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Completed Research Paper

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Abstract

The purpose of this paper is to identify the key roles that enable e-leaders to build high-quality exchanges with their team members. We use behavioral complexity theory to analyze the roles played by leaders of virtual teams, and helping them to develop effective leader-member exchanges (LMX). We draw up a research model to explain how e-leaders build cooperative and collaborative relationships through social-related and work-related activities. We then test the research model using a large survey of 193 virtual team members. Our findings show that apart from coordination and monitoring roles, open systems roles, roles of rational pursuit of goals and human relations roles have a positive and significant effect on LMX.

Keywords: Behavioral complexity theory, LMX theory, e-leaders' roles, structural equation modeling.

Introduction

Relationship building and development continue to interest researchers in the virtual team field. A number of studies have focused on how to build trusty and cooperative relationships in the specific context of virtuality (Brown et al., 2004; Chen et al., 2008; Iacono and Weisband, 1997; Jarvenpaa et al., 2004; Paul and McDaniel, 2004). Virtual teams are characterized by lack and even absence of face-to-face interaction, geographical separation of members, and electronic communication, which hinder relationship development (Bell and Kozlowski, 2002; Larsen and McInerney, 2002; Lipnack and Satmsp, 1997; Townsend et al., 1998). Jarvenpaa et al. (1998), Jarvenpa and Leidner (1999), Beranek (2000) and others conducted studies to identify factors affecting relationship-building in virtual teams. Among other things, their findings show that leadership plays an important role in this process.

Jarvenpaa et al. (1998), for example, found that teams with a leader develop a higher level of trust than teams without leaders. The mechanisms that help e-leaders to build effective relationships were not explained, however. Thus, the question arises as what actions and behaviors e-leaders use to develop high quality exchanges with their team members. We believe that this issue needs to be analyzed for a number of reasons.

In effect, we noted that several studies in the leadership literature were interested in exchange between team leaders and members (LMX) (Brower et al., 2000; Schriecheim, 1999) but few identified the factors that influenced them. Prior research has tended to focus on identifying LMX dimensions or developing relevant instruments to empirically test the concept. However, little attention has been paid to the variables that determine the quality and nature of relationships between leaders and their team members. Among these variables, leaders' characteristics seem to be a key determinant of LMX (Dienesh and Liden, 1986). In addition, to the best of our knowledge, these questions have never been investigated in the virtual context.

This paper thus aims to address two gaps in the literature. First, we analyze how leaders' actions and behaviors shape their relationships with their team members and second, we study the question in the context of virtual teams. Our purpose is to identify the key elements that enable e-leaders to develop high-quality exchanges with their team members. Our study thus contributes to both leadership and virtual team literature and management.

To this end, we built a research model based on two well-established theories of organizational leadership. First, LMX theory is used to analyze the characteristics of the relationships between e-leaders and virtual team members. Second, behavioral complexity (BCT) theory is used to identify the key roles played by e-leaders in developing high quality exchanges with their team members. Although LMX theory has never been tested in the virtual context, BCT has been tested in two studies. Kayworth and Leidner (2001-2002) used the theory to study leadership effectiveness in virtual teams, while Yoo and Alavi (2002) used BCT to identify the key roles of emergent e-leaders.

The stages of our research model-building are presented in the following section. We empirically tested the model via a survey involving virtual team members. The data collected was then analyzed using factor analysis and structural equation modeling. The data collection and analysis are presented in section 3 and are followed by a presentation of the results. In the fifth section, we discuss our findings and compare them with the results of previous studies. Finally, we conclude with the implications of our findings on the theory and management of virtual teams as well as the study's limitations and its possible future extensions.

Theoretical foundations

LMX in virtual teams

LMX is a leadership theory that focuses on the relationship between leaders and their subordinates and its consequences on individual and organizational outcomes (Brower et al., 2000; Dansereau et al., 1995). According to the LMX theory, "*effective leadership processes occur when leaders and followers are able to develop mature leadership relationships (partnerships) and thus gain access to the many benefits these relationships bring*" (Graen and Uhl-Bien, 1995, p: 225).

