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Exploring the role of the transactive memory system in virtual team resilience: Evidence from online medical teams

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Exploring the Role of the Transactive Memory System in Virtual Team Resilience: Evidence from Online Medical Teams

Short Paper

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Abstract

The capacity to resist and recover from challenges and adversities (i.e., resilience capacity) is critical for a virtual team to survive. However, our knowledge of what influence the development of resilient virtual teams have yet to be fully developed. Drawing on the transactive memory system (TMS) theory, we propose that TMS will enhance a virtual team resilience capacity. Applying discontinuous growth modeling, results of an empirical study involving 1974 online medical teams from a popular online healthcare platform in China provide available evidence. We found inconsistent effects of the three dimensions of TMS on online medical team resilience capacity. Specifically, specialization shows no significant impact. Credibility can enhance online medical team resilience capacity for both process and outcome performance. For coordination, voice centralization positively affects online medical team resilience capacity for process performance. These findings advance virtual team resilience literature and inform practitioners about how to build resilient virtual teams.

Keywords: Virtual teams, team resilience, transactive memory system

Introduction

Organizations require flexibility and agility in delivering products and services in the current highly competitive market environment. Benefiting from the rapid development of information and communication technology, organizations have opportunities to establish virtual teams to meet these needs. Virtual teams are geographically, temporally, or organizationally dispersed individuals who are united for a common purpose and collaborate through information and communication technologies (Kirkman et al., 2004). Today, virtual teams appear in various fields and play a critical role in integrating information, decision-making, and implementing actions (Lin & Roan, 2022). According to a recent survey with 2,700 respondents from 106 countries, nearly 70 percent preferred virtual and remote work (CultureWizard, 2021).

Although virtual teams have many advantages over traditional teams (i.e., face-to-face teams), such as flexibility, lower costs and improved resource utilization, they also inevitably face various adverse

situations. Virtual team adversities may occur in many forms, from chronic stressors (e.g., lack of timely communication, constant pressure, unclear team roles) to acute shocks (e.g., crisis events, sudden interpersonal conflict, technology failure) (Degbey & Einola, 2020). These adverse events can lead to team failure or performance setbacks, adversely affecting team cooperation. Previous studies have emphasized team resilience, the capacity to resist and recover from setbacks and adversities, as a vital role in virtual teams coping with these adverse situations (Hartwig et al., 2020). However, most of these are qualitative or empirical studies based on experiments or surveys; there is a lack of empirical validation based on objective data from actual events.

Based on the conservation of resources (COR) theory, Stoverink et al. (2020) proposed a theoretical model of work team resilience and pointed out that a transactive memory system (TMS) may enhance a team's ability to respond to adversity and improve team resilience. The TMS in a team is especially relevant for understanding team knowledge processes, which describes team members actively using interactive memory to store, retrieve, and communicate information cooperatively (Lazar et al., 2022). Teams with TMS enable quick access to specialized expertise in handling complex team tasks (He & Hu, 2021). In this way, a well-developed TMS can help the team enhance information processing efficiency and organizational effectiveness, which will, in turn improve team improvisation capacity (To et al., 2021; Vera & Crossan, 2005). Therefore, a well-developed TMS of a team may contribute to team resilience by strengthening its inventory of adversity responses (Gomes et al., 2014). In other words, the TMS is critical to team resilience as it can make teams more flexible in dealing with adversity and unexpected events.

However, we still lack an understanding of building resilient virtual teams by developing TMS. The body of empirical literature verifying the role of TMS on team resilience has remained modest, mainly attributed to two reasons. One is partly due to the lack of a commonly accepted conceptualization of resilience (Gucciardi et al., 2018). Since resilience research is usually driven by specific circumstances, the definitions of resilience vary across studies. Another reason is that it is difficult to obtain objective data for external threats, disruptions, or disasters because they are hardly predictable, and there is no preparation to record information, while resilience can only be demonstrated in adversity (Degbey & Einola, 2020).

