of a receiving unit to identify, evaluate, and apply new knowledge. The scale items measured the existence of a common language, clear division of responsibilities and abilities, and technical and managerial competences needed to absorb. The scale also includes the need to know both the subjects who can exploit the new information and those who can help in the case of problems with the new information. Although other scales to measure absorptive capacity have been developed with different goals, Szulanski's best fits our research objective because we analyze absorption from the internal perspective, that is, how different members of R&D groups (researchers) absorb knowledge during the research process. We thus propose a six-item scale, accompanied by a seven-point Likert scale.

Exploratory factor analysis

To guarantee the scales' one-dimensionality, we performed exploratory factor analysis with the statistical program SPSS 15.0. One-dimensionality is achieved if all items explain a single construct (Ahire et al., 1996). The variable of teamwork was divided into two, since the statistical analyses showed that it was measuring more than one factor: flexible teamwork, which, following the literature review, measures teamwork that heightens the capability for flexibility in the team; and strategic teamwork, which attempts to analyze the role of management in the group (see Table 2). As the principal components analysis matrix shows, the indicator measured more than one factor. We used Varimax rotation method with Kaiser's Normalization.

Insert Table 2

All scales fulfill the requirements of one-dimensionality, demonstrating that each indicator measured only one construct (see Table 3). Analysis of the scales' internal consistency shows a high Cronbach's alpha coefficient ($\alpha = 0.7$), an acceptable value given the recommended minimum of 0.7 (Nunnally, 1978).

Insert Table 3

Common Method Variance (CMV)

Since we used a single informant, we controlled for effects related to CMV (Podsakoff and Organ, 1986) following the criteria recommended by Podsakoff et al. (2003). First, the survey was composed of scales that have been tested and widely used. Second, we performed a pre-test to guarantee that the scales were clearly comprehensible and unambiguous. Third, we selected the survey respondents carefully and guaranteed anonymity, a condition that helps to overcome potential problems of CMV (Miller and Roth, 1994). Finally, we performed Harman's single-factor test, taking all elements from the 257 questionnaires and performing exploratory factor analysis without rotation (Podsakoff and Organ, 1986). No single factor represented most of the variance, and the main factor corresponded to only 31%, suggesting that CMV is not a problem.

Confirmatory factor analysis

The results of the confirmatory factor analysis show that all indicators fulfill the three requirements: (a) all factor loadings are significant ($t>1.96$; $p<0.05$), (b) all factor loadings are greater than 0.5, and (c) the value for individual reliability (R^2) is above 50% (Hulland, 1999) (see Table 3). Further, the Cronbach's alphas must be greater than 0.7 and the measurements of variance extracted greater than 0.5 (Nunnally, 1978) (see Table 4).

Insert Table 4

In the analysis, no items were removed, maintaining nearly all of the content validity of the scales. All scales used can thus be considered reliable and valid. They fulfill all requirements for one-dimensionality, reliability, and validity.

To conclude the validation process, we study the discriminant validity of the variables analyzed. We do this by comparing the correlation value observed to the correlation value calculated for the case of perfect correlation. The value calculated should always be greater than the value observed (Howell, 1987; Szulanski, 1996; Tamayo-Torres et al., 2013). Appendix C presents the results obtained, which show that the condition is fulfilled in all cases, ensuring discriminant validity.

4. Data analysis

For the data analysis, we used the multiple linear regression technique with moderation effect, supported by the statistical program SPSS version 15.0. The moderating variable was QM practices, treated as a second-order latent variable measured through six first-order latent variables. We performed tests to determine whether the data were well suited, observing whether the expectations of linearity, normality, homoscedasticity, and multicollinearity were fulfilled (Hair et al., 2004). When interaction terms are used in the analysis, these terms are highly correlated, causing multicollinearity and unstable estimations (Hair et al., 2004). They thus focus on the direct terms, subtracting the mean of each variable from the values of each observation. Table 5 shows the descriptive analysis of the sample, as well as the correlation matrix (see Table 6).

