Impact of transformational leadership on the diffusion of innovation in firms: Application to mobile cloud computing

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IMPACT OF TRANSFORMATIONAL LEADERSHIP ON THE DIFFUSION OF INNOVATION IN FIRMS: APPLICATION TO MOBILE CLOUD COMPUTING

Abstract

Leadership is a key determinant for organizations to adopt innovation successfully. However, research has not explored the leadership components that impact adoption stages (initiation, adoption, and routinization). In this work, we develop and empirically test a model based on both the transformational leadership components and the stages of the diffusion of innovation theory, using PLS methods and drawing on data from 154 firms, to study the adoption of a new technology, mobile cloud computing (MCC). Components such as vision, intellectual stimulation, supportive leadership, and personal recognition are significant for the intention to adopt, while supportive leadership is a driver for both adoption and routinization. The results of our study show that leaders' vision, combined with the capacity to consider others' feelings and recognize others' personal needs (both indicators of providing individual support), are strongly related with the adoption of an important IS innovation such as MCC. The present study shows that it is relevant to understand the influence of the leadership component separately on the diffusion of an innovation, rather than to keep them as just one all-encompassing construct. To the best of our knowledge, this is the first study to address the adoption of MCC in firms.

Keywords: Transformational leadership, mobile information systems, mobile cloud computing, diffusion of innovation (DOI), cloud computing.

IMPACT OF TRANSFORMATIONAL LEADERSHIP ON THE DIFFUSION OF INNOVATION IN FIRMS: APPLICATION TO MOBILE CLOUD COMPUTING

Introduction

Definitions of leadership often address the nature of influence and the role of individuals defined as leaders. Researchers have defined leadership in terms of group processes, traits, behaviors, or as a tool for achieving goals (Berson et al., 2006). Leadership can be defined as "the ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members" (House et al., 2002, p. 5). In today's work environment, which emphasizes adapting to change, leaders must thus consider how they can motivate followers to think and act creatively in both the development of new products and services and in the design of new work processes or problem-solving.

Transformational leadership has been linked to organizational innovation (Sarros et al., 2008, Jung et al., 2003) and can be defined as the leadership style that emphasizes the consciousness of collective interest among members of the organization, helping them to achieve their collective goals (García-Morales et al., 2012). It provides a favorable environment for innovation by involving employee's personal values system (Bass, 1985, Gardner and Avolio, 1998, Jung et al., 2003), raising motivation levels for the achievement of top performances (Shamir et al., 1993), encouraging employees to think creatively (Sosik et al., 1998, Sarros et al., 2008), and influencing the choices they make for management control systems (MCS) design (Nguyen et al., 2017). The results in Qu et al. (2015) suggest that transformational leadership positively influences the creativity of followers by creating a relational identification with the leader. Transformational leaders motivate others to do more than initially thought, and often even more than they thought possible (Bass and Riggio, 2006). They set more challenging expectations and often achieve higher performances. Transformational leaders have an interactive vision; they pay maximum attention to fostering effective communication, sharing values, and encouraging an appropriate environment for innovative teams (Tushman and Nadler, 1986).

In this study we assess the impact of leadership components on the diffusion of innovation in firms, within the context of an emerging paradigm in mobile IS, mobile cloud computing. The reason to address mobile IS, and in particular mobile cloud computing, is that the challenges around the multiplicity of technologies and the complexity of their interactions combined with the pervasive nature of mobile IS call for new levels of leadership (Lyytinen and Yoo, 2002). In mobile IS, leadership is not confined to company premises but can potentially exert influence anywhere, anytime, even in unexpected contexts. By spanning business and personal uses, and unlike other systems deployed in organizational settings, such as enterprise systems, mobile IS have revolutionized classic IT adoption logics (Leclercq-Vandelannoitte et al., 2014).

Mobile cloud computing (MCC) combines two important trends in IS, mobility and cloud computing, to enable the development of new service models, platforms, and applications (Bahl et al., 2012). MCC uses the cloud to expand the capabilities of mobile clients, such as smartphones and tablet computers (Khan et al., 2014, Yang et al., 2013), reducing resource utilization, providing an overall robust utilization experience, improving mobile device users' performance (Dinh et al., 2013, Ruay-Shiung et al., 2013). MCC also helps to overcome the growing need to store and process large amounts of data by offloading it to the cloud (Zhou and Buyya, 2018), and extending the capacities of current firm IS to applications that leverage high-performance computing resources, namely the use of intensive data-mining or simulations.

Depietro et al. (1990) identified top management leadership support as a key process in establishing a positive environment for adoption decision making. However, so far, research has not focused on and specifically identified, what components of leadership impact adoption and the diffusion of innovations. In this study, we aim to address this gap, while researching the adoption of mobile cloud computing from the perspective of the firm. Research in MCC has centered on the design and implementation challenges of MCC platforms and services, while MCC adoption literature has focused, so far, on the end-user perspective (Park and Kim, 2014, Kim and Kim, 2018). The present work also helps to address this lacuna. Thus, the research question for this study is the following: How, and in what stages, do the components of transformational leadership impact the diffusion of an IS innovation, here in the context of mobile cloud computing, in firms?

This paper, supported by an empirical study, makes an important contribution to the body of knowledge surrounding the diffusion of innovation and leadership, revealing the extent to which transformational leadership components are associated with the diffusion of innovation in IS. The study also addresses a significant gap in the research on the drivers and stages of MCC in firms.

The organization of the paper is as follows: in the next sections, we give an overview of transformational leadership, diffusion of innovation and MCC, the research hypotheses, and the research method. We close with the theoretical contributions and managerial implications, as well as perspectives for future work.

Background

In this section we discuss mobile cloud computing as an important emerging IS technology; diffusion of innovation theory, to frame the adoption conversation in an enterprise perspective; and transformational leadership, leading to the analysis of the role of leadership in the adoption of innovations.

Mobile Cloud Computing

Mobile devices enable mobile IS by providing users with multifunctional and powerful computing capacity to be available in any place (Middleton et al., 2014), supported, for this capability, by the ubiquity of mobile broadband.