Rooted in social exchanges and Katz and Kahn's role theory (1978), LMX theory states that the accomplishment of roles by leaders and members results in differentiated relationships between them. Thus, LMX theory is interested in the nature of the relationship that consequently occurs between the two parties (Uhl-Bien, 2006). It is possibly the

most frequently studied theory in organizational leadership literature (Schiersheim, 1999). Previous studies on LMX have focused on identifying its dimensions and determinants, and its effects on organizational outcomes. Lively debate has arisen from LMX dimensionality as early studies considered the relationship as multidimensional (Dienesh and Liden, 1986; Schiersheim *et al.*, 1999). However, no empirical evidence has supported this assertion. No consensus was found regarding LMX multidimensionality or the number of its dimensions. To resolve this issue and given empirical results of previous studies, Graen and Uhl-Bien (1995) suggested that the LMX dimensions are correlated in such a way that we can consider it as a one-dimensional concept. High-quality LMX is thus characterized by trust, respect and mutual obligation between leaders and members.

With regard to the LMX impact on organizational processes, variables analyzed to date have included communication frequency, interaction styles, congruence between leaders' and members' values, decision-making processes, etc. (Erdogan and Liden, 2006; Liden et al., 2000; Sparrowe and Liden, 2005; Yrle et al., 2003; Zhou and Schiersheim, 2009) The results of these studies indicate that mutuality and high-quality LMX lead to positive outcomes, namely, high work performance, member satisfaction, and strong commitment to the work unit (Butler *et al.*, 1992; Yammarino and Dubinsky, 1992).

We should note that there is also lively debate in LMX literature concerning how the concept should be measured. Indeed, different scales have been developed and used in empirical studies, involving from 2 to 14 items. Such studies finally recommend the 7-item scale as the one which provides the greatest reliability and extracted variance of factors. In addition, this scale correlates with other scales used (Graen and Uhl-Bien, 1995). We therefore adopted this scale in our empirical study to test the effects of leader's behavioral complexity on LMX.

To build our research model, we analyzed the developmental model of LMX suggested by Dienesh and Liden (1986). This model describes LMX building as a process which includes leaders' and members' characteristics together with their interactions as inputs (Valcea et al., 2009). The nature and quality of their relationships (the output) result from the interaction between leaders and members' behaviors and attributions under the effects of psychological mechanisms (Steiner, 1997). However, neither the behaviors nor the actions of leaders or members are specified. The present paper attempts to fill this gap in the literature and to analyze how leaders' actions influence their relationship with their team members. In addition, the issue is also studied in the specific context of virtual teams.

In effect, in the virtual environment, ordinary relationship development conditions are missing. Direct and face-to-face contacts are replaced by electronic interactions. Proximity is substituted by members' dispersion and physical separation. This raises challenges related to lack of knowledge between members (including leaders) and difficulties in building trusting and effective relationships (Pauleen, 2003-04; Purvanova and Bono, 2009). It is therefore very important to see how LMX is built in virtual teams, and how e-leaders actions and behaviors influence it.

Behavioral complexity of e-leaders

Complexity theory of leadership is a recent approach, providing an integrative theoretical framework of previous leadership theory (such as traits theory, behavioral theory and contingency theory) (Lischtenstein *et al.*, 2006; Uhl-bien and Marion, 2009). It is rooted in the complexity theory of adaptive systems (Schneider and Sommers, 2006) which focuses on the interaction and dynamics of such systems (Hogue and Lord, 2007; Hunter et al., 2009; Uhl-Bien et al., 2007). It, thus, provides a dynamic framework for studying leadership in different contexts.

Applied to the field of leadership, complexity theory implies that leaders need to develop cognitive and behavioral skills to manage all situations (complex and contradictory) in their environment. To this end, "*effective leaders must be the ability to both conceive and perform multiple and contradictory roles*" (Denison *et al.*, 1995, p: 525). Complexity theory of leadership is hence based on both cognitive and behavioral complexity (Hooijberg, 1997).

Cognitive complexity describes human information processing and the individual ability to deal with a set of ambiguous and contradictory forces. It concerns "the ability to hold two opposing ideas in the mind at the same time and still be capable of retaining the ability to function" (Carmeli and Halevi, 2009, p: 209). Moreover, the behavioral complexity of leaders is the ability to develop and perform multiple roles that may be simultaneously conflicting.