Insert Table 5

Insert Table 6

Table 7 shows the results of the analyses, which confirm that there are no problems of multicollinearity among the independent variables. The tolerance values (close to 1, threshold set at 0 -1) and variance inflation factor (VIF) (close to 1, threshold set at 10) are within the appropriate levels. The tolerance may not be greater than the degree to which each independent variable is explained by other independent variables, and the VIF must be the inverse of the tolerance (Hair et al., 2004).

Insert Table 7

Multiple regression analysis with moderating effect

We propose a total of two regression models, accompanied by the control variables, since control variables ensure that changes in the independent variable do not explain or cause changes in the dependent variable. We used the number of members and income of the group. Neither was significant, making the results valid for any Spanish university R&D group, regardless of its number of members or income level. These two control variables, as well as others, have been used in studies of R&D (Filatotchev et al., 2003; Hoegl and Praveen, 2006; Muethel, 2012). Due to the importance of group size and budget to the intensity of the R&D, we used the variable of size in our study.

These control variables enable us to extrapolate from the results to any university R&D group, regardless of the group's size or income level. This control variable could affect other variables and, if not taken properly into account, could change the results due to bias.

Tables 8 and 9 present the analyses of the regressions performed. The tables show that introducing the moderating effect MC X PC increases the value of R2 by 0.058 for a confidence level of 99%, explaining 20.6%-26.2% of KT. The total effect of CM on KT thus increases positively with the introduction of the interaction element, which is represented by both the linear effect and the moderating effect (0.125 + 0.100 x PC). The independent variables explain more variance of KT when we introduce the moderating effect on the relationship studied, supporting the hypothesis analyzed. We therefore accept research Hypotheses H1a and H2.

Insert Table 8

Table 9 shows the result of estimating the regression model for QM practices as a variable moderating the relationship between CM and KA. Only Hypothesis H1b was supported, demonstrating a relationship between CM and KA. We see that introducing the moderating element in the equation does not cause a change in the value of R^2. The influence of the moderating effect CM X PC is not significant for the relationship studied. Consequently, Hypothesis H3 is not supported.

Insert Table 9

5. Discussion and conclusions

This study has investigated the relationship between CM and knowledge transfer and absorption, using QM practices as a moderating variable. We identified six QM practices, treated as a second-order variable, that strengthen creation of one of the dynamic capabilities analyzed (KT) in the sector studied (university R&D), from both the theoretical and the empirical points of view. This was not the case for KA.

Our study is the first to analyze the moderating effect of QM practices on the relationships proposed. These results thus advance knowledge to fill a theoretical gap and position this research among the studies that argue the positive effects of QM practices. The results also make important contributions to our understanding of the constructs KT, KA, and CM. Further, we provide information on the use of moderating variables to strengthen the explanation of the relationship between variables in Economics, supporting other studies in this field that use the moderating effect and obtain positive results (Oltra and Flor, 2010; Prajogo, 2011). We propose that QM practices are one variable that facilitates the relationship between CM and KT in the sector of university R&D. Confirming this hypothesis also provides information relevant to improving these groups' performance.

Further, CM enables continuous improvement, better connection between tasks, and development of encrusted knowledge among members, facilitating the growth of internal attributes of the group through the interrelations created (Dougherty and Takacs, 2004). We believe that our positive results are due primarily to the benefits of QM practices in helping to create unity among people in organizations. Another factor that may influence our results is the different internal mechanisms of university research groups, such as their structure (Van den Bosch et al., 1999), rotation of positions, and connectivity and socialization techniques (Jansen et al., 2005).

A study by Messeni (2011) affirms that the existence of prior links helps to increase knowledge exchange in groups. The moderating effect achieved by inclusion of QM practices strengthens the relationship in these groups, which have flexible structures, and in which quality practices (supported by group teamwork, leadership, strategic planning, customer focus, human resource management, and correct use of information and analysis) encourage group members to share a set of beliefs and conditions that produce much stronger CM and KT, as well as credibility and security. Quality practices permit better communication and encourage stronger bonds between individuals, groups, departments, and organizations, tending to increase CM creation and improve KT among group members.

In our research, quality practices did not show any effect on the relationship between CM and KA. Given this result, further research should consider analyzing both internal and external elements not included in our study and that could improve the relationship of KA to the antecedent CM. We believe that this result is due to sector-specific characteristics, as achieving good KA requires the presence of factors beyond working in a quality environment—factors such as extensive preparation that enables one to identify the most important knowledge, as well as personal intentions of wanting to absorb knowledge.