Mobile cloud computing can be defined as a rich mobile computing technology that controls integrated elastic resources of different clouds and network technologies toward unlimited functionality, mobility, and storage. With the purpose of serving a broad array of mobile equipment anywhere and at any time through the Ethernet channel or Internet in spite of heterogeneous environments and platforms, on the basis of the pay-as-you-use principle (Sanaei et al., 2014).

Mobile cloud computing leverages the cloud infrastructure to allow mobile users to access diverse and scalable resources through mobile devices, offloading processing to the cloud, anywhere (Fernando et al., 2013). Bahl et al. (2012) argue that it also brings a shift in the cloud

paradigm itself since public clouds are designed for enterprise applications without any explicit consideration of mobile applications.

Mobile computing contributes with some unique features to IS (Picoto et al., 2014): time and location flexibility, enabled by portability (ability to readily carry the mobile devices), user or product identification (through SIM card), localization (ability to identify the geographic position of the mobile user), and instant connectivity (ability to be reachable and to have access at any time and in any place). However, mobile computing is subject to a few limitations, such as battery lifetime, storage capacity, processing ability and visualization power that MCC can help to overcome (Sanaei et al., 2014, Fernando et al., 2013). MCC empowers mobile users with the processing capabilities and storage services available in the cloud so that mobile devices do not need a powerful configuration (processor speed or memory capacity) because most of the complex processing can be offloaded to the cloud. Physical or virtual capabilities in the cloud can be quickly and elastically adjusted, in some cases automatically, giving the cloud service customer the appearance that the available physical or virtual resources are unlimited and can be purchased in any quantity at any time, subject only to the restrictions of service agreements (Mell and Grance, 2011, ITU-T, 2014).

Transformational leadership

Depietro et al. (1990) recognize top management leadership support as a key process in setting up a positive environment for adoption decision making. Many IS adoption studies in firms have therefore attempted to account for the support of top management. Neufeld et al. (2007) note, however, in their meta-analysis of 24 of these empirical IS adoption studies, that the measures used to capture involvement, commitment, and the different outcomes of the top management support are inconsistent and often weak, across different studies. Much of the research around top management support has not, seemingly, been built upon existing management theories in order to explain how leaders, in organizational settings, might influence technology implementation. As a result, the inconsistencies in both definitions and measures may not be surprising (Neufeld et al., 2007).

Transformational leadership is often contrasted to transactional leadership (Avolio and Bass, 1995), which focuses on the promotion of the interests of individual leaders and their followers and that fulfill contractual obligations on the part of both the establishment of objectives and

the monitoring and control of results. Transformational leaders empower followers and pay attention to their individual needs and personal development, helping them develop their own leadership potential, through coaching, mentoring, and support as well as challenging them to solve problems innovatively. Transformational leadership involves inspiring followers to engage in a shared vision and goals of an organization or unit. Transformational leaders tend to have more engaged and satisfied followers (Bass, 1985). Followers show extraordinary performance, often exceeding expectations, as an outcome responding to transformational leadership. On reviewing decades of studies in transformational leadership, Bass (1999) found that transformational factors generally have a greater correlation with outcomes in peer effectiveness and satisfaction than contingent reward. Contingent reward usually has a greater correlation with outcomes than exception management, particularly passive exception management. *Laissez-faire* leadership often has a negative correlation with the results. Emerging, and more recent, leadership theories such as authentic leadership (AL) (Avolio and Gardner, 2005), have received significant attention within the management literature, but despite the advances made both theoretically and empirically, researchers have expressed concerns regarding the contribution of AL theory to the leadership literature, due to the possibility of empirical redundancy between AL and transformational leadership (Banks et al., 2016).

The most widely used instrument in transformational leadership development is the multifactor leadership questionnaire (MLQ) by Bass and Avolio (2000), which assesses the full range of leadership (FRL) model. The FRL attempts to model leadership styles from non-leadership to transformational leadership. MLQ includes the components of transformational leadership; laissez-faire leadership; the components of transactional leadership, namely, management by exception (both active and passive forms); and contingent reward (Bass and Riggio, 2006). The content of the MLQ has varied over time, with the addition of transformational and transactional behaviors. Bass's (1985) conceptualization of transactional and transformational leadership included seven leadership factors, named then charisma, inspiration, intellectual stimulation, individualized consideration, contingent reward, management-by-exception, and *laissez-faire* leadership. In subsequent writings, Bass noted that although charismatic and inspirational leadership were unique constructs, they were often not empirically distinguishable, and reduced his original multifactor model to six factors (Avolio et al., 1999). Transactional leadership includes contingent reward behavior, passive management by exception, and active management by exception (Yukl, 1999). The original MLQ consisted of

73 items, measuring five factors. The MLQ was revised to respond to criticisms about the incorporation of items that did not focus directly on leader behaviors and concerns about the factor structure and subscales. The first version of the MLQ had 67 items measuring the FRL model. Of these, 37 items assessed transformational leadership. The 5X revision of the MLQ was significantly redefined and contains 36 items, with four items evaluating each of the nine leadership dimensions associated with the FRL model and nine additional outcome items (Bass and Riggio, 2006).

The MLQ has been criticized for its measurement properties (Lievens et al., 1997, Van Knippenberg and Sitkin, 2013), leading to the development of the alternative by Podsakoff et al. (1990) as well as the more recent by Rafferty and Griffin (2004), which distinguishes between the five subdimensions of vision, inspirational communication, intellectual stimulation, supportive leadership, and personal recognition. In this study, we follow this last model because it was developed to address the issues with the discriminant validity of the subcomponents identified in previous models (Rafferty and Griffin, 2004).