On January 23, 2020, the Chinese government officially locked down Wuhan in Hubei province to prevent the spread of COVID-19. Since then, other cities in China have taken measures such as self-isolation and partial lockdowns. Therefore, January 23, 2020, can be seen as a time point for the outbreak of COVID-19 in China. The outbreak of COVID-19 has affected people's lives, which will undoubtedly bring external interference to the operation of virtual teams as collaboration becomes more challenging. The outbreak of COVID-19 provides a realistic environment for us to explore virtual team resilience empirically. Building on the TMS theory, we empirically examine the essential role of TMS on virtual team resilience, reflected by the resilient virtual team performance, based on the data from 1974 online medical teams on an online health platform in China. We adopt the discontinuous growth modeling (DGM) method, which allows us to identify different team resilience stages: resistance and recovery. The service-oriented nature of these teams leads us to focus on both team process and outcome performance. Figure 1 shows our research model. Specifically, we theorize about and empirically test the role of three indicators of TMS in teams (Lewis, 2003): (1) specialization: the diverse knowledge of team members; (2) credibility: members' beliefs in the reliability of other members' expertise; (3) coordination: team members' ability to coordinate work efficiently based on their transactive memory. The greater the presence of TMS's every indicator, the more developed the TMS in a team.

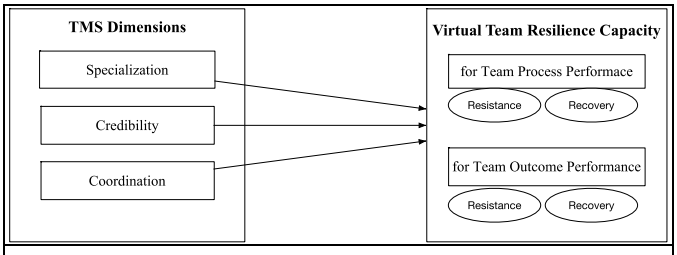

Figure 1. Research Model

Theoretical Background and Hypotheses

Team Resilience

Given the turbulence of the business environment, it is unsurprising that team resilience has gained a rich body of work over the past few decades (Hartwig et al., 2020). However, there are no commonly accepted definitions of team resilience. Most studies defined team resilience as a process (Bennett et al., 2010; Morgan et al., 2013), outcome (Gucciardi et al., 2018), belief (Vera et al., 2017), or capacity (Degbey & Einola, 2020). Different studies have different understandings of team resilience (see Table 1).

Reference	Perspective	Definition
(Morgan et al., 2013)	Process	A dynamic psychosocial process protects individuals from the potential adverse effect of the stressors they encounter together
(Bennett et al., 2010)	Outcome and process	The outcome and processes of achieving positive adaptation in risk or adversity
(Gucciardi et al., 2018)	Outcome	An emergent outcome characterized by the trajectory of a team's functioning, following adversity exposure, as one that is mainly unaffected or returns to normal levels after some degree of deterioration in functioning
(Stoverink et al., 2020)	Capacity	The capacity to bounce back from the adversity-induced loss
(West et al., 2009)	Capacity	The capacity to bounce back from failure, setbacks, conflicts, or any other threat to well-being that a team may experience
(Hartmann et al., 2021)	Capacity	The capacity to successfully cope with adverse situations, adapt, and grow
(Brykman & King, 2021)	Capacity	The capacity to bounce back from adversities or setbacks
(Degbey & Einola, 2020)	Capacity	The capacity to bounce back from adversity
(Vera et al., 2017)	Belief and capacity	The belief that a team can cope with strain, as well as the capacity to cope, recover, and adjust positively to difficulties

Table 1. Team Resilience Perspectives and Definitions of Current Literature

Based on previous work, we conceptualize virtual team resilience as a team's capacity to resist and recover from adversities (Stoverink et al., 2020). Building on process-based resilience research (Bennett et al., 2010; Morgan et al., 2013), we define two successive resilience stages (resistance and recovery) and assign essential team capacity to each stage. We conceptualize virtual team resilience capacity as a team property that varies as a function of team inputs, processes, outcomes, and context, demonstrated by the resistance and recovery trajectory following exposure to adversities (Hartmann et al., 2021). To express more clearly and concisely, we define the team resilience capacity in the two resilience stages as resistance capacity and recovery capacity. The conceptualization highlights the dynamic nature of virtual team resilience capacity, influenced by teams' composition, existing experience, knowledge, and interactions among team members.