This result may also be due to the fact that absorbing knowledge is a daily work routine in the university sector, one that must be performed whether or not one works in a quality environment. This condition is not the case for KT, which requires a university environment to stimulate the benefits of QM practices. Landry et al. (2007) obtain statistical evidence indicating that researchers in some fields were much more active in KT than researchers in others, suggesting different levels of knowledge activities across research fields.

Volberda et al. (2010) note a lack of studies exploring key intragroup factors that favor KA. Our results may be due to the importance of the prior knowledge level of individuals who compose the group. Prior knowledge enables identification of relevant knowledge (Reagans and McEvily, 2003; Volberda et al., 2010) and its subsequent absorption. Even when working in a quality environment, the receiver of knowledge must have the prior knowledge necessary to enable proper absorption or non-absorption of the knowledge transferred.

Our study has implications for practice. QM is a practical, non-prescriptive instrument that permits university R&D groups to evaluate where they are on their path to excellence. It aids them in identifying their key strengths and possible lacks relative to their vision and mission: Having a single language and way of thinking about the group facilitates effective communication of ideas within and outside the

group, integrating existing initiatives and those already planned, eliminating duplication, and identifying lacks, while also establishing a basic structure for management. As a result, our findings can guide the managers of R&D groups. The study conclusions demonstrate a generic character of QM practices that enables their adaptation to any environment. R&D groups that develop QM practices can promote KT, supported by CM as an antecedent, better than research groups that do not work in a QM environment. Since the literature lacks studies that prove this effect empirically, we provide information to fill this theoretical gap, as well as information on the use of QM practices in R&D in universities.

Based on the results obtained, we propose future lines of research fundamentally related to KA and the integration of knowledge in R&D. First, it would be interesting to study other antecedents that facilitate KT and KA in groups, as well as the possible effects of the relationships studied on innovative performance of groups when they work in a quality environment. Since innovation is the main result of these groups, advances along these lines would be positive developments. Second, longitudinal studies could evaluate the effectiveness of the initiatives proposed in conjunction with the QM practices used, taking into account their evolution over time. Third, future research could analyze the moderating influence of QM on other dynamic capabilities found in these groups: managerial capacities, flexibility, orientation to learning, or shared vision. Finally, it would be interesting to study other elements that could encourage KT and KA, such as prior relationships between members of groups, gender, or seniority.

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Table 1 Description of the sample

	Frequency	Percentage %)
Scientific area		
Humanities	54	21.00
Economics, social sciences	46	18.00
Bio-health sciences	34	13.00
Physics, chemistry, and mathematics	29	11.00
Health technology	27	11.00
Natural resources and ecology	25	10.00
Agro-food	19	7.00
Information and communication technologies	14	5.00
Production technologies	9	4.00
	257	100.00
Group size (number of researchers)		
< 5	129	50.20
6-10	95	36.96
>10	33	12.84
	257	100.00

Table 2 Separation of teamwork

Rotated components matrix		
	Components	
	1	**2**
TW1	0.290	0.530
TW2	0.242	0.855
TW3	0.102	0.879
TW4	0.895	0.204
TW5	0.919	0.203
TW6	0.827	0.271

Indicators	**Component**	**% variance explained**

TWF 1	0.643	63.677
TWF 2	0.883	
TWF 3	0.847	
TWS 1	0.914	83.172
TWS 2	0.941	
TWS 3	0.879	

Legend:
TWF - Flexible teamwork
TWS - Strategic teamwork

Table 3 Internal consistency of the measurement model employed

Variable	Composite Reliability (>0.7)	Variance Extracted (>0.5)	Cronbach's Alpha (>0.7)	Initial No. of Items	Final No. of Items
Leadership	0.948	0.823	0.872	4	4
Strategic planning	0.931	0.775	0.778	4	4
Customer focus	0.961	0.834	0.824	5	5
Information and analysis	0.910	0.721	0.739	4	4
Human resources management	0.934	0.781	0.821	4	4
Flexible teamwork (TWF)	0.792	0.723	0.711	3	3
Strategic teamwork (TWS)	0.968	0.909	0.892	3	3
CM	0.978	0.919	0.928	4	4
KT	0.958	0.822	0.911	5	5
KA	0.944	0.741	0.870	6	6