Diffusion of Innovation (DOI) theory

Theories based on technological innovation have been applied in empirical studies on IT adoption, also driving a better understanding of the questions of IT implementation (Cooper and Zmud, 1990). The DOI theory (Rogers, 2003) can be used to explain the process of diffusion of an innovation within a firm. Per DOI, *diffusion* is the process by which an innovation is communicated through certain channels, over time, among members of a social system. An *innovation* is an idea, practice, or object perceived as new by an individual or another unit of adoption. De Mattos and Laurindo (2017) refer that innovation is related to variables such as individual characteristics (leadership) as well as internal and external organizational characteristics. *Adoption* is the process of selecting a technology or initiative new to the organization and implementing it for use by its members (Damanpour et al., 2018). The rate of adoption is the relative speed with which members of a social system adopt the perceived attributes of an innovation. Studies of innovation adoption have been using these attributes among others in their search for factors influencing technological innovation adoption (Oliveira and Martins, 2011, Puklavec et al., 2018).

DOI enables us to take a process view moving from pre-adoption, adoption decision, and post-adoption (Damanpour and Schneider, 2006). They are usually named intention (persuasion stage), adoption (decision stage), and routinization (implementation stage) (Chong and Chan, 2012, Zhu et al., 2006b). When a firm has determined to adopt the innovation to support its business processes, we consider that it has entered the *intention* stage. As the firm becomes more knowledgeable and learns from the experience gained through the intention stage to reap the benefits of the innovation effectively through the application of technologies, it enters the next stage, which is the *adoption* stage. Once integration is complete and full-scale deployment of the innovation across the firm's value chain activities is assured, the final stage, *routinization*, is reached (Martins et al., 2016).

Theory

In this section, we develop the theoretical rationale for our research model shown in Figure 1. Recently, research has called for the introduction of transformational leadership as an extension to widely established technology adoption models, in particular through the components of intellectual stimulation and inspirational motivation, in which transformational leadership acts should "increase users' feature-level use and reduce the negative impact of legacy system habit" (Venkatesh et al., 2016). Following the five components of transformational leadership proposed by Rafferty and Griffin (2004): vision, inspirational communication, supportive leadership, intellectual stimulation, and personal recognition, as well as building on Damanpour and Schneider (2006) three stages of innovation diffusion, we develop the following hypotheses and conceptual model for the adoption of MCC.

Vision

Vision is an important dimension of transformational leadership that falls within the more general concept of charisma (Rafferty and Griffin, 2004). According to Bass (1985), the most important and general element in transformational leadership is charisma. A frequent theme when charisma is discussed is the importance of articulating a vision. McClelland (1975) said that the vision is the result of an internalization of values and organizational goals and aims that encourage individuals to adopt behaviors because of their attractiveness as opposed to the attractiveness of the leader. According to House (1976) vision is a transcendent ideal that represents shared values, and that is ideological in nature. Following Rafferty and Griffin

(2004), vision is defined here as the expression of an idealized picture of the future, based on organizational values. Zhang et al. (2015) emphasize that among the behaviors of the transformational leader is giving an appropriate and exemplary model to be followed by employees, which they can in mobile enterprise systems, in particular, MCC. Thus, we propose:

H1. Leader Vision positively impacts MCC diffusion (intention, adoption, and routinization).

Inspirational communication

Inspiration was defined by Downton (1973) as the action or the power to move the intellect or the emotions. Bass (1985) limited the use of the words "inspirational leadership" to instances in which a leader employs or adds emotional qualities to the process of influence, adding affective qualities through an inspirational discourse and emotional appeals (Rafferty and Griffin, 2004). A common element among the existing definitions of inspirational leadership is the use of oral communication to motivate and stimulate the emotions of followers. Joshi et al. (2009) argue that inspirational leaders are especially important in highly dispersed and technology intermediated contexts, such as the ones enabled by MCC. Following Rafferty and Griffin (2004), we define inspirational communication as the expression of positive and encouraging messages about the organization, and statements that build motivation and confidence. Thus, we propose:

H2. Leader Inspirational Communication positively impacts MCC diffusion (intention, adoption, and routinization).

Supportive leadership

According to Podsakoff et al. (1990), supportive leadership is defined as behavior on the part of the leader who indicates that he respects his followers and cares about their respective needs and feelings. The leader supportive behavior was set by House (1996) as behavior directed to the needs and preferences of subordinates, showing concern for the well-being of subordinates, and creating a friendly work environment able to provide support. Mobile information systems such as MCCs enhance the user's agency in managing interactions with business information systems and allow them more control over how, when, and where they engage in their various

personal and organizational roles (Middleton et al., 2014). Here we define supportive leadership as expressing concern for the followers and taking into account their respective individual needs (Rafferty and Griffin, 2004). Thus, we propose:

H3. Leader Supportive Leadership positively impacts MCC diffusion (intention, adoption, and routinization).

Intellectual stimulation

Intellectual stimulation includes behaviors that increase the interest of the followers in problems and in developing their ability to think through them in new ways (Bass, 1985). The effects of intellectual stimulation are increments in the abilities of the followers to conceptualize, understand, and analyze problems and the improvement of the qualities of the solutions they generate. This factor has been under-explored (Rafferty and Griffin, 2004), but this construct includes a set of behaviors more focused and internally consistent than other components of transformational leadership. Transformational leadership behaviors correlate positively with exploratory innovation (Jansen et al., 2009). Exploratory innovation requires new knowledge and was defined in March (1991) as "experimentation with new alternatives [that produce] returns [that] are uncertain, distant, and often negative." In a dissimilar way to the fixed information systems implemented in organizational environments, mobile information systems (and in particular MCC) can be implemented in order to dissolve organizational boundaries, to defuse professional and personal time and space, to challenge the classic logic of technology adoption, and to redefine the use of information systems (Leclercq-Vandelannoitte et al., 2014). Based on work by Rafferty and Griffin (2004) and Bass (1985), we define intellectual stimulation as the increase in the interest of employees and their sensitivity to the issues and the increase of their ability to think about problems in new ways. Thus, we propose:

H4. Leader Intellectual Stimulation positively impacts MCC diffusion (intention, adoption, and routinization).