In order to give a complete picture of online medical team resilience capacity for service performance, we consider its two dimensions: process (service efficiency) and outcome (order quantity), which are widely used to evaluate the medical service performance (Huang et al., 2021). Therefore, when a disruption occurs, online medical teams will show a performance degradation immediately after the disruption, and this low level of degradation is considered an indicator of high resistance capacity. Furthermore, the high recovery rate of online medical team service performance is considered an indicator of high recovery capacity.

Specialization and Virtual Team Resilience Capacity

Specialization refers to "the differentiated structure of members' knowledge" (Lewis, 2003), which is the tendency for teams to specialize in different aspects of the task. A virtual team with members specialized in different areas can provide complementary resources and increase team access to valuable information from within (To et al., 2021). In addition, according to the motivated information processing in groups

model, diverse knowledge within a team can trigger team members' epistemic motivation for information processing and, in turn, drive team members to seek more relevant information for an accurate understanding of the situation (Nijstad & De Dreu, 2012). Consequently, virtual team members with high knowledge or expertise diversity will increase team knowledge coordination and utilization, facilitating team members' interactions with the environment and improving team adjustment to adverse situations (Kirkman & Stoverink, 2021). Therefore, specialization may enhance virtual teams' resistance and recovery capacity for both process and outcome performance in facing adversities. Thus, we hypothesize:

Hypothesis 1: Specialization is positively related to virtual team resistance capacity for both (a) process performance and (b) outcome performance.

Hypothesis 2: Specialization is positively related to virtual team recovery capacity for both (a) process performance and (b) outcome performance.

Credibility and Virtual Team Resilience Capacity

Credibility refers to team members' beliefs about the reliability of other members' expertise and knowledge (Lewis, 2003). Prior studies have proved that credibility could promote team information exchange by enhancing team members' psychological safety (Stoverink et al., 2020). Furthermore, credibility will enhance members' collaboration by promoting their understanding of others' knowledge and expertise, which leads to a more effective information process (Vera & Crossan, 2005). Accurate judgments of adversity mainly rely on the willingness of members to exchange information. Therefore, credibility could help virtual teams make effective decisions when adversity is detected, reducing misunderstandings and miscommunications. In addition, credibility may also strengthen the belief that the collective process will reach its goals (Vera & Crossan, 2005). Hence, we hypothesize:

Hypothesis 3: Credibility is positively related to virtual team resistance capacity for both (a) process performance and (b) outcome performance.

Hypothesis 4: Credibility is positively related to virtual team recovery capacity for both (a) process performance and (b) outcome performance.

Coordination and Virtual Team Resilience Capacity

Coordination refers to "effective, orchestrated knowledge processing" (Lewis, 2003), that is, the team members' ability to coordinate teamwork efficiently based on their knowledge about who knows what in the team. In virtual teams characterized by a high level of coordination, team members can quickly access specialized expertise, improving the team's efficiency in tackling information and reducing the cognitive workload. In other words, specialization expands virtual teams' accessible resource pool, whereas coordination improves their utilization of the pool (Ren & Argote, 2011). The effective use of team members' input resources relies on knowledge coordination. Numerous studies emphasize the vital role of coordination in team resilience, which could drive more effective operational responses to adverse situations (Barton & Kahn, 2019; Brykman & King, 2021). On this basis, we hypothesize:

Hypothesis 5: Coordination is positively related to virtual team resistance capacity for both (a) process performance and (b) outcome performance.