Behavioral complexity is based on two key concepts: behavioral repertoire and behavioral differentiation (Wu *et al.*, 2009). The former refers to a portfolio of contradictory and complementary roles performed by leaders. The latter refers to their ability to switch from one role to another to deal in paradoxical situations. In this regard, behavioral

differentiation is linked to cognitive complexity as it implies the ability to assimilate paradoxical situations and retain a certain level of integrity and reliability. Expressed differently, behavioral complexity in leadership consists of building a behavioral repertoire of contradictory and complementary behaviors using behavioral differentiation/integration movements to perform them (Hooijberg *et a*l., 1997).

To define the behaviors that comprise the repertoire of effective leaders, Denison *et al.*, (1995) used Quinn's model of leadership roles (1984, 1988).[1] In this spatial model, two dimensions are borrowed from the Competing Value Model of organizational effectiveness: stability versus flexibility, and external focus versus internal focus. These dimensions express the contradiction and paradoxes in leaders' behavioral repertoires, comprising the four following categories of role:

- Open systems roles: behaviors included in this category enable leaders to adapt to the organization's external environment. It encompasses two roles: innovator-leaders are those characterized by high creativity and vision. They encourage and facilitate change and anticipate members needs (Lawrence *et al.*, 2009). The broker role focuses on acquiring resources and representing the unit with regard to external network contacts (Denison *et al.*, 1995).

- Roles of rational pursuit of goals: this category includes stable roles with an external focus. It emphasizes behaviors that enable leaders to introduce initiatives, define goals and motivate team members to reach these goals. Two additional roles are defined in this category. The leader-producer initiates actions that encourage and facilitate the effective completion of work. The director role concerns goal definition, task repartition, and clarification and specification of expectations.

- Internal process roles: these focus on initiatives enabling internal control and providing the unit with stability. They are achieved through coordination and monitoring roles. The leader-coordinator establishes coordination mechanisms and activity planning, manages problems and conflicts, and controls compliance with rules and standards. The monitoring role encompasses information management. The leader-monitor collects and provides information for the teams members regarding task accomplishment and evaluates performance.

- Human relation roles: this category emphasizes human interactions and processes. Roles in this category are interested in relationship building and development. They incorporate facilitation and mentoring. Leader-facilitators show concern for their team members and encourage self-expression and participation. Mentoring roles encourage individual development, support legitimate requests and develop awareness of individual needs.

While the roles specified for each category are not really contradictory, there is nonetheless some paradox and contradiction in the formulation of role categories. In this regard, roles of rational pursuit of goals (producer and director) contrast with human relation roles (facilitator and mentor), while internal process roles (coordinator and monitor) contrast with open system roles (innovator and broker) (Denison *et al.*, 1995).

According to Lawrence *et al.* (2009), leaders who can balance or diversify their behaviors are expected to have a high degree of behavioral complexity and are better able to meet organizational demands. For these reasons, applying the concept of behavioral complexity to virtual team leaders, we argue that e-leaders need to excel in each category of role in order to build strong relationships and high-quality exchanges.

Research model

Given the ambiguity of the virtual context due to lack of information about team members and their dispersion, e-leaders' behavioral complexity becomes increasingly important to enhance their abilities to build effective relationships. Performing paradoxical and complementary roles enables e-leaders to deal with problems of limited (and even impossible) face-to-face interaction, lack of knowledge among team members and the geographical and temporal separation that hampers relationship development, and effective and collaborative exchanges.

We should note at this level of analysis that although the behavioral complexity model developed by Denison *et a*l. (1995) identifies 8 roles grouped into 4 categories, recent testing of the model by Lawrence *et al.*, (2009) supported

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[1] Cited in Denison *et al.*, (1995).

the 4-category structure. For this reason, we have applied the 4-category model to test the effects of open systems roles, roles of rational pursuit of goals, internal process roles and human relation roles on LMX.

First, we argue that open systems behaviors of e-leaders have a positive impact on LMX. However we posit that this impact does not strongly influence LMX quality. Rather, it is the team members' perceptions that enhance their relationship with e-leaders. Perceptions of e-leaders as innovators and brokers positively influence their image among their team members'. In this sense, when team members perceive their e-leaders as creative, facilitators of change, and effectively representing the team, they form a positive attitude about them, and this is expected to facilitate relationship building. Thus, we believe that although this category of role positively influences LMX, its impact on LMX is weak as it has an external focus and does not emphasize internal processes and relationship management. Given these arguments, we posit that:

H1: Open system roles positively influence leader-member exchange in virtual teams.