Personal recognition

Personal recognition occurs when a leader shows that he values individual efforts and rewards achievements through praise and appreciation of the employees' efforts. Behaviors involving performance rewards are crucial to transformational leadership. Transformational leaders give due credit, express satisfaction, and appropriately reward followers when they do their work well. Transformational leaders lead their followers to "buy" their visions and internalize them so that followers become intrinsically motivated to strive for common goals and visions. The fact that they do not include reward contracts for performance in their leadership style does not prevent them from providing forms of public or social reward, monetary, or other forms (Goodwin et al., 2001). Personal recognition is thus defined as the provision of rewards, such as praise and recognition, for the attainment of specific objectives (Rafferty and Griffin, 2004). An appropriate combination of transformational leadership and cultural factors can improve organizational innovation and performance, overcoming traditional barriers to enterprise adoption such as cost and complexity, uncertain investment returns, changes of procedures, and the time required to integrate new technologies (Sarros et al., 2008). Thus, we propose:

H5. Leader Personal Recognition positively impacts MCC diffusion (intention, adoption, and routinization).

Diffusion of innovation (DOI)

In the intention to adopt stage the firm gathers information on the innovation. Through this process, the firm recognizes a need, searches for a solution, becomes aware of the existing innovations, identifies their suitability and advantages, and proposes the adoption (Damanpour and Schneider, 2006). The next stage is adoption, which refers to the decision making about the innovation. Adoption reflects evaluating the proposed innovation from technical, financial, and strategic perspectives, making the decision to accept the innovation as the desired solution, and allocating resources for its acquisition (Damanpour and Schneider, 2006, Chong and Chan, 2012). In this study, we adopt a unitary pattern that assumes the adoption process as orderly and occurring in a linear sequence (Damanpour and Schneider, 2006), from intention to adopt to routinization.

The intention to adopt stage establishes the baseline (Martins et al., 2016) for the firm to move toward the effective adoption, and from adoption to routinization (Chan and Chong, 2013). Thus, we propose:

H6. Intention to adopt MCC positively influences MCC adoption.

H7. MCC adoption positively influences MCC routinization.

We propose an integrative model grounded on the earlier theoretical foundation, encompassing both the transformational leadership theory and the diffusion of innovation (DOI) theory, as shown in Figure 1.

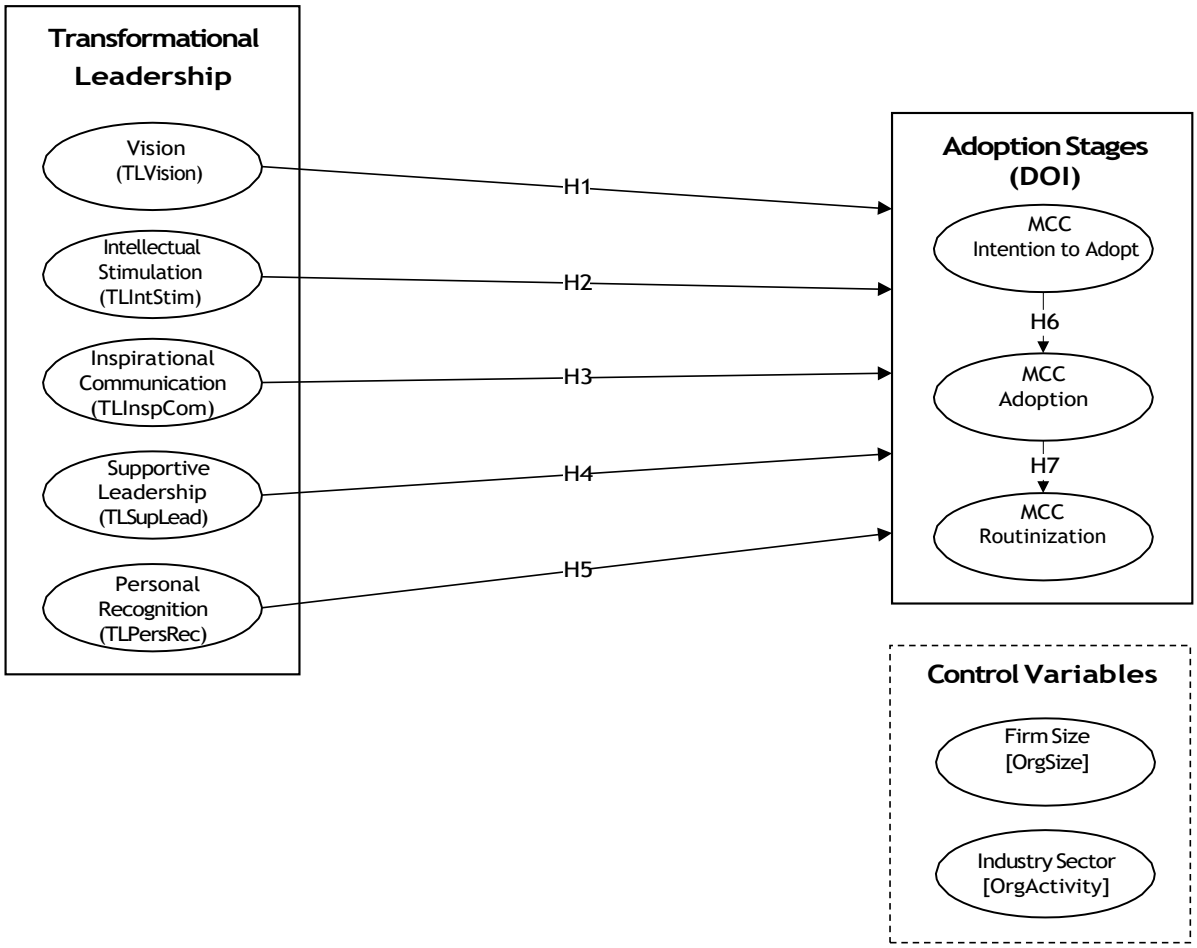

Fig. 1 Conceptual model of mobile cloud computing diffusion.