Hypothesis 6: Coordination is positively related to virtual team recovery capacity for both (a) process performance and (b) outcome performance.

Method

Empirical Context and Data

To test our hypotheses, we rely on an empirical study with online medical teams (i.e., virtual medical teams) from a popular online health platform in China. Online medical teams are built by a couple of physicians who may come from different departments, hospitals, and regions. Team members collaborate to diagnose and treat the same patient via the internet, and the patient can get answers and suggestions from multiple physicians through the team service. The website maintains a homepage for each team, displaying each team's basic information and service information. We collect all medical team data on the website at the

end of each month from October 2019 to March 2020 (6 months: 3 months pre- and 3 months post-outbreak day). We exclude those inactive teams as no patient consulted them for six months. We thus get our final dataset of 1974 teams, resulting in a balanced panel with 11844 observations.

Measures

In this study, *Team service process performance* is measured by a team's reply speed for a given month, calculated by the percentage that team members can reply to patients' questions within 24 hours. *Team service outcome performance* is measured by the log transformation for team service consultations during the month.

Following the definition of specialization (Lewis, 2003), we measure *Specialization* by the team's expertise diversity, computed using Blau's index (Bunderson, 2003). In the Chinese healthcare system, a physician's professional seniority is represented by the clinical tile assigned by the government. Therefore, a higher proportion of physicians with senior clinical titles on the team will bring firmer belief about the reliability of members' expertise because members tend to believe physicians with senior clinical titles. Therefore, we measure *Credibility* by the proportion of physicians with senior clinical titles. Regarding coordination, we considered the team's service mode: *Voice centralization*, which describes the distribution of physicians' replies during team service consultations. We use the Gini coefficient to reflect the distribution of physician members' replies during team service consultations in month t. We operationalize *Voice centralization* as a binary variable, with 1 for Gini coefficient > 0.4 and 0 otherwise.

We control team size, team service price, and the characteristics of team leaders, including their personal service waiting time, personal service outcome performance, recommended popularity, clinical title, and gender, which may influence online medical team service performance. In addition, we also control for month fixed effects and team department fixed effects by dummy codes.

Analytic Strategy

We adopt DGM to analyze the model, which allows us to model changes in team service performance before (pre-outbreak), during (transition), and after (recovery rate) the outbreak of COVID-19. DGM provides a dynamic perspective to identify team resilience capacity for service performance, including resistance (reflected in transition) and recovery capacity (reflected in recovery rate). We follow modeling procedures common in organizational literature (Bliese et al., 2020). Dependent variables are *Team service process performance* and *Team service outcome performance*. The change variables allow us to capture team resistance and recovery capacities. Their coding and interpretations are summarized in Table 2. Our moderating variables are *Specialization*, *Credibility*, and *Voice centralization*. The interaction items between these variables and *TRANS*/*RECOV* allow us to test whether three dimensions of TMS (i.e., specialization, credibility, coordination) impact online medical team resilience capacity.

Change Variables	Measurement Period						Interpretation
	1	2	3	4	5	6	
TIME	0	1	2	3	4	5	The natural trend of team service performance over time
TIME.A	0	1	2	2	2	2	Absolute coding of the TIME
TRANS	0	0	0	1	1	1	The initial change in the level of team service performance following the outbreak of COVID-19
RECOV	0	0	0	0	1	2	Longer-term change in trend (i.e., slope) of team service performance after the outbreak of COVID-19

Table 2. Coding and Meaning of Change Variables in the Discontinuous Growth Model

Results

We first add *TIME* and its square term to the model to check the nonlinear growth trajectory of dependent variables. Following this, we run a baseline DGM by adding *TIME.A*, *TRANS*, and *RECOV*. Table 3 provides the results. As shown in Model 1 and Model 3, the coefficients of $TIME^2$ are both significantly positive and

the coefficients of *TIME* are both negative. These results indicate that *Team service process performance* and *Team service outcome performance* are U-shaped over time, implying a process of decline and recovery over the six months. In Model 2, we find that the coefficient of *RECOV* is significantly positive, which indicates a positive recovery slope of *Team service process performance* after the outbreak of COVID-19. In Model 4, we find that the coefficient of *TRANS* is significantly negative, which indicates a decrease in *Team service outcome performance* caused by the outbreak of COVID-19. Furthermore, the significantly positive coefficient of *RECOV* indicates a positive recovery rate of *Team service outcome performance* after the outbreak of COVID-19.