Second, with regard to prior literature on relationship building in virtual teams, roles of rational pursuit of goals are expected to have an important effect on LMX. Indeed, several studies have found that work-focused actions are positively perceived by virtual team members and contribute to the development of good relationships. In addition, trust relationships are built through goal setting, clarifying expectations, clear task repartition and motivating work-related messages. This clearly corresponds to the producer and director roles acknowledged by behavioral complexity theory. Thus, we posit that:

H2: Roles of rational pursuit of goals positively influence leader-member exchange in virtual teams.

The third category of roles concerns the internal processes of virtual teams. Like the previous category, internal process roles are designed to establish high-quality exchanges between e-leaders and members. Coordination and monitoring roles aim at developing behaviors and work rules through activity planning, coordination mechanisms, information distribution, and performance evaluation. Regular application of these activities leads to the development of work habits that are accepted and shared by all team members, reinforcing their cohesion. We can subsequently posit that:

H3: Internal process roles positively influence leader-member exchange in virtual teams.

Human relation roles are at the heart of high-quality LMX building. Through their role as facilitator and mentor, e-leaders encourage the expression of opinions, establish consensus, support individual development and manage differences. In this way, e-leaders enhance team cohesion and build a collective identity (Fiol and O'Connor, 2005). These factors also contribute to strengthening links between team members and building high-quality exchanges with their leaders. The following hypothesis is then formulated:

H4: Human relation roles positively influence leader-member exchange in virtual teams.

We summarize our arguments in the following figure describing our research model.

Figure 1: A proposed model of leadership behavioral complexity effects on LMX
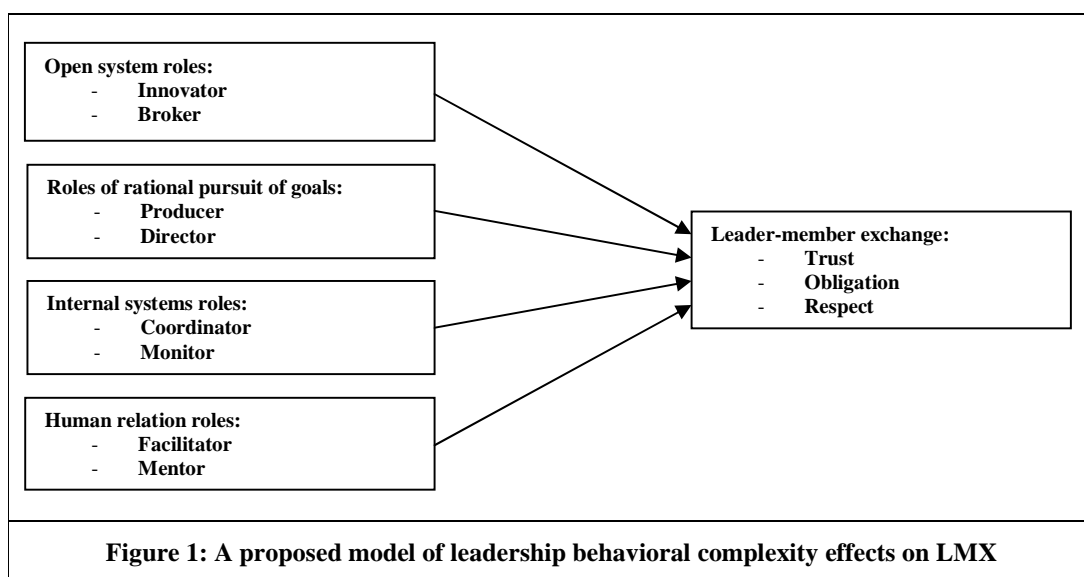
Method

To test our research hypothesis, we conducted a quantitative study using a large survey of virtual team members. The data collected was then analyzed in two main stages: factor analysis to evaluate dimensionality and reliability of measured variables, and structural equation modeling to test the research theoretical model. In this section, we successively describe our sample, the data collection procedure and the stages of data analysis.

