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MANAGEMENT'S IT COMPETENCE IN TURBULENT MARKET ENVIRONMENTS

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Research in Progress

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Abstract

We analyze the effect of IT competence on management’s support for novel technology when facing environmentally-induced pressures. We argue that competent managers are less prone to the effects of mimicry in turbulent environments. We aim to evaluate our hypotheses with a study on blockchain technology in the energy sector, which has recently been particularly affected by rapid changes and uncertainty. Apart from the theoretical contribution, this project has several potential implications for practice. For instance, organizations may be able to increase their resilience in turbulent environments by investing in management’s IT competence.

Keywords: IT Competence, Environmental Turbulence, Top Management Support, IT Assimilation.

1 Introduction

Many industry environments are currently characterized by fast-paced changing markets and uncertainty regarding technological developments. In these environments, organizations tend to mimic competitors when facing technology investment decisions. In this project, we investigate how management's IT competence helps organizations resist such tendencies and make more informed technology investment decisions. Environments that exhibit rapid and highly unpredictable changes regarding technology and markets have been described as turbulent (Buganza, Dell'Era, and Verganti, 2009). Researchers have found that in such environments institutional pressures lead management to imitate other, presumptively successful organizations when facing technology investment decisions (Ang and Cummings, 1997; Liang et al., 2007). In this way, management hopes to safeguard market shares and minimize technology search costs. However, to assess a technology's true potential, management's IT competence is an important factor for organizations (Sambamurthy, Bharadwaj, and Grover, 2003).

In this project, we combine these research perspectives to understand whether IT competence helps management mitigate the effects of mimetic pressures in turbulent environments. This has not been analyzed before and would imply the possibility that investing in management's IT competence is a suitable means for organizations to counteract the adverse effects of fast-paced and uncertain environments in decision-making. We are building a structural model to evaluate how IT competence interacts with the investigated factors within the use case of blockchain technology (Risius and Spohrer, 2017) in the transitioning energy sector (Markard, 2018). In particular, we perform reliability and validity tests for our derived measurement model based on survey data.

The remainder of the paper is structured as follows. In Section 2 we summarize prior work on institutional pressures, turbulent environments and IT competence and relate these factors to each other in our research model. Section 3 explains the methodology of the prestudy we performed to validate the constructs of our model. It also includes an interpretation of initial results and an outlook on the full empirical study. Finally, Section 4 concludes with the presentation of expected contributions and underlying implications.

2 Conceptual Model

Digital transformation induces rapid changes and uncertainty regarding technology- and market environments in multiple industries. In these turbulent environments, existing stakeholders are searching for ways to cope with this uncertainty This effort entails the introduction of IT innovations such as big data analytics in mobility (Dremel et al., 2017), ERP-systems in logistics (Olorunniwo and Li, 2010), fintech in banking (Sia, Soh, and Weill, 2016), digital publishing in media (Hess et al., 2016), and smart grid technologies in the energy sector (Markard, 2018). We derive insights from prior research of similar environments in which uncertainty exerts pressures on management to mimic other organizations' efforts to introduce IT innovations. We extend the state of the art by additionally analyzing the influence of IT competence, which we hypothesize to mitigate such pressures in turbulent environments. Accordingly, we propose the structural model in Figure 1, which is based on well-established relations (Liang et al., 2007; Wolf, Beck, and Pahlke, 2012). As existing approaches study environmental turbulence and IT competence separately, we are unaware of any research combining these two perspectives.