Legend:
CM - Collective mind
KT - Knowledge transfer
KA - Knowledge absorption

Table 4 Confirmatory factor analysis of the measurement model employed

Indicators	Factor loadings	T-value	R^2	Measurement Error
LED1	0.82	32.92	0.67	0.33
LED2	0.95	60.55	0.89	0.11
LED3	0.90	45.61	0.80	0.20
LED4	0.96	62.01	0.93	0.07
SP1	0.96	68.16	0.92	0.08
SP2	0.95	57.32	0.89	0.11
SP3	0.87	35.28	0.76	0.24
SP4	0.73	21.99	0.53	0.47
CF1	0.91	43.18	0.82	0.18
CF2	0.94	50.39	0.88	0.12
CF3	0.93	60.14	0.87	0.13
CF4	0.96	66.42	0.91	0.09
CF5	0.83	31.15	0.69	0.31
IA1	0.92	43.40	0.84	0.16
IA2	0.81	29.15	0.66	0.34

IA3	0.94	43.09	0.89	0.11
IA4	0.70	21.22	0.50	0.50
HRM1	0.87	36.05	0.77	0.23
HRM2	0.91	45.63	0.84	0.16
HRM3	0.93	48.88	0.87	0.13
HRM4	0.81	28.73	0.65	0.35
TWF1	0.75	21.10	0.57	0.43
TWF2	0.99	49.58	0.97	0.03
TWF3	0.79	28.98	0.63	0.37
TWS1	0.96	70.97	0.93	0.07
TWS2	0.97	85.25	0.93	0.07
TWS3	0.93	53.05	0.87	0.13
CM1	0.93	54.88	0.86	0.14
CM2	0.97	94.79	0.95	0.051
CM3	0.98	109.59	0.96	0.045
CM4	0.95	70.77	0.91	0.088
KT1	0.85	33.16	0.72	0.28
KT2	0.92	61.25	0.84	0.16
KT3	0.91	55.59	0.83	0.17
KT4	0.91	52.37	0.84	0.16
KT5	0.94	66.21	0.88	0.12
KC1	0.84	31.02	0.70	0.30
KA2	0.81	28.83	0.66	0.34
KA3	0.92	52.57	0.84	0.16
KA4	0.87	40.20	0.75	0.25
KA5	0.86	37.52	0.74	0.26
KA6	0.87	38.11	0.75	0.25

Legend:
LED- Leadership
SP- Strategic planning
HRM - Human resources management
CM – Collective mind
KT - Knowledge transfer
TWF - Flexible teamwork
TWS - Strategic teamwork
CF - Customer focus
IA - Information and analysis
KA - Knowledge absorption

Table 5 Descriptive statistics

		CM	KT	KA	LED	SP	CF	IA	HRM	TW
N	Valid	257	257	257	257	257	257	257	257	257
	Lost	0	0	0	0	0	0	0	0	0
	Mean	5.1634	6.4778	5.8340	5.7704	4.5846	4.7518	4.4251	5.6595	5.3153
	Median	5.2500	6.8000	6.0000	6.0000	4.7500	4.8000	4.5000	6.0000	5.5000
	SD	1.2787 9	0.7034 6	0.8595 7	1.1584 9	1.3402 5	1.3136 9	1.3861 3	1.1120 5	1.2088 3
	Variance	1.6353 0	0.4948 6	0.7388 6	1.3421 1	1.7962 8	1.7257 9	1.9213 7	1.2366 6	1.4612 8

Legend:
LED- Leadership
SP- Strategic planning
HRM - Human resource management
CF - Customer focus
KT - Knowledge transfer
TWF - Flexible teamwork
TWS - Strategic teamwork
CM – Collective mind
IA - Information and analysis
KA – Knowledge absorption