The survey lasted 4 months (from March to June 2008). The questionnaire was administrated in a well known French training center receiving both French and international trainees. It was distributed by the trainers in each session they animate and to different public. 1000 questionnaires were distributed to all trainees. To distinguish virtual team members from non virtual members, we added at the beginning of the questionnaire the following question: "Was/Are you a member of a virtual team?". Following this procedure we collect a total number of 600 responses from which only 300 concern virtual team members. So, the response rate was about 30%. However, only 193 were well filled and then exploitable.

The descriptive statistics show that the sample is almost equally composed of male (47%) and female (53%) respondents. Most respondents were between 36-50 years old (48%) and operate in the industrial sector (41%). 72% of the population works in project-organized sectors. From this number, 50% work with members outside their country of origin and the remaining 50% with members located in the same country (but in separated localization). In other words, the individuals in our sample come from highly diversified teams, crossing organizational and cultural boundaries.

To operationalize the concept measured, we use existing survey of LMX and BCT used in previous leadership literature. The LMX construct was measured on a five-point Likert scale, using Graen and Uhl-Bien's (1995) recommended 7-item scale (LMX7). This scale was used to assess members' perceptions of the quality of leader–member exchange. Leadership roles were assessed using Denison *et al.*'s (1995) scale.

Data analysis was performed in three stages: exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and model testing through structural equation modeling. To purify and specify internal scale structure, an SPSS-based principal component exploratory factor analysis was performed on each measurement scale without specifying the number of factors to be extracted. The test of Kaiser, Meyer and Olkin (KMO), as well as Bartlett's test of sphericity, enabled us to check the data's ability to be factored. Factor analysis was deemed appropriate for both measurement scales in our data set.

Following this, a confirmatory factorial analysis was conducted using STATISTICA 7.0 (StatSoft, Tulsa, OK). The model's overall validity was appraised based on the following goodness-of-fit indices: Chi-square value normalized by degrees of freedom (χ^2/df.), goodness-of-fit index (GFI), incremental fit index (IFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA).

Using Structural Equation Modeling, the structural paths were estimated using a maximum likelihood estimation method and a correlation matrix as input data. Open systems, rational pursuit of goals, internal processes and human relations roles were included as exogenous variables, and the Leader-Member exchange quality as latent endogenous variable.

Results

The EFA performed on the LMX items yields a one-factor variable, which accounts for about 62% of the variance. Examination of the data revealed a KMO measure of sampling adequacy of .850, with a highly significant Bartlett's test of sphericity (χ^2_{10}= 365.83, *p*= 0.000). Two of the seven items measuring the LMX construct were dropped from further analysis because they had factor loadings below 0.50. The items eliminated were "Regardless of how much formal authority he/she has build into his/her position, what are the chances your leader would use his/her power to help you solve problems in your work?" and "Again, regardless of the amount of formal authority your leader has, what are the chances that he/she would 'bail you out' at his/her expense?".

There are two possible explanations for the elimination of these items. First, the respondents in our sample do not perceive their leaders as helpful in difficult situations or as making a positive contribution to problem solving. Second, given the formulation of the items (formal authority, use his/her power), e-leaders may be perceived as helpful and reliable regardless of their authority and power. In this sense, the association between e-leaders' power

and their ability to manage their team members' problems may bias the answers. Given the role analysis results (that we discuss later), we believe that the second explanation is the most likely in this case.

The EFA performed on the leader role items produced a four-dimensional solution, which cumulatively explained 75.54% of the variance. Five of the sixteen items initially analyzed had to be eliminated because they either had low-factor contributions (below 0.50) or, on the contrary, their contributions were split among several factors. Two of the eliminated items concern the innovator roles (as defined by Denison *et al*. (1995)). Elimination of these items shows that virtual team members from our sample do not perceive their leaders as innovators. Hence, the remaining analysis only tested the effects of the broker role on LMX quality. The KMO measure of the sampling adequacy was 0.75, and the Bartlett test of sphericity was significant (χ^2_{55}= 926.95, p= 0.000), providing support for the applicability of factor analysis. Items dropped from analysis are specified in table 1.