2.1 Mimicry of IT Innovations in Turbulent Environments

In organizations, top management is able to foster the assimilation of technologies by using its authority to shape values, rules-, and routines (Liang et al., 2007).Top management support for a given technological innovation is influenced by institutional pressures (DiMaggio and Powell, 1983), as found by Liang et al. (2007) and Saraf et al. (2013). Among these, *mimetic pressures* incentivize organizations to imitate apparently successful competitors in order to minimize search costs under uncertainty (Teo and Pian, 2003). While institutional pressures in general have been found to be among the best predictors for

technology assimilation (Jeyaraj, Rottman, and Lacity, 2006), mimetic pressures in particular have been identified as the strongest institutional forces responsible for influencing management's IT decisions (Mignerat and Rivard, 2009). Since these established models yield evidence that mimetic pressures positively impact top management support, we expect the following hypothesis to hold true:
H1*: Mimetic pressures are positively linked to top management support in favor of an innovation.*

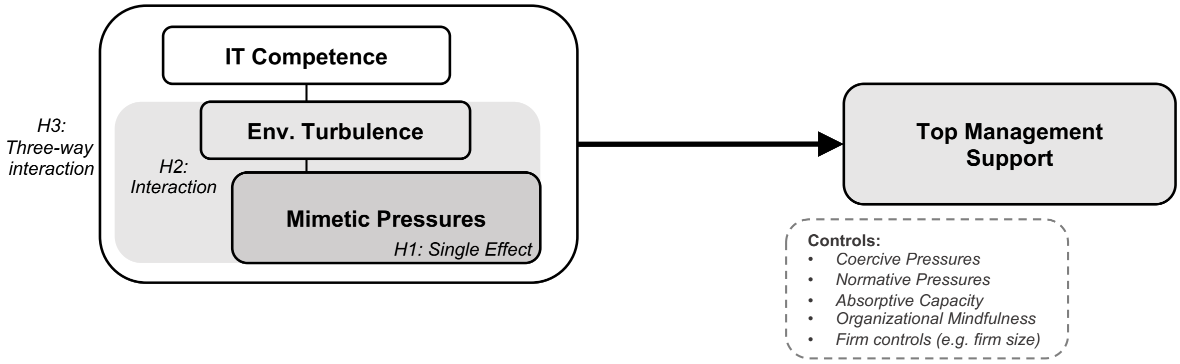

Figure 1. Conceptualized structural model

While mimetic pressures impact top management support, the industry environment in which these effects manifest also plays an important role for the assimilation of a technological innovation by firms (Jeyaraj, Rottman, and Lacity, 2006). Transitioning industries are characterized by uncertainty that manifests as both unpredictability (implying the possibility of frequent change) and rapidity of change in firms' technology- and market environments (Buganza, Dell'Era, and Verganti, 2009). This phenomenon is described generally as environmental dynamism (Dess and Beard, 1984) or, more specifically, *environmental turbulence* (Damanpour and Gopalakrishnan, 1998; Haleblian and Finkelstein, 1993; Mendelson and Pillai, 1998). In turbulent environments, in which future developments are uncertain, organizations mimic other, presmuptively succesful organizations, in the hope to stabilize future outcomes (Ang and Cummings, 1997). Accordingly, Wolf, Beck, and Pahlke (2012) find that environmental turbulence reinforces mimetic pressures on management to adopt an IT innovation. We follow this reasoning and propose:
H2*: The interaction of environmental turbulence and mimetic pressures is positively related to management support for an innovation.*

