Journal of Business Studies Quarterly
2024, Volume 14, Number 3
ISSN 2152-1034

Journal of Business Studies Quarterly jbsq.org

A New Perspective on Leadership, Management, and Technology Within Virtual Team Environments

Dr. Raushan Gross
Pfeiffer University, USA
Raushan.gross@pfeiffer.edu

Abstract
We have witnessed the proliferation of technological tools at this moment more than at any other time in the history of business, management, and leadership. Digital platforms are created, implemented, and applied to business management and decision-making and provide the ability to enhance performance across borders in real-time. While technology has increased by leaps and bounds in decades past, there needs to be more to say in the literature about how leadership styles operate in virtual environments to ascertain further advancement in team environments. Artificial team members, virtual tools, and other technological advances have taken place in management, but we need to assess these realities to determine if a new management framework for the establishment of new virtual team configurations. Although we need a theoretical floor to assess virtual team interactions, artificial team members, task dependencies, relational attitudes, etc., in the leadership and business management literature, where the results and inquiries are relatable, and the reality matches the theory concerning the distance of time and space, global management, and leadership styles. Alternatively, will artificial intelligence (AI) and other technological platforms negate human leadership? Will natural leadership systems and human leadership skills enhance virtual team effectiveness? At the intersection of theory and the real world, this theoretical assessment of leadership and technology pinpoints the apparent leadership styles as drivers of team effectiveness related to leadership styles via digital platforms. There is an alignment, albeit theoretical, with team effectiveness and a corresponding leadership style within various team environments, primarily virtual and geographically dispersed team configurations.

Key words: leadership styles, Artificial Intelligence, Team effectiveness, Management performance, AI team member

Introduction

According to the current literature on virtual teams, there is a sizable gap in the literature on leadership styles' influence on virtual team member effectiveness. With the advent of digital platforms and software such as Notion, Mirco, Zoom, ChatGTP, AI for Everyone, Slack, and MS Teams, with little knowledge that lends itself to leading in these virtual environments, it is not surprising that Zeuge et al. (2020) agreed that "Further research is needed because the future will continue to be shaped by virtual teams during and sometime after the rapid change" (p. 2). Employees and management will meet virtually now as an alternative to in-person meetings and project-based work. The missing element in this development is the role management and organizational leadership styles required to engage and motivate performance via team environments. Although the literature has reported some research about the qualitative role of leadership in virtual teams, there is a theoretical connection between leadership styles, managerial performance, and virtual team effectiveness. Virtual meetings and working allow firms to recruit and employ the best talent globally (Smith & Ruiz, 2020). Digital virtual-related tools, such as Zoom, Webex, Google Meet, GoTo Meeting, Skype, text, Slack, etc, have increased in the past decade, allowing people to conference with one another in a technology-driven form. Virtual meeting tools enhance the firm's ability to mobilize knowledge and resources. The same assumption can be made regarding virtual team entrepreneurial orientation and members' ability to be creative and transmit knowledge and ideas (Gross, 2017). As such, there is a chasm at the theoretical level of virtual team leadership management performance across platforms, and to some degree the importance of entrepreneurial leadership on virtual team process and impact on innovation within the firm.

Although several studies have demonstrated leadership differences in team-level performance, a theoretical gap in the literature reports on the assessment and extent to which leadership styles explicitly or implicitly impact virtual team effectiveness or virtual esprit de corps still exists. Past studies in this domain have provided much of the groundwork on theory for virtual team development; however, as far as effectiveness is concerned. Recently, resource allocation, trust, adaptation to new technology, power distance, and diversity are a few of the challenges of distance and virtual team effectiveness (Smith & Ruiz, 2020). Since many virtual team environments imply increased collaboration, these environments of actual or perceived distance and the challenges have not been researched via the leadership lens. Are team members willing to take calculated risks when perceived or actual geographical distance exists? Is there an entrepreneurial threshold in which employees in virtual environments are unwilling to go beyond as perceived managerial support is unseen and unrealized? Transformational and transactional styles were positively associated with the Entrepreneurial orientation (EO) dimensions. A virtual team environment can have unintended benefits on member behaviors related to risk-taking, innovativeness, and proactiveness employed by managerial actions which perceived positively can encourage performance. Smith and Ruiz's (2020) study reported that these questions are essential in the virtual team context. Still, there is the mystery of the effects of leadership styles in virtual environments and their effect on team members' effectiveness.

The effectiveness of teams is vital to virtual team success. Still, the factors—behavioral or otherwise—that make teams effective are needed to concretize theoretical developments and to provide researchers with new avenues to study further. Nevertheless, a theoretical understanding of leadership styles in virtual team configurations is required to determine better

the impact of employing leadership styles and to understand how technology might supplement or otherwise enhance leadership effectiveness across time and space. These timely statements beg for attention and give rise to the current research foci—to determine a theoretical link between leadership styles (transformational, transactional, and laissez-faire) and virtual team effectiveness dimensions (task, relationships, absorptive capacity, and innovativeness). Four research questions proceed from these points of inquiry:

1. Is there a positive or negative association between the three leadership styles and virtual team effectiveness via digital platforms?