Based on transformational leadership theory we specify five sub-components (H1-H5: Vision, Intellectual Stimulation, Inspirational Communication, Supportive Leadership, and Personal Recognition) as determinants of Intention to Adopt, Adoption and Routinization of mobile cloud computing. Building on the diffusion of innovation theory we also posit a linkage from

Intention to Adopt to Adoption (H6) and from Adoption to Routinization (H7). We also incorporate Industry Sector and Firm Size as control variables in our model, in addition to the previously presented explanatory variables, to better reflect cross-sectional variations in MCC adoption (Zhu et al., 2006a). Regarding the impact of industry sector on adoption, Depietro et al. (1990) state that intense competition appears to stimulate the rapid spread of an innovation, and that the rates of diffusion are faster in industries that are not dominated by a few large firms. As per firm size, it is a widely studied organizational factor in the innovation and adoption literature (Bose and Luo, 2011, Oliveira and Martins, 2010) and research has shown that it impacts the way employees adapt to change as a result of IT implementation (Love et al., 2005). Some of the cross-sectional variations in adoption can only be explained if controls are appropriately applied (Zhu et al., 2003). Following a standard convention in IS research (Zhu et al., 2003, Chatterjee et al., 2002, Damanpour et al., 2018) of using dummy variables to control for effects of various sample characteristics, our study used firm size and four industry dummies to control for data variations that would not have been captured by the explanatory variables.

Methods

Measurement

To test the conceptual model, we built a questionnaire to survey European firms that are considering adopting or have already adopted MCC. This study uses pre-tested constructs from published empirical studies to ensure their validity and reliability. The constructs were thus based on literature and measured on a seven-point Likert scale ranging from “strongly disagree” to “strongly agree.” The Appendix presents each construct and its measurement items. All constructs are operationalized as reflective, to be consistent with the literature.

Data

A market consulting company provided the company and contact data, and we obtained the sample frame from a list source representative of the local market. The sampling was a stratified sample by industry and firm size, with a random selection within each category to minimize bias. To collect the data, we sent an e-mail with a brief description of the research and a link to the online survey to qualified personnel at 2,000 firms (e.g., CIOs, directors, and senior IS

managers) in Portugal. The introduction to the survey presented the research objectives, the academic aim of the results and defined mobile cloud computing as the expansion of the cloud computing concept to mobile devices, while also exemplifying its use in enterprise environments in applications such as communication and collaboration and customer relationship management. We gave respondents the opportunity to receive the findings of the study, in order to encourage a higher response rate. Data collection occurred in mid-year, 2016. Of the 230 responses received during a time interval of four weeks, 154 were complete and fully usable. We checked for consistency of the data. We found that distribution of firm size reflected a balance of large and small businesses. Following the recommendations by Podsakoff et al. (2003), we found no significant common method bias in our data. Furthermore, we did not find statistically significant differences in non-response bias. Table 1 presents the sample characteristics.

Table 1. Sample characteristics (n=154)

Industry			**Firm size (number of employees)**		
Services	65	42%	Micro (=<10)	19	12%
Manufacturing	25	16%	Small (11–50)	27	18%
Information and Communication	27	18%	Medium (51–250)	32	21%
Public Sector	17	11%	Large (>250)	76	49%
Other	20	13%			

Results

To empirically assess the research model, we used structural equation modeling (SEM). SEM techniques can be characterized in two families: covariance-based techniques and variance-based techniques (Henseler et al., 2009). Partial least squares (PLS) path modeling is a variance based technique that is required when maximum model complexity and low theoretical information are present (Henseler et al., 2009). We used SmartPLS 3 (Ringle et al., 2015) to evaluate the structural model.

5.1 Measurement model

Table 2 presents the composite reliability (CR) and the average variance extracted (AVE). All constructs have CR greater than 0.7, which confirms the reliability of the scales. Similarly, the average variance extracted (AVE) is greater than 0.5 for all constructs, which means that the measurement model demonstrates convergent validity. The latent variable explains more than half of the variance of their indicators. We evaluated the reliability of the indicators based on the criterion that the loadings should be greater than 0.7. In the values presented in Table 3, the loadings (in bold) are greater than 0.7, which means that the instrument displays good indicator reliability.

Table 2. CR, AVE, and Correlations

	CR	AVE	1	2	3	4	5	6	7	8
1. TLVision	0.96	0.889	**0.943**							
2. TLIntStim	0.948	0.858	0.691	**0.927**						
3. TLInspCom	0.957	0.882	0.699	0.758	**0.939**					
4. TLSupLead	0.944	0.85	0.596	0.725	0.63	**0.922**				
5. TLPersRec	0.977	0.935	0.552	0.675	0.689	0.801	**0.967**			
6. MCCi	0.922	0.798	0.456	0.427	0.391	0.242	0.336	**0.893**		
7. MCCa	0.924	0.801	0.35	0.343	0.341	0.263	0.310	0.796	**0.895**	
8. MCCr	0.915	0.782	0.346	0.229	0.25	0.219	0.203	0.605	0.627	**0.884**

Notes: Vision (TLVision); Intellectual Stimulation (TLIntStim); Inspirational Communication (TLInspCom); Supportive Leadership (TLSupLead); Personal Recognition (TLPersRec); Intention to adopt MCC (MCCi); MCC adoption (MCCa); MCC routinization (MCCr). The diagonal elements, in bold, represent the square root of AVE.