Variables	*Team service process performance*		*Team service outcome performance*	
	Model 1	Model 2	Model 3	Model 4
TIME	-0.0095		-0.0784***	
	(0.006)		(0.010)	
$TIME^2$	0.0021*		0.0138***	
	(0.001)		(0.002)	
TIME.A		-0.0044		-0.0183**
		(0.005)		(0.008)
TRANS		-0.0051		-0.1197***
		(0.009)		(0.014)
RECOV		0.0103**		0.0708***
		(0.004)		(0.009)
Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.				

Table 3. Growth Curve Pre-Test and Baseline DGM Results

Based on the above analysis, we test our hypotheses by adding interactions to the models and controlling other possible effects. Table 4 and Table 5 show the results. First, we find that the interactions between *TRANS* and *Specialization* in both Model 5 (0.0303, $p > 0.1$) and Model 11 (0.0153, $p > 0.1$) are insignificant. Also, the interactions between *RECOV* and *Specialization* in both Model 8 (-0.0013, $p > 0.1$) and Model 14 (-0.0243, $p > 0.1$) are still insignificant. Therefore, Hypotheses 1 and 2 are not supported. Second, we observe that the coefficients of the interaction between *TRANS* and *Credibility* in both Model 6 (0.0487, $p < 0.1$) and Model 12 (0.1455, $p < 0.01$) are significantly positive, which indicates that online medical teams with higher *Credibility* showed a smaller decrease in *Team service process performance* and *Team service outcome performance* when the COVID-19 outbreak occurred. Therefore, Hypothesis 3 is supported. The coefficient of the interaction between *RECOV* and *Credibility* is not significant In Model 9 (0.0218, $p > 0.1$) but positively significant in Model 15 (0.0663, $p < 0.05$), indicating that the outcome performance of the online medical teams with higher *Credibility* recover faster, but no evidence for process performance. Hence, Hypothesis 4 (a) is not supported, but Hypothesis 4 (b) is supported.

Third, we find a significantly positive coefficient of the interaction between *TRANS* and *Voice centralization* in Model 7 (0.0705, $p < 0.01$), which indicates that online medical teams with voice centralization service mode decreased smaller in process performance when the COVID-19 outbreak occurred, which is contrary to our hypothesis. Moreover, the interaction coefficient between *TRANS* and *Voice centralization* in Model 13 is insignificant (-0.0059, $p > 0.1$). Hence, Hypothesis 5 is not supported. In addition, we find that the coefficient of the interaction between *RECOV* and *Voice centralization* in Model 10 is positive and significant (0.0358, $p < 0.05$), but insignificant in Model 16 (0.0066, $p > 0.1$). These results indicate that online medical teams with voice centralization service mode recover faster in process performance following the outbreak of COVID-19, contrary to our hypothesis. And this phenomenon does not exist for outcome performance. Therefore, Hypothesis 6 is not supported.

Variables	Resistance Stage			Recovery Stage		
	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
TRANS × *Specialization*	0.0303					
	(0.030)					
TRANS × *Credibility*		0.0487*				
		(0.026)				
TRANS × *Voice centralization*			0.0705***			
			(0.027)			
RECOV × *Specialization*				-0.0013		
				(0.016)		
RECOV × *Credibility*					0.0218	
					(0.014)	
RECOV × *Voice centralization*						0.0358**
						(0.017)
Change Variables	YES	YES	YES	YES	YES	YES
Moderating and Control Variables	YES	YES	YES	YES	YES	YES