2.2 IT Competence in Turbulent Environments

IT competence is essential for the assimilation of information systems in businesses (Armstrong and Sambamurthy, 1999; Thong, Yap, and Raman, 1996). It is an antecedent for firms' performance through competitive innovation and complexity along their information value chain (Sambamurthy, Bharadwaj, and Grover, 2003). IT competence represents management's increased understanding of IT through gathered knowledge (of IT infrastructures or professional IT contacts) and experience (in the setting of IT strategies and budgets). We build on this foundation (Bassellier, Benbasat, and Reich, 2003) for the conceptualization of IT competence in our model. Prior studies have revealed links between institutional pressures, induced by mimicry or competition, and IT-related competences (Braojos-Gomez, Benitez-Amado, and Llorens-Montes, 2015; Liang et al., 2007). Research on the assimilation of IT systems in the context of institutional pressures on top management has suggested the integration of constructs from the field of organizational learning, such as IT competence (Liang et al., 2007). Congruently, Bharati, Zhang, and Chaudhury (2014) suggest reviewing IT competence as a factor to determining the impact of institutional effects in IT assimilation. While Hsu, Lee, and Straub (2012) established a model in which top management support and IT capabilities independently act as moderators for institutional effects on IT assimilation, we aim to further this approach by investigating the dynamics between these two factors within the context of institutional pressures. In turbulent environments, the increased knowledge intensity of the competitive setting requires the effective utilization of IT capabilities to support business processes (Pavlou and El Sawy, 2006). With a sufficient IT infrastructure, firms can quickly adjust to shifting environmental contingencies and facilitate an organizational learning process (Hsu, Lee, and Straub, 2012). Furthermore, wide-ranging information networks – such as social ties to information sources (as operationalized through IT competence – enable firms to exhibit superior responsiveness and performance in turbulent business environments (A. Zaheer and S. Zaheer, 1997). In the presence of uncertainty, IT competence improves the information availability for members of an organization (Davis and Golicic, 2010). Management is incentivized to develop IT expertise and thus improve its firm's internal information environment in order to avoid potential backlash and penalties for making poor-quality forecasts (Haislip and Richardson, 2017). Accordingly, management with substantial IT knowledge can rely on an improved information environment when making operational decisions, which positively affects rationality in IT planning and decision-making (Ranganathan and Sethi, 2002). We are building upon the discussed research and derive a three-way interaction (Little, Bovaird, and Widaman, 2006) of IT competence with mimetic pressure and environmental turbulence. Since managers with high IT competence are adequately informed regarding IT innovations, we assume that they are more resilient to both mimetic pressures and uncertainty in their industry environment. Therefore, we propose:

***H3**: IT competences mitigates mimetic pressures and environmental turbulence in a three-way interaction.*

2.3 Control Variables

While the established effect of mimetic pressures on management support is subject to our hypothesized interactions, we include the remaining institutional pressures as controls. *Coercive pressures* represent formal institutions, government regulations and standards (Liang et al., 2007; Xue, Liang, and Boulton, 2008), while *normative pressures* represent norms among professionals who share values (Meyer and Rowan, 1977). Within a system of institutional pressures, dynamic capabilities become known linkages to management support. In this context, it was identified as necessary to review IT-focused competencies in their interaction with institutional effects (Bharati, Zhang, and Chaudhury, 2014). For instance, IT capabilities, such as the prevalence of IT knowledge sources outside the firm, and *absorptive capacity* as the ability to identify external knowledge (Roberts et al., 2012) may be interlinked in turbulent environments (Pavlou and El Sawy, 2006). In specific environmental conditions, another concept from dynamic capability research – *organizational mindfulness* – is considered a requirement in order to tailor correct decisions (Weick, Sutcliffe, and Obstfeld, 1999) as it enables more nuanced decision-making capabilities (Langer, 1989). In organizations, mindfulness describes the use of expertise, as well as a general awareness of the organization's processes (Fiol and O'Connor, 2003; Wolf, Beck, and Pahlke, 2012). This concept has been studied as a means of resisting mimicry phenomena (Swanson and Ramiller, 2004; Wolf, Beck, and Pahlke, 2012). Since the dynamic capabilities discussed in these previous studies pertain to access and utilization of specific knowledge (such as IT competence) as essential for decision-making in technology assimilation, we include the respective constructs in our model as controls. Additionally, we control for the heterogeneity of the *firm* (size, departments of respondents, etc.) and the implemented ledger technology.