2. Does virtual team effectiveness, leadership style, and the firm's entrepreneurial orientation align with its technology strategy?

3. Does a leadership style across many digital platforms intersect with cross-cultural leadership behaviors?

4. Can a particular leadership style enhance the firm's use of artificial intelligence (machine and natural learning systems)? In other words, will AI capabilities negate the application of human-driven leadership styles?

Leadership styles, in the sense of adaptability during situations involving distance and collaboration, are vital to team effectiveness ipso facto. Given their proliferation in technology management and the working tools of virtual work-related technologies, it is surprising that these variables have been undiscussed in the extant literature for some time. It is established in the literature that leadership styles impact firm entrepreneurial orientation, performance (Yukl, 2009), employee task orientation (Wofford & Goodwin, 1994), control mechanism (Love & Roper, 2015), and strategic thinking (Gross, 2016), and trust and higher team-related performance (Turesky et al., 2020). In a more mosaic sense, leadership involves technological implementation and labor development that can harness the value of various communication technologies. Take for instance, Large Language Models (LLMs) are changing the methods by with management and leaders create work environments and delegate tasks. However, these technologies go deeper into the broader technology called artificial intelligence, which is used by firms to cover vast computing networks on digital platforms for meeting purposes. However, According to Tolan al. (2021), "the ability of understanding human language can be applied in a variety of tasks (such as reading or writing e-mails, or advising customers/clients). Abilities are therefore a better parameter for evaluating AI progress" (p. 4). For virtual teams that use digital platforms, the implementation of these virtual platforms will require skills in the technical sense, but capabilities to interact with artificial intelligence (AI) effectively are far more critical to a firm's effectiveness in virtual environments. Any technologies that suffuse knowledge to increase absorptive capacity, communication, relationships, and task efficiencies require leadership from both management and employees as tasks so often are repetitive, and the nature of work allocating time and effort to the most needed work requirements will indeed require virtual environments to harness artificial intelligence in the working space for years to come; this however, the use of AI and digital platforms will not decrease tasks complexity or tasks and other skills based on human labor (Estherita & Shanmugam, 2024) since digital platforms and AI (natural learning systems, etc.) cannot lead people to performance.

Leadership literature about virtual team environments has overlooked the role of leadership style, where literature has inordinately emphasized the leadership employed in face-to-face team configuration and those skills needed in that context rather than leadership styles and skills that are most effective to lead virtual teams—inter-organizational, intraorganizational, and global. Leadership skills and employees' capabilities must be oriented toward shared goals and complementary concerning virtual leading, sharing knowledge, and cohesiveness between members throughout time and space. These skills and abilities are needed even more so in virtual leading, as they are germane to member trust and member visibility and ensure members benefit from team creation. This is necessarily true in the virtual context, where interaction between members is increasingly interdependent due to task complexity and distance between team members. Because time and distance are salient factors, considering the transmission and transmutation of knowledge between team members, the leader's role is to effectively utilize the specialized knowledge culled by organizational demands to capitalize on virtual configuration despite the geographical distance.

The primary motivation of the current research is to investigate and pose timely propositions on the influence of leadership styles on virtual team effectiveness. Substantial research on the overall virtual domain to support these propositions has yet to be explored. The secondary motivation of this research is to extend the work initiated by Gross (2018), who focused on transformational and transactional leadership styles and included a version of excluded laissez-faire leadership style for reasons due to changes in the philosophy of management from a dominating perspective of the collocated approach, with movement increasing in just the opposite direction – we are now changing philosophies and accepting work can be accomplished via virtual and digital environments or in a physical location. Adding laissez-faire to this research strengthens the confirmation of the effects of the full-range leadership theory on team outcomes—most notably, virtual team effectiveness. The culminating theoretical content and proposals guide literature and theory enough to transpierce through cluttered, segmented, and unfounded assumptions in the extant literature regarding virtual team effectiveness—how performance is increased—and where can work take place. The proceeding sections include a review of the literature, proposed theoretical development, conclusion, implications, and future research.

Literature Review

A review of the extant literature supports this analysis in an attempt to develop meaningful theoretical propositions that can thrust virtual team theory forward. This review is framed with relevant research in leadership and virtual teams to establish links between leadership style and virtual team effectiveness. Criteria for literature inclusion are intentionally parochial and attempt to remain within the confines of the virtual aspects of team effectiveness with a minimum deviation into the general cosmos of team concepts and constructs.