Table 3. Loadings and cross-loadings for the measurement model

	TLVision	TLIntStim	TLInspCom	TLSupLead	TLPersRec	MCCi	MCCa	MCCr
TLVision1	**0.950**	0.660	0.675	0.575	0.550	0.480	0.348	0.289
TLVision2	**0.944**	0.693	0.677	0.593	0.520	0.410	0.346	0.317
TLVision3	**0.933**	0.602	0.625	0.517	0.470	0.395	0.295	0.375
TLIntStim1	0.663	**0.935**	0.739	0.740	0.655	0.436	0.340	0.196
TLIntStim2	0.632	**0.934**	0.719	0.652	0.603	0.363	0.328	0.266
TLIntStim3	0.625	**0.911**	0.643	0.616	0.610	0.386	0.284	0.173
TLInspCom1	0.681	0.726	**0.947**	0.615	0.653	0.364	0.358	0.252
TLInspCom2	0.660	0.665	**0.928**	0.544	0.622	0.334	0.272	0.251
TLInspCom3	0.630	0.741	**0.941**	0.609	0.647	0.402	0.325	0.202
TLSupLead1	0.569	0.659	0.560	**0.950**	0.697	0.209	0.238	0.207
TLSupLead2	0.510	0.581	0.500	**0.908**	0.710	0.170	0.182	0.115
TLSupLead3	0.557	0.728	0.645	**0.907**	0.780	0.265	0.282	0.249
TLPersRec1	0.511	0.634	0.641	0.762	**0.973**	0.334	0.303	0.200
TLPersRec2	0.549	0.673	0.685	0.784	**0.966**	0.299	0.271	0.178
TLPersRec3	0.543	0.654	0.676	0.778	**0.977**	0.338	0.322	0.210
MCCi1	0.397	0.389	0.374	0.206	0.321	**0.917**	0.775	0.590
MCCi2	0.500	0.437	0.396	0.300	0.364	**0.919**	0.674	0.448

MCCi3	0.323	0.316	0.274	0.140	0.187	**0.840**	0.677	0.583
MCCa1	0.373	0.299	0.319	0.242	0.298	0.839	**0.868**	0.621
MCCa2	0.306	0.357	0.369	0.223	0.274	0.625	**0.908**	0.485
MCCa3	0.248	0.269	0.226	0.237	0.218	0.640	**0.909**	0.558
MCCr1	0.297	0.148	0.189	0.118	0.123	0.585	0.570	**0.860**
MCCr2	0.325	0.249	0.229	0.223	0.168	0.499	0.539	**0.887**
MCCr3	0.296	0.212	0.244	0.241	0.226	0.521	0.553	**0.906**

We examined the discriminant validity of the constructs using three criteria: Fornell-Larcker criteria, cross-loadings, and Heterotrait-Monotrait Ratio (HTMT) (Henseler et al., 2015). The Fornell-Larcker criterion requires the square root of the AVE to be larger than the correlations between constructs. In Table 2, the diagonal elements, namely, the square root of AVE, is larger than the correlations between constructs. All loadings are greater than the cross-loadings (please, see Table 3). As for the HTMT ratios, all are below the threshold of 0.9 (Table 4). Therefore, all the measures satisfy the discriminant validity of the constructs. The assessment of the construct reliability, convergent validity, and indicator reliability produces satisfactory results, showing that the constructs can be used to test the conceptual model.

Table 4. Heterotrait-Monotrait Ratio

	MCCa	**MCCi**	**MCCr**	**TLInspCom**	**TLIntStim**	**TLPersRec**	**TLSupLead**
MCCi	0.894						
MCCr	0.713	0.698					
TLInspCom	0.374	0.431	0.279				
TLIntStim	0.382	0.476	0.258	0.815			
TLPersRec	0.332	0.362	0.222	0.726	0.717		
TLSupLead	0.281	0.260	0.233	0.664	0.772	0.844	
TLVision	0.380	0.502	0.387	0.748	0.745	0.580	0.637

5.2 Structural model

We evaluated the significance of path coefficients through a bootstrapping procedure with 5000 iterations of resampling, as recommended by Henseler et al. (2016). In the model, in Figure 2, we indicate the variables that are statistically significant to each of the adoption stages. The results suggest that *vision* ($\hat{\beta}$ = 0.32; p < 0.01), *intellectual stimulation* ($\hat{\beta}$ = 0.30; p < 0.05), *supportive leadership* ($\hat{\beta}$ = -0.39; p < 0.01), and *personal recognition* ($\hat{\beta}$ = 0.28; p < 0.10) are

statistically significant to explain the intention to adopt MCC. The research model explains 32.1% of variation in intention to adopt MCC.