3 Design of Empirical Study & Domain Background

We choose to conduct our empirical study in the energy sector. This industry is in the process of transitioning from centralized power plants to distributed energy assets. Firstly, this transition induces uncertainty regarding technological developments to address coming challenges such as the coordination of an increasing number of generation assets (e.g. congestion management). Secondly, fast-paced market developments challenge conventional utility business models. For instance, electricity is evolving from a basic commodity to a product catered to customers' individual needs (Woo et al., 2014). Furthermore, higher market participation by consumers, as well as pending regulatory reform, are indicators of a given degree of uncertainty. While electric utilities are searching for ways to cope with these uncertainties, innovations like the Internet of Things (IoT) and smart building systems are maturing into market-ready products. These technological developments are becoming a potential foundation for electric utilities to meet changing customer demand and to stand out in an increasingly competitive energy market. In particular, blockchain innovations, such as the inclusion of smart contracts in Ethereum (Wood, 2014), may be potential building blocks to address the stated challenges. While generally, the distributed ledger technology (DLT) has been around for a decade, blockchain remains an abstract term. For this research project, we refer to a broad definition of blockchain as describing all distributed ledger technologies that can be used to record and validate information exchanges between different stakeholders.

We investigate blockchain technology based on a structural model derived from theory and survey data, similar to the manner in which previous literature has researched IT innovations such as ERP-systems (Liang et al., 2007), cloud computing (Oliveira, Thomas, and Espadanal, 2014), grid computing (Wolf, Beck, and Pahlke, 2012) or RFID (Lee and Shim, 2007). These innovations have differing impacts on industries depending on how closely they are intertwined with firms' processes and legacy IT systems. In contrast to innovations affecting only core technological processes (type I) and administrative support (type II), we consider blockchain to be a so-called type III innovation (Swanson, 1994), one that potentially affects multiple stations along the value chain. For instance, blockchain is utilized for data transfer in critical infrastructures (Merz, 2018), renewable energy certificates (SP Group, 2018), or peer-to-peer transactions (Mengelkamp et al., 2017).

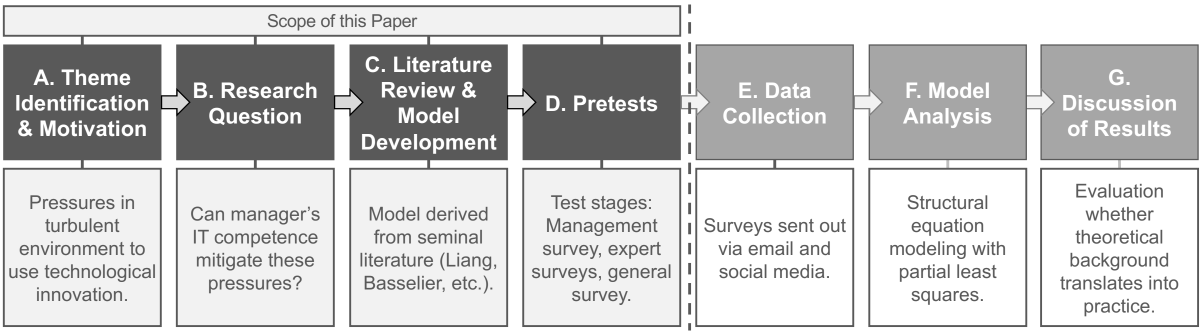

Figure 2. Research design.

The procedure of our empirical study is depicted in Figure 2. After deriving a general theme (A), research questions (B) and hypotheses from the theoretical background (C), we designed a pretest (D). We will collect the data (E) for assessing the proposed model (F) through an online survey targeting professionals. We will present the full set of questions to 3500 professionals who will be surveyed on the discussed topics regarding their management. The prepared database comprises contacts we collected at industry events (e.g. conferences), as well as a comprehensive list of professional development course participants at the authors' academic organizations.