	LED	SP	CF	IA	HRM	TEF	TEE	CM	KT	KA
LED	1	0.630(**)	0.498(**)	0.399(**)	0.613(**)	0.383(**)	0.570(**)	0.591(**)	0.477(**)	0.519(**)
SP	O.630(**)	1	0.609(**)	0.490(**)	0.488(**)	0.429(**)	0.490(**)	0.624(**)	0.354(**)	0.497(**)
CF	0.498(**)	0.609(**)	1	0.621(**)	0.619(**)	0.510(**)	0.490(**)	0.496(**)	0.324(**)	0.441(**)
IA	0.399(**)	0.490(**)	0.621(**)	1	0.571(**)	0.498(**)	0.486(**)	0.375(**)	0.261(**)	0.341(**)
HRM	0.613(**)	0.488(**)	0.619(**)	0.571(**)	1	0.448(**)	0.634(**)	0.544(**)	0.480(**)	0.570(**)
TWF	0.383(**)	0.429(**)	0.510(**)	0.498(**)	0.448(**)	1	0.482(**)	0.336(**)	0.215(**)	0.377(**)
TWS	0.570(**)	0.490(**)	0.490(**)	0.486(**)	0.634(**)	0.482(**)	1	0.520(**)	0.460(**)	0.496(**)
CM	0.591(**)	0.624(**)	0.496(**)	0.375(**)	0.544(**)	0.336(**)	0.520(**)	1	0.497(**)	0.657(**)
KT	0.477(**)	0.354(**)	0.324(**)	0.261(**)	0.480(**)	0.215(**)	0.460(**)	0.497(**)	1	0.535(**)
KA	0.519(**)	0.497(**)	0.441(**)	0.341(**)	0.570(**)	0.377(**)	0.496(**)	0.657(**)	0.535(**)	1

Table 6 Correlation matrix

** Correlation is significant at 0.01 (bilateral).

Table 7 Indicators of multicollinearity of the independent variables composing the hypotheses analyzed

First Model (KT)	Variable	Tolerance	VIF
1	Number of members	0.975	1.026
	Income	0.915	1.026
2	Number of members	0.967	1.035
	Income	0.910	1.099
	Collective Mind	0.613	1.630
	QM	0.575	1.740
3	Number of members	0.964	1.037
	Income	0.905	1.105
	Collective Mind	0.564	1.774
	QM	0.570	1.754
	Collective Mind x QM	0.813	1.230

Table 8 Regression analyses of QM practices as variable moderating the relationship between CM and KT

Variable	Model 1		Model 2		Model 3	
	β	Error	β	Error	β	Error
Constant	6.332***	(0.185)	4.838***	(0.247)	5.306***	(0.260)
No. Members	0.084	(0.072)	0.055	(0.064)	0.068	(0.062)
Income	0.002	(0.053)	- 0.079	(0.049)	- 0.095	(0.047)
CM			0.178***	(0.041)	0.125**	(0.041)
QM			0.154**	(0.052)	0.134*	(0.051)
CM X QM					0.100***	(0.022)
F	0.701		17.605***		19.157***	
Adjusted R^2	0.002		0.206		0.262	
Change in R^2	0.005		0.213***		0.058***	

Dependent variable: KT

Regression coefficients and standard deviations shown in parentheses

Significance level: *p<0.1, **p<0.05, ***p<0.01

Table 9 Regression analyses of QM practices as a moderating variable of the relationship of CM and KA

Variable	Model 1		Model 2		Model 3	
	β	Error	β	Error	β	Error
Constant	5.482***	(0.220)	2.993***	(0.251)	2.983***	(0.274)
No. Members	0.089	(0.085)	0.042	(0.065)	0.041	(0.065)
Income	0.109	(0.063)	- 0.018	(0.050)	- 0.018	(0.050)
CM			0.309***	(0.042)	0.310***	(0.044)
QM			0.242***	(0.053)	0.242***	(0.053)
CM X QM					0.02	(0.024)
F	2.392		48.718***		38.823***	
Adjusted R^2	0.011		0.427		0.425	
Change in R^2	0.018		0.418***		0.000	

Dependent variable: KA

Regression coefficients and standard deviations shown in parentheses

Significance level: *p<0.1, **p<0.05, ***p<0.01

Figure 1: Conceptual model