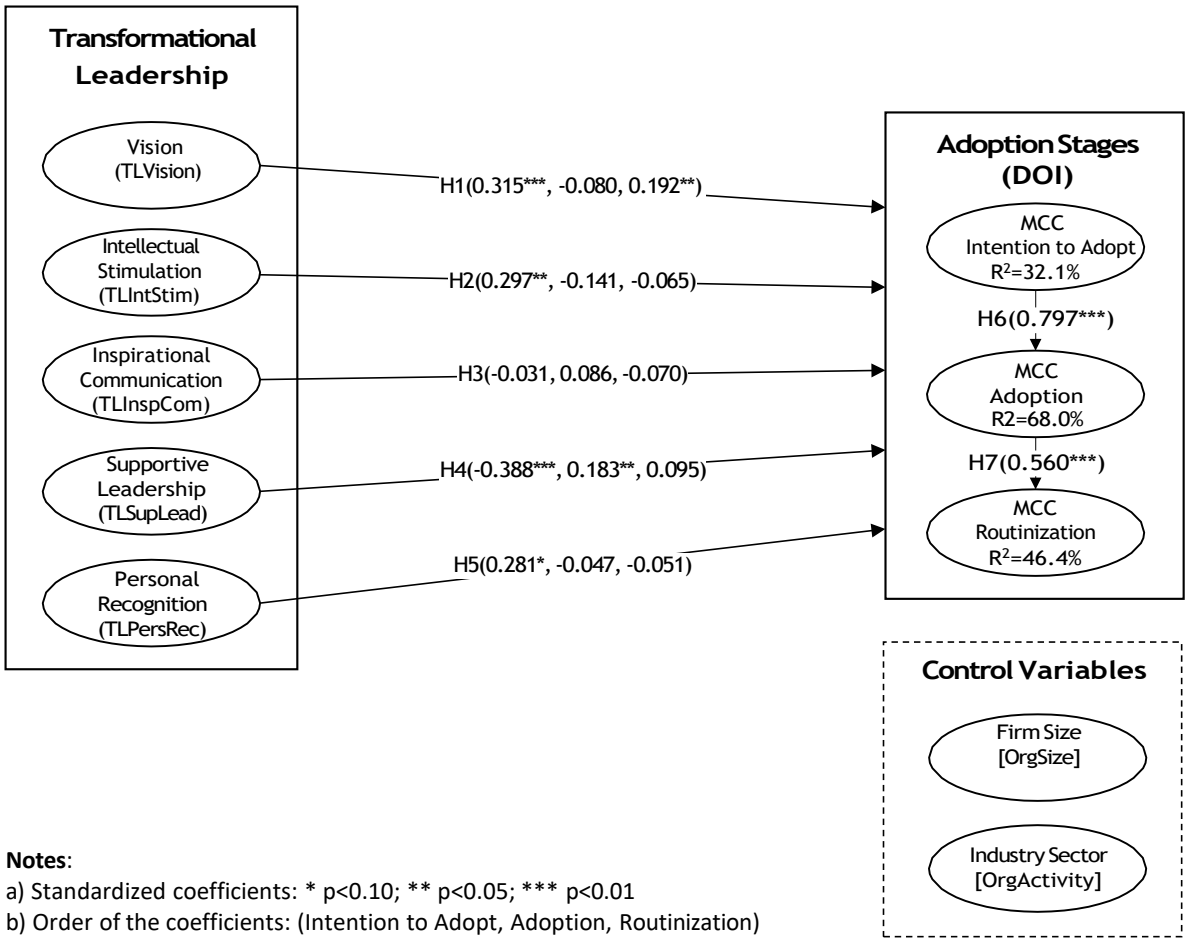

Figure. 2. Structural model of MCC diffusion

For adoption, *supportive leadership* ($\hat{\beta}$ = 0.19; p < 0.05) and *MCC intention to adopt* ($\hat{\beta}$ = 0.80; p < 0.01) are statistically significant in explaining MCC adoption. The research model explains 68% of variation in MCC adoption.

For routinization, *vision* ($\hat{\beta}$ = 0.19; p < 0.05) and *MCC adoption* ($\hat{\beta}$ = 0.56; p < 0.01) are statistically significant. The research model explains 46.4% of variation in MCC routinization.

Hypotheses 1, 2, 4, and 5 are partially supported, and hypothesis 3 is not supported (leader inspirational communication does not influence the innovation diffusion process). Hypothesis 6 (Intention to adopt MCC positively influences MCC adoption) and 7 (MCC adoption positively influences MCC routinization) are fully supported.

Discussion

This study seeks to understand the influence of transformational leadership components on the three stages of diffusion (intention, adoption, and routinization) of MCC in firms. The findings of this study contribute to our understanding of the connections among these constructs.

Transformational leadership

Research has shown that transformational leaders can motivate the follower to challenge the current ways of doing work and to seek improvements (Ng, 2017) and stimulate, support, and reinforce creative engagement, communicating to employees that their organization expects and values creativity and innovation (Wang et al., 2013).

As a result of our study, we conclude that the component of transformational leadership with the strongest positive influence on intention to adopt mobile cloud computing is leader vision. This finding confirms the assertion of Sarros et al. (2008) that visionary leaders are associated with organizations that provide resources, funding, people, and rewards for innovation, as well as the time for employees to pursue their own creative ideas. Intellectual stimulation also has explanatory power regarding the intention to adopt. Intellectual stimulation refers to the dynamics established by the leader for employees to rethink methods of work and engage in problem-solving activities (Rafferty and Griffin, 2004, Podsakoff et al., 1990). The intellectual stimulation of a leader leads to new ideas and an experience that is an integral part of the innovation process and the perception that the leader has of this process (Sarros et al., 2008). On the other hand, supportive leadership shows a negative influence on the intention to adopt mobile cloud computing and a positive one on adoption. This factor is consistent with findings that higher levels of transformational leadership may not always lead to favorable outcomes (Tepper et al., 2018). Supportive leader behavior provides psychological support for followers (House, 1996) and is primarily associated with their satisfaction (Rafferty and Griffin, 2004). Pierce and Aguinis (2013) argue, regarding individualized consideration, which encompasses supportive leadership (Rafferty and Griffin, 2006), that it can become a case of “too much of a good thing” effect: a desirable antecedent such as supportive leadership may also lead to neutral or even negative consequences, such as resistance, when those antecedents reach an inflection threshold. The inflection thresholds are context specific: what is considered excessive in one context may not be considered sufficient in another (Pierce and Aguinis, 2013). After the

decision to adopt being taken, however, leader support is a predictor to adoption which is also consistent with supportive leadership being strongly positively associated with affective commitment to the organization (Rafferty and Griffin, 2006). The initial resistance in the intention to adopt process gives way, once overcome, to a commitment to adoption, as a result of identification with the organization and its goals. Personal recognition is also a predictor for adoption. This finding is consistent with the overall idea of reward in transformational leadership literature. In the case of transformational leadership, a "psychological contract" is established in which the leader and follower share a vision and work toward its realization. A follower of a transformational leader is drawn by this vision and by the leader's inspiration and charisma. Due to the mutual investment in vision, followers implicitly assume that they can trust the leader to deliver the reward consistent with the level of performance (Goodwin et al., 2001).

Results also show that intellectual stimulation is not a predictor for the adoption and routinization of an innovation such as mobile cloud computing, which is also consistent with existing research on organizational innovation (Sarros et al., 2008, Strange and Mumford, 2005), in which vision showed greater ability to influence a climate more conducive to innovation than intellectual stimulation. Rafferty and Griffin (2004) argue for the differences between vision and inspirational communication, and this study confirms that by underlining the importance of vision, and the negligible impact of inspirational communication in the diffusion of MCC. According to Rafferty and Griffin (2004), when leaders communicate in a positive, even encouraging way, followers are likely to feel better able to perform a series of proactive, integrative tasks that go beyond the prescribed technical requirements. However, inspirational communication has an impact at an emotional, follower self-confidence level, and it was shown that for MCC diffusion, this level has no significant impact.