Following the procedure suggested by Moore and Benbasat (1991), for the pretest stages, we first generated items for measuring each construct from existing instruments and adjusted them to the domain context where necessary. During the early stages, we conducted interviews with 12 experts to ensure content validity. We use 5-point Likert scales, which have been found to maximize response rate, while either 5-, 7- or 10-point scales yield comparable results in structural equation modeling (Dawes, 2008). We then consulted 15 managers from electric utility companies to verify whether our observed circumstances from the domain match the constructs from the seminal literature. Afterward, we handed an initial version of the survey to 20 participants during an energy conference. This survey included space for open comments in order to refine the items. We then repeated the refinement process through an online test survey that also included empty boxes to accommodate comments. This survey was filled out by 30 personal contacts from

Construct	Items: *5-point Likert (1 = disagree; 5 = agree)*
Mimetic Pressures	
(Liang et al., 2007)	"Our competitors who use blockchain...
MP1	...have greatly benefitted."
MP2	...are favorably perceived by others in the same industry."
MP3	...are favorably perceived by their suppliers and customers."
Environmental Turbulence	
(Buganza, Dell'Era, and Verganti, 2009)	"In our industry...
ET1	...customer requirements change rapidly over time."
ET2	..it is difficult to anticipate the changes of customer needs."
ET3	...technologies change rapidly over time."
ET4	...it is difficult to anticipate the changes of technologies."
IT Competence	
(Bassellier, Benbasat, and Reich, 2003)	"Our top management...
IT1	...generally has valuable knowledge of IT."
IT2	...has valuable knowledge of blockchain technology."
IT3	...knows how to carry out IT projects."
IT4	...has knowledge of the IT infrastructure in our firm."
IT5	...has a network of IT sources outside of our firm."
IT6	...has often participated in developing IT strategy."
IT7	...has often participated in setting IT budgets."
Top Management Support	
(Liang et al., 2007)	"Our top management...
TM1	...believes blockchain has the potential to provide sign. business benefits."
TM2	...believes blockchain will create a significant competitive arena for firms."
TM3	...believes it is necessary to use blockchain to conduct business activities."
TM4	...formulated a strategy for the organizational use of blockchain."
TM5	...articulates a vision for the organizational use of blockchain."
TM6	...established goals to monitor blockchain-related activities."
Absorptive Capacity	
(Ettlie and Pavlou, 2006)	"Our firm...
AC1	...is able to identify and import knowledge from external partners."
AC2	...has adequate internal routines to analyze the knowledge obtained."
AC3	...can successfully integrate new knowledge acquired."
AC4	...can successfully exploit new knowledge into concrete applications."
Coercive Pressures	
(Liang et al., 2007)	"The...
CP1	...local government requires our firm to use blockchain."
CP2	...the industry association requires our firm to use blockchain."
CP3	...the competitive conditions require our firm to use blockchain."
Mindfulness	
(Weick, Sutcliffe, and Obstfeld, 1999)	"In our firm...
MF1	...people are encouraged to express opinions and we appreciate scepticism."
MF2	...people have informal contacts to use for solving problems."
MF3	...the people most qualified to make decisions make them."
MF5	...we learn from mistakes and people feel free to talk to about problems."
Normative Pressures	
(Liang et al., 2007)	
NP1	"Our firm's IT services providers already use blockchain."
NP2	"Our firm's business partners already use blockchain."
NP3	"The government promotions influence our firm to use blockchain."

Table 1. Survey items.

the energy sector. Building on the previous tests, the final prestudy stage included an online survey with our finalized items, which are depicted in Table 1. For this survey, we consulted another 110 personal contacts through email, of whom 82 people responded. From the collected data, we removed 11 observations exhibiting missing values, resulting in a sample of 71 full survey responses for the final pretest.

We chose partial least squares (PLS) as an analytical technique because it can map reflective and formative constructs, both of which will potentially be relevant for the full analysis (Gefen, Straub, and Boudreau, 2000; Hair, 2017). We evaluate the measurement model by analyzing its construct validity and reliability (Table 2). The internal consistency reliability of the constructs is being tested with the Cronbach's Alpha criterion – which uses the intercorrelations of the indicator variables – and the more robust composite reliability criterion. Furthermore, the ρ_A criterion is being used to test for consistent reliability. The recommended threshold of 0.7 is met for all measures (Dijkstra and Henseler, 2015).