For both LMX and behavioral complexity constructs, reliability was evaluated by assessing the internal consistency of the items representing each construct using Cronbach's alpha (1951). The constructs exhibited sufficient reliability, ranging from .72 to .88 (see table 1). These results enabled us to perform confirmatory factor analysis.

As shown in Table 1, all goodness-of-fit indices surpassed the common acceptance levels, indicating that the model fits well the data.

Table 1. Results of confirmatory factor analysis		
Latent construct and items	**Factor loading**	**Reliability**
Leader-Member exchange quality (LMX-Q)		
Do you know where you stand with your leader….do you usually know how satisfied your leader is with what you do?	0.680	
How well does your leader understand your job problems and needs?	0.779	
How well does your leader recognize your potential?	0.722	0.84
Regardless of how much power your leader has built into his/her position, would he/she be personally inclined to use his/her power to help you solve problems in your work?	*Dropped*	
I have enough confidence in my leader that I would defend and justify his/her decision if he/she were not present to do so?	0.703	
I usually know where I stand with my leader.	*Dropped*	
How would you characterize your working relationship with your leader?	0.744	
Open Systems roles (OS)		
Comes up with inventive ideas	*Dropped*	0.88
Experiments with new concepts and idea	*Dropped*	
Exerts upward influence in the organization	0.976	
Influences decisions made at higher levels	0.805	
Rational Pursuit of Goals roles (RPG)		
Sees that the unit delivers on stated goals	0.869	0.82
Gets the unit to meet expected goals	0.882	
Makes the unit's role very clear	0.646	
Clarifies unit's priorities and directions	*Dropped*	
Internal Process roles (IP)		
Anticipate workflow problems, avoid crisis	*Dropped*	0.72
Brings a sense of order into the unit	0.740	
Maintains tight logistical control	0.733	
Compares records, reports, and so on to detect discrepancies	0.584	
Human Relations roles (HR)		
Surfaces key differences among group members, then work anticipatively to resolve them	*Dropped*	0.79
Encourages participative decision-making in the group	0.635	
Shows empathy and concern in dealing with subordinates	0.779	
Treats each individual in a sensitive, caring way	0.871	

Goodness-of-fit indices	
χ^2/df.	1.91
GFI	.90
IFI	.94
CFI	.94
RMSEA	.064

Both the convergent and discriminant validities were controlled for. Estimations of average variance extracted from all constructs were generally higher than 0.50, except for internal process roles, which were slightly below the recommended cut-off value. This indicates that the measurement model has good convergent validity. Discriminant validity was tested by comparing the shared variance among any two constructs (i.e., the square of their inter-correlation) with the corresponding figure for convergent validity (Fornell & Larcker, 1981). The results supported discriminant validity between each possible pair of latent constructs (see Table 2).

Table 2. Means, standard deviations and correlation of construct

	Mean	SD	Correlation of constructs[1]				
			LMX-Q	RPG	HR	IP	OS
LMX-Q	3.60	0.71	**0.73**				
RPG	3.81	0.84	0.527*	**0.81**			
HR	3.36	0.89	0.562**	0.422**	**0.77**		
IP	3.11	0.89	0.274**	0.457**	0.335**	**0.69**	
OS	3.46	0.98	0.254**	0.231**	0.181*	0.291**	**0.89**

Note: * Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

[1]Diagonal elements in the correlation matrix are the square root of the average variance extracted. For adequate discriminant validity, diagonal elements should be greater than corresponding off-diagonal elements.

Hypothesis testing through structural equation modeling supports H1, H2, and H4 and rejects H3. The Leader-Member exchange quality (R^2 = .58) is significantly predicted by open systems roles, and more specifically by the broker's role (β_1 = .17, p = .011), roles of rational pursuit of goals (β_2 = .38, p = .000), and human relations roles (β_4 = .51, p = .000). All the confirmed hypotheses are supported at the .01 level. However, a negative and non significant link was found between internal process roles and LMX quality (β_2 = -.08, p = .384). In the following section, we explain these results and compare them with those of previous studies.

Discussion

This paper attempted to identify the key roles enabling leaders of virtual teams to establish effective and high-quality relationships with their team members. Based on the behavioral complexity theory of leadership, we postulated that open system roles, roles of rational pursuit of goals, internal process roles and human relation roles help e-leaders to develop effective relationship management in their teams. Our results show that, apart from internal process roles, all other roles positively and significantly influence LMX.