Notes: Change variables include *TIME.A*, *TRANS*, and *RECOV*; Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4. DGM Results Predicting Team Service Process Performance

Variables	Resistance Stage			Recovery Stage		
	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
TRANS × *Specialization*	0.0153					
	(0.054)					
TRANS × *Credibility*		0.1455***				
		(0.047)				
TRANS × *Voice centralization*			-0.0059			
			(0.053)			
RECOV × *Specialization*				-0.0243		
				(0.037)		
RECOV × *Credibility*					0.0663**	
					(0.032)	
RECOV × *Voice centralization*						0.0066
						(0.038)
Change Variables	YES	YES	YES	YES	YES	YES
Moderating and Control Variables	YES	YES	YES	YES	YES	YES

Notes: Change variables include *TIME.A*, *TRANS*, and *RECOV*; Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5. DGM Results Predicting Team Service Outcome Performance

Discussion

This study obtained several crucial findings. First, specialization does not significantly impact online medical team resilience capacity, contrary to our expectations. One possible explanation relates to the spatial distance feature of virtual teams, leading to the complex effects of specialization. On the one hand, highly diverse professional backgrounds of team members can increase the available resources within the team, thereby improving the team's ability to cope with adversity (Vera & Crossan, 2004). On the other hand, the diversified knowledge may not play a role due to lacking of timely communication (e.g., physicians' online time is not synchronized). Another possible explanation relates to team conflict. Physicians from diverse functional backgrounds have different goals and working styles, which may cause conflict (Dougherty, 1992). Thus, online medical teams with high level of specialization may be challenging to guarantee the effectiveness of members' communication and knowledge integration. Second, our findings show that credibility can enhance online medical team resistance capacity for process and outcome performance and team recovery capacity for outcome performance. However, we find no significant impact of credibility on team recovery capacity for process performance, possibly due to the lack of statistical power.

Finally, we find significantly positive effects of voice centralization on online medical team resistance and recovery capacity for process performance, but not outcome performance. These findings indicate that coordination can help online medical teams resist service efficiency loss and recovery faster following the outbreak of COVID-19. In our research context, voice centralization means only a few physician members respond to patients' questions. These few physicians do most of the responding work, saving the time of physician handover and reducing patients' waiting time. Therefore, the voice centralization service mode can improve team resilience capacity for process performance, but may harm the use of members' diverse expertise. Hence, the advantages and disadvantages of voice centralization may jointly lead to an insignificant impact on team resilience capacity for outcome performance.

The contributions of the current study are three-fold. First, our study contributes to the literature on virtual team resilience and TMS theory. This study is among the first to verify TMS's effect on virtual team resilience empirically. We shed light on the vital role of TMS in virtual teams and provide practical insights on building a resilient virtual team. Our findings suggest that devoting time to nurturing team members' reliability and personal ability is critical in improving team functioning and virtual team resilience capacity. Second, our study identifies virtual team resilience's resistance and recovery stage through the DGM method, which allows us to examine virtual team resilience from a dynamic perspective. We answer the scholarly calls to illuminate the dynamic nature of team resilience (Linnenluecke, 2017). Third, we contribute to scaring empirical research on virtual team resilience. We provide empirical evidence by exploring the critical factors for building resilient virtual teams based on the external disruption of the COVID-19 pandemic. We respond to the scholarly call for empirical research to extend the understanding of resilience issues (Degbey & Einola, 2020).

Although our study provides important insights, there are still some limitations. First, we investigated virtual teams from an online healthcare platform, and these virtual teams are built to provide online healthcare services to patients. Hence, certain distinctive characteristics of the research context may have impacted the results. Although we are confident that our results hold implications for virtual teams in different backgrounds, constructive replications in other contextual settings are warranted to further explore and refine the theory developed in this study. Second, resilience can only be demonstrated in adversity. Our study investigated virtual team resilience based on teams' responsiveness to the outbreak of COVID-19. Therefore, future studies can extend this study in different adverse situations.

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