	Cronbach's Alpha	ρ_A	Composite Reliability	AVE
AC	0.87	0.89	0.91	0.72
CP	0.79	0.82	0.87	0.70
ET	0.78	0.86	0.85	0.59
IT	0.92	0.95	0.94	0.67
MF	0.79	0.86	0.86	0.55
MP	0.88	0.88	0.93	0.80
NP	0.75	0.79	0.85	0.65
TM	0.94	0.94	0.95	0.77

Table 2. Reliability measures.

To test for convergent validity, we consider the average variance extracted (AVE), which is above the recommended value of 0.5 for all constructs, meaning that the constructs explain more than half of the variance in the measurement model (Hair, 2017). We further control the outer loadings of the model in Table 3 (Appendix). These loadings indicate how much the items have in common that is captured by the respective construct. Most item loadings are above the recommended threshold of 0.708 (Hair, 2017), with the exception of ET4 and MF2. However, deleting these items did not increase the average variance extracted. In order to test for discriminant validity, we consider item cross-loadings, suggesting that all items are measuring their respective constructs instead of others in Table 3 (Appendix). Our results suggest that each construct is unique and does not represent other items of the model. Furthermore, we consider the heterotrait-monotrait ratio, a criterion for which the respective measures in Table 4 (Appendix) were all below 0.9, suggesting that the distinguished constructs are unrelated to each other (Henseler, Ringle, and Sarstedt, 2015). When the data collection is finished for the full study, we will analyze the structural model in Figure 1 for the complete collected dataset. After an initial calculation of the model, we plan to perform pair-wise t-tests resulting from bootstrapping subsamples during the PLS procedure in order to obtain the significance levels for the respective hypotheses. Finally, we aim to include additional tests, such as a finite mixture partial least squares analysis to control for unobserved heterogeneity throughout different segments of the observations (Ringle, Wende, and Will, 2010).

4 Expected Contributions and Implications

In this research project, we aim to investigate how management's IT competence affects their support for a given IT innovation in turbulent environments. We are unaware of existing research that has answered this question before. Insights into these dynamics are relevant for investment decision-making in relation to new technologies in transitioning markets. Assuming that our hypotheses hold, our research would have the following implications: 1) IT competence is a suitable means of mitigating the effect of mimicry in turbulent market environments; 2) investing in IT competence can enable firms to remain resilient in the face of technological uncertainty. We conduct our empirical study in the energy sector, as it is subject to rapidly changing markets and uncertainty regarding technological developments. Even though we cannot guarantee generalizability, we are confident of yielding valuable implications for IS researchers and managers beyond the energy sector, since many industries are currently experiencing similar turbulence. So far, we have tested a measurement model from a pretest survey. As our next steps, we will finish the ongoing data collection and analyze the full structural model.