According to our findings, coordination and monitoring roles are not key elements in relationship building in virtual teams. One explanation for this is that internal process roles focus on coordination and control mechanisms. These roles may be negatively perceived by team members as they tend to identify undesirable behaviors (such as absenteeism). According to Piccoli and Yves (2003), behavior control mechanisms are negatively perceived by virtual team members and contribute to a decline in trust as they highlight individuals' incapacity to fulfill their obligations and participate in work achievements.

Our results also emphasize the contribution of roles of rational pursuit of goals to enhance LMX. This is consistent with previous studies, such as Jarvenpaa *et al.* (1998) and Jarvenpaa and Leidner (1999) who showed that trusty relationships are constructed when e-leaders clarify work goals, perform task repartition, set up shared work and communication norms, and ensure regular interaction and immediate feedback. Although no reference is made to behavioral complexity theory in these studies, we can see that such activities fall into the category of rational pursuit of goals. In addition, Beranek (2000) found that the emergence of a leader in virtual teams who sets up functioning mechanisms and clarifies work rules contributes to the building of trusty relationships.

This study also shows that effective conflict and crisis management by e-leaders helps them to develop effective exchanges. This finding directly indicates facilitator roles included in human relation roles also confirmed in our results. Indeed, we find that human relation behaviors that are shaped via mentoring and facilitation positively influence LMX. This result is not surprising as this category of roles is exclusively interested in relationship building and is expected to have the most significant impact. Similarly, it is confirmed by our study as the β coefficient is the highest ($\beta_4 = .51$), indicating that these roles are the most important predictor of LMX quality.

This finding is also confirmed by Kayworth and Leidner (2001-2002) and Larsen and McInerney (2002), even though they did not explicitly analyze LMX. Kayworth and Leidner (2001-2002) highlighted the importance of building and developing team cohesion to maintain high-quality relations. They also found that effective leaders displayed a high degree of empathy towards their team members. Larsen and McInerney (2002) emphasized the contribution of mentoring roles to avoid a decline of trust in virtual teams.

Regarding open system roles, as the innovator role was eliminated from factor analysis, our results only concern the broker role. Although a positive and significant link is revealed between this role and LMX, the β coefficient is low. This means that resource acquisition and team representation in external networks are not perceived as key determinants of LMX. This is not really surprising as this category of roles has an external focus whereas relationship management is an internal function. Thus, they are not expected to play an important role in building high-quality exchanges.

Overall, our results are consistent with previous research and provide additional validation of behavioral complexity theory in virtual contexts (Kayworth and Leidner, 2001-2002; Yoo and Alavi, 2002). Regarding the contribution of behavioral complexity to LMX building, we only found one study that confirms our findings. Wu *et al.* (2009) suggest that developing a behavioral repertoire enables supply managers to have a good relationship with suppliers. This finding should be treated with caution, however, as it concerns face-to-face contexts and may not be true in virtual teams.

Our results provide significant insights into virtual team management and literature that we discuss in the conclusion. We also identify some limitations that may be addressed in future studies.

Conclusion

Research contributions

The results of this study contribute to both the literature and the management of virtual teams. In theoretical terms, we linked and tested two leadership theories through our research model. LMX theory and behavioral complexity theory were used to build a model that identifies key roles enabling e-leaders to develop high-quality exchanges in their teams. The results of the hypotheses testing (goodness-of-fit, convergent and discriminate validity) prove the parsimony and robustness of the model. However, as it is the first essay in virtual team literature, it needs to be validated by further research.

In addition, concerning open system roles, the elimination of the innovator role and the low β coefficient of the broker role raise questions regarding the contribution of this category of roles to relationship management in virtual

teams. Future work could help to confirm this low contribution and subsequently to drop open system roles from the model to enhance its parsimony.