Diffusion stages

This study evaluated MCC diffusion in a three-stage process: intention to adopt mobile cloud computing, adoption, and routinization. Results indicate that each stage impacts the following one: intention to adopt impacts adoption, which, in turn, impacts routinization. The results obtained are consistent with other studies on the diffusion of innovations (Martins et al., 2016, Chan and Chong, 2013). The impact of transformational leadership should be felt more in the intention of adoption, contrasting with adoption and routinization, as confirmed by the

empirical results. The key role of top management in implementing change processes, including technology adoption, is to formulate an integrative vision and overall strategy, build a base of support, and guide and coordinate the process by which the strategy will be implemented. Complex changes usually involve a process of experimentation and learning. It is impossible to predict all the problems or to prepare detailed plans that allow us to realize all the aspects of the change. Instead of specifying the detailed guidelines for change at all levels of the organization, it is preferable to encourage intermediate levels of management to transform their own units in a manner consistent with vision and strategy. Top management should provide the incentive, support, and resources needed to facilitate change, but should not attempt to dictate the details of how to do so (Yukl, 2009). Successful implementation of innovation thus requires the continued commitment of top management and the collaboration of the organizational teams to build support among users, and monitoring progress, until it becomes a regular feature of the organization (Damanpour et al., 2018, Damanpour and Schneider, 2006).

Practical implications

The results of our study show that leaders' vision, combined with the capacity to consider others' feelings and recognize others' personal needs (both indicators of providing individual support (Sarros et al., 2008), are strongly related with the adoption of an important IS innovation such as MCC. Vision must be communicated often and using various communication channels. Face-to-face communication to explain and clarify issues that may arise is probably more effective than less interactive and personalized forms of communication (including, but not limited to, e-mail, newsletters, or recorded communications). If a form of non-contact communication is used to present the vision, then it is convenient to provide opportunities for further interaction (Berson et al., 2006). Results from this study also support the call from Van Knippenberg and Sitkin (2013) for further research on leader vision communication as a sub-dimension of transformational leadership.

Limitations and future research

This study presents limitations, that should be considered in interpreting and applying its findings, and that can pave the way for future research. First: the investigation refers to a single country in Europe, and it will be important to assess whether the results are consistent with those of other countries and regions. Second: it should be noted that this work focuses on

transformational leadership, but authors such as Vera and Crossan (2004) point out that the value of transactional leadership in organizational learning processes must also be considered, as is undoubtedly the process of technology diffusion. The tendency to make an equivalence between organizational learning and transformational leadership requires a simplification of learning processes throughout the organization (Vera and Crossan, 2004, Bass, 1985). Third: the adoption of any innovation is a dynamic process, as noted in earlier diffusion studies (Zhu et al., 2006b), and this study refers to a static measurement, not offering a longitudinal perspective of diffusion. We suggest, therefore, a longitudinal study to evaluate the diffusion of MCC over a prolonged interval of time. Fourth: this study focusses on the impact of the transformational leadership components on the adoption of mobile cloud computing. While it is based on solid research on adoption in firms, many other factors may impact the adoption of innovations (Oliveira and Martins, 2011, Rogers, 2003, Depietro et al., 1990, Venkatesh et al., 2016) and that can be considered in future studies. Fifth: the drivers for MCC adoption might differ for firms in different industry sectors (Love et al., 2005, Oliveira and Martins, 2010), as well as from large size to small and medium-size organizations (Zhu and Kraemer, 2005). Future research can address these different drivers. Sixth: analysis and determination of the inflection points for transformational leadership dimensions are the domain of relation-specific theorizing, as also noticed by Pierce and Aguinis (2013), and may be addressed in future studies.

Conclusion

Although leadership characteristics have fundamental importance in the adoption of innovation, components of transformational leadership have seldom been studied in the diffusion of innovation. Some authors propose collapsing the components of transformational leadership into a single construct (Avolio et al., 1999) while others propose keeping them separate. The present study shows that it is relevant to understand their influence separately. We studied the adoption of mobile cloud computing because it is a technology in which, by its nature, the leader can provide “exemplary behavior” as a role model for employees to follow (Zhang et al., 2015). Results suggest that transformational leadership is associated with the adoption stages through the processes of articulation of a vision and by providing individual support to employees.

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Appendix

	Measurement Items	Source
Constructs		
Vision	TLVision1: Has a clear understanding of where we are going. TLVision2: Has a clear sense of where he/she wants our organization to be in 5 years TLVision3: Has no idea where the organization is going. (R)[a]	(Rafferty and Griffin, 2004)
Inspirational communication	TLIntStim1: Says things that make employees proud to be a part of this organization. TLIntStim2: Says positive things about the organization. TLIntStim3: Encourages people to see changing environments as situations full of opportunities.	(Rafferty and Griffin, 2004)
Intellectual stimulation	TLInspCom1: Challenges me to think about old problems in new ways. TLInspCom2: Has ideas that have forced me to rethink some things that I have never questioned before. TLInspCom3: Has challenged me to rethink some of my basic assumptions about my work.	(Rafferty and Griffin, 2004)
Supportive leadership	TLSupLead1: Considers my personal feelings before acting. TLSupLead2: Behaves in a manner which is thoughtful of my personal needs.	(Rafferty and Griffin, 2004)

	TLSupLead3: Sees that the interests of employees are given due consideration.	
Personal recognition	TLPersRec1: Commends me when I do a better than average job. TLPersRec2: The top executive acknowledges improvement in my quality of work. TLPersRec3: The top executive personally compliments me when I do outstanding work.	(Rafferty and Griffin, 2004)
Intention to adopt MCC	MCCi1. My company intends to use MCC if possible. MCCi2. My company collects information about MCC with the possible intention of using it. MCCi3. My company has conducted a pilot test to evaluate MCC.	Chan and Chong (2013)
MCC adoption	MCCa1. My company invests resources in MCC. MCCa2. Business activities in our company require the use of MCC. MCCa3. Functional areas in my company require the use of MCC.	Chan and Chong (2013)
MCC routinization	MCCr1. We have integrated MCC with our existing backend/legacy systems. MCCr2. MCC is being implemented with our trading partners. MCCr3. MCC is being implemented with our customers.	Chan and Chong (2013)

[a](R) indicates that the item was reverse-scored.