Appendix

	AC	CP	ET	IT	MF	MP	NP	TM
Absorptive Capacity: AC1	0.84	0.08	0.18	0.26	0.42	0.17	0.12	0.32
Absorptive Capacity: AC2	0.82	0.19	0.13	0.38	0.37	0.08	0.18	0.34
Absorptive Capacity: AC3	0.91	0.17	0.10	0.46	0.64	0.24	0.13	0.49
Absorptive Capacity: AC4	0.82	0.16	0.14	0.39	0.45	0.30	0.16	0.45
Coercive Pressures: CP1	0.12	0.85	0.21	0.28	-0.14	0.32	0.55	0.32
Coercive Pressures: CP2	0.13	0.83	0.17	0.27	-0.10	0.31	0.56	0.30
Coercive Pressures: CP3	0.18	0.82	0.25	0.11	0.10	0.40	0.40	0.46
Environmental Turbulence: ET1	0.20	0.33	0.88	0.19	0.05	0.52	0.28	0.37
Environmental Turbulence: ET2	0.19	0.12	0.82	0.13	0.19	0.27	0.06	0.23
Environmental Turbulence: ET3	0.05	0.18	0.75	0.13	0.00	0.23	0.07	0.26
Environmental Turbulence: ET4	-0.11	0.01	0.58	-0.08	0.00	0.17	-0.02	0.08
IT Competence: IT1	0.30	0.18	0.04	0.85	0.21	0.25	0.22	0.34
IT Competence: IT2	0.34	0.25	0.13	0.83	0.25	0.30	0.20	0.49
IT Competence: IT3	0.49	0.27	0.33	0.88	0.48	0.42	0.22	0.62
IT Competence: IT4	0.44	0.32	0.22	0.77	0.42	0.40	0.30	0.66
IT Competence: IT5	0.34	0.14	0.01	0.87	0.31	0.24	0.16	0.39
IT Competence: IT6	0.22	0.07	-0.05	0.75	0.38	0.12	0.08	0.30
IT Competence: IT7	0.32	0.02	0.08	0.78	0.42	0.12	0.04	0.41
Mindfulness: MF1	0.47	0.01	0.06	0.49	0.86	0.01	0.06	0.44
Mindfulness: MF2	0.35	-0.14	0.09	0.10	0.45	-0.01	-0.16	0.12
Mindfulness: MF3	0.48	-0.04	0.12	0.38	0.74	0.04	-0.14	0.34
Mindfulness: MF4	0.38	-0.20	0.03	0.20	0.78	0.01	-0.11	0.23
Mindfulness: MF5	0.44	0.09	0.03	0.32	0.81	0.10	0.11	0.38
Mimetic Pressures: MP1	0.25	0.44	0.34	0.39	0.04	0.85	0.32	0.51
Mimetic Pressures: MP2	0.19	0.33	0.45	0.27	0.08	0.93	0.35	0.51
Mimetic Pressures: MP3	0.22	0.36	0.37	0.29	0.01	0.91	0.43	0.42
Normative Pressures: NP1	0.10	0.36	0.08	0.05	0.01	0.26	0.79	0.29
Normative Pressures: NP2	0.16	0.32	0.06	0.13	-0.01	0.32	0.83	0.25
Normative Pressures: NP3	0.15	0.63	0.22	0.30	-0.04	0.38	0.80	0.46
Top Management Support: TM1	0.36	0.43	0.40	0.60	0.34	0.59	0.36	0.88
Top Management Support: TM2	0.39	0.39	0.36	0.55	0.31	0.56	0.35	0.87
Top Management Support: TM3	0.29	0.42	0.39	0.45	0.28	0.53	0.35	0.86
Top Management Support: TM4	0.50	0.36	0.22	0.53	0.51	0.40	0.38	0.89
Top Management Support: TM5	0.48	0.35	0.26	0.54	0.48	0.38	0.45	0.89
Top Management Support: TM6	0.52	0.42	0.18	0.48	0.40	0.38	0.44	0.85

Table 3. Item cross-loadings.

	AC	CP	ET	IT	MF	MP	NP	TM
Absorptive Capacity (AC)	0	0	0	0	0	0	0	0
Coercive Pressure (CP)	0.21	0	0	0	0	0	0	0
Environmental Turbulence (ET)	0.22	0.27	0	0	0	0	0	0
IT Competence (IT)	0.46	0.30	0.20	0	0	0	0	0
Mindfulness (MF)	0.67	0.22	0.19	0.46	0	0	0	0
Mimetic Pressures (MP)	0.27	0.49	0.46	0.35	0.09	0	0	0
Normative Pressures (NP)	0.21	0.71	0.19	0.23	0.20	0.49	0	0
Top Management Support (TM)	0.52	0.50	0.36	0.60	0.47	0.59	0.49	0

Table 4. Heterotrait-monotrait ratio.

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