In managerial terms, our study identifies a key finding concerning factors influencing relationship-building in virtual teams. Indeed, the high correlation between human relation roles and LMX quality suggests that, according to our respondents, high-quality exchanges are established when e-leaders show concern and empathy towards their team members and encourage individual development and self expression. Although this result does not correlate with previous studies, it nonetheless gives important insights into virtual team management. E-leaders should no longer focus only on task-related activities (goal clarification, task repartition, etc.) as recommended by previous studies. They should also pay close attention to socially-related activities to motivate team members and enhance their involvement and participation in effective work achievement. This recommendation is strengthened by the absence of a significant impact of internal process roles and the low impact of rational pursuit of goals and open systems roles. We call for further testing on the impact of human relation roles to generalize the result.

These results also emphasize important characteristics of technologies provided to virtual team members and e-leaders to communicate and to coordinate work. These technologies have to facilitate relationship building through possible transmission of needed elements to build trusty and cooperative relationships such as facial expression, voice tone, etc. Expressed differently, ICT would have a high richness level (Daft and Lengel, 1984, 1986) to enable social information exchanges.

According to Kirkman and Mathieu (2005), work coordination and accomplishment are enabled through high informational value ICT. This means that ICT used by virtual team members have to be adapted to task activities performed (analytical or technical tasks). With relation to our study, high informational value technologies would help e-leaders to enhance production and direction roles accomplishment, dealing with task repartition, goal setting, etc. It would then consolidate the effect of rational pursuit of goal roles on LMX.

Limitations and future extensions

Despite the significant insights provided by our study, a number of limitations should be noted to enhance future research on LMX and behavioral complexity in virtual teams.

First, we would draw attention to a problem of compatibility between LMX theory and behavioral complexity theory. According to Graen and Uhl-Bien (1995), LMX is classified in the domain of relationship theories, while behavioral complexity belongs to the domain of leadership theories. Each domain has its own specific focus, which differ from one another. LMX focuses on the relationship between leaders and subordinates and its outcomes on both parties. Behavioral complexity theory focuses on leaders' characteristics and actions, and their effects. In addition, behavioral complexity theory is considered as a dynamic theory (Osborn and Hunt, 2007; Uhl-Bien and Marion, 2009), whereas LMX is considered as a more static theory. Hence, we call on future research to identify greater levels of compatibility between the two theories to avoid issues with the validity of findings.

From a methodological point of view, the data collected via the survey is extremely heterogeneous. Our sample is composed of virtual team members attending a training session from a range of activity sectors. We believe, however, that more homogeneous data could provide more relevant results. In addition, as our study is exploratory, we would like to add more qualitative data to help us to better understand relationship-building mechanisms from a behavioral complexity perspective before applying quantitative methods. Moreover, the data gathered only describes team members' perceptions of LMX and their leaders' roles. It would be interesting in future work to analyze leaders' perceptions of their contribution to relationship management in the team and to compare these findings with the members' perceptions (Zhou and Schreisheim, 2009).

Further research could be undertaken in the following areas. First, as relationship building is a continuous process, we believe that a longitudinal study (qualitative or quantitative) may provide more interesting results. A longitudinal study, for example, could illustrate how exchanges evolve over time and how the leaders' behaviors affect such relations. Second, as the functioning of virtual teams is based on information and communication technologies, we suggest that the integration of leaders' communication behaviors (interaction rhythm and style, communication nature, feedback nature and rhythm) may provide important insights into relationship dynamics (Sudweeks and Simoff, 2005). In this regard, we believe that the extension of behavioral complexity theory to include the communicator role of e-leaders would be interesting to enhance the results of future studies (Lawrence *et al.*, 2009).

Third, the effect of virtuality on e-leaders' contributions to LMX building could also be investigated. Previous research has suggested that virtuality plays a moderating role on team dynamics. We recommend that future work investigates how distance between members, communication frequency, the synchronicity of exchanges, etc. influence e-leaders' behaviors and their contribution to relationship management. In this sense, both LMX and BCT theories, initially developed for face-to-face teams, could be adapted to the virtual context and take into account virtual teams specificities regarding ICT used to communicate, how they are used, with which frequency, etc.

Finally, we believe that an interesting way of enhancing our study would be to analyze e-leaders' behavioral complexity and LMX quality effects on team performance. Identifying factors that influence virtual team performance would be of interest to both researchers and managers. It would make a valuable contribution to virtual team literature and would provide team managers with solutions to avoid failure. In this regard, investigating leaders' and members' contribution to team performance through behavioral complexity theory and LMX theory provides an interesting avenue of study.

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