Leadership Theory and Leadership Style Taxonomy

In previous studies, leaders' styles enhanced subordinate innovation, firm performance, creativity (Gardner & Avolio, 1998), guidance, intellectual stimulation, shared vision (Bass & Avolio, 1993), emotional intelligence (Mayer & Salovey, 1995), overall subordinate

effectiveness (Yukl & Becker, 2006), sustainable individual leadership performance (Piwowar-Sulej & Iqbal, 2023), and trust between team members or lack thereof (DeRosa et al., 2004). Leadership is effective when it provides meaning to events and the employees who participate in them, aligns objectives to strategies, engages subordinates' commitment to tasks, and establishes trust between leaders and subordinates.

There are different levels of analysis in which leadership can be assessed. At each level, leadership styles influences people, structures, and processes. DeRosa et al. (2004) maintained, "There has been a lack of theory and research guiding virtual team trust and leadership" (p. 227). Fundamentally, leadership is influential in team configurations, a priori, and can have both negative and positive results, direct and indirect causal effects, intended and unintended consequences, and determinates related to many organizational functions. Leadership is dynamic. It adds task value, bridges gaps between echelons, and influences the organizational climate. Several theorists have defined leadership, all of whom have provided definitions that incorporate value systems, vision, goal setting, support, and encouragement needed to engage in innovative behavior. These aspects of leadership were categorized as a taxonomy—first by Yukl (1989) and then by Fleishman et al. (1991)—as a method to explain the diverse nature of the phenomenon called leadership.

Subordinates observe leaders' actions through interactive queues; leadership characteristics are attributed to leaders' performance, attitude, and intention. The more prominent the leader, the more subordinates pronounce the leader as competent or incompetent. More importantly, not only do subordinates attribute leaders' competence in many respects, but they also attribute the effectiveness of leaders' intentions. This is the basis for employing the implicit theory as a theoretical perspective. This perspective is helpful in the current case because of the implicit focus that employees attribute to a leader's leadership style. Under implicit theory, leadership is viewed from the employees' perspective and in their subjective observation (Verlage et al., 2012). This notion shows the complexity of leading in virtual configurations and that styles should be linked to their implicit undergirding effect and influence on virtual team effectiveness.

The theoretical link between these elements occurs at a reasonable time when leadership theory warrants more development in the realm of virtual and collocated team configurations. Based on this reasoning, three leadership styles—transformational, transactional, and laissez-faire—are grouped into a typology. Avolio and Bass (2001) initially developed the full-range leadership theory as depicted in Table 1, which included the three overarching transformational, transactional, and laissez-faire styles. Later, additional dimensional factors were embedded in each style.

Table 1: Full-Range Leadership Styles and Dimensions

Style	Dimension
Transformational	Idealized influence
	Individual consideration
	Intellectual stimulation
	Inspirational motivation
Transactional	Contingent reward
	Active management by exception
	Passive management by exception
Laissez faire	Reward omission
	Punish omission

Yammarino and Bass (1990) defined a transformational leader "as one who articulates a vision of the future that can be shared with peers and subordinates, intellectually stimulates subordinates, and pays high attention to individual differences among people" (p. 1). In contrast, a transactional leader is "one who operates within the existing system or culture, prefers risk avoidance, pays attention to time constraints and efficiency, and generally prefers process over substance as a means for maintaining control" (Bass, 1985, p. 2). This leadership style has favorable outcomes when the organizational climate has predictability and task orientation is paramount. Laissez-faire, as a style, has been differentiated from the other two full-range leadership styles due to its nonleadership characteristics. One of the primary characteristics of this style is the hands-off approach to situations when employees need them. Below are three general research questions that motivate the remainder of this study:

Q1: What leadership styles enhance virtual teams' effectiveness when operating in a virtual configuration?

Q2: Is team effectiveness positively linked to virtual tools such as artificial intelligence team members in virtual environments?

Q3: What type of leadership and virtual tools enhance virtual team absorptive capacity and innovativeness?

A Concept of Virtual Teams

The notion of in-person, face-to-face work arrangements has changed dramatically in the past decades regarding the technology at managers' fingertips and how employees effectively use digital platforms to share knowledge between projects. However, a mental challenge exists as employees see technology taking over their work roles. At the same time, the sentiment that technology will overrun human capacity is unfounded. Work teams that are geographically dispersed have outpaced traditional work arrangements since the COVID-19 pandemic. In 2023,

Greimel et al. (2023) defined the environment in which "[virtual teams] communicate solely through a technological medium, excluding occasional face-to-face contact" (p. 2). Piccoli, Powell, and Ives (2004) defined virtual teams as “groups of geographically and organizationally dispersed knowledge workers brought together across time and space through information and communication technologies on an ‘as needed basis in response to specific customer needs or to complete unique projects” (p. 575). Effectiveness is a term used to describe members’ acceptance and quality of problem-solving methods and the solutions team members employ for work productivity. The goal of reaching effectiveness is to produce positive and quality solutions based on efficient and effective problem-solving methods (Hambley et al., 2009).

As a result, various general characteristics enable virtual teams to perform at maximum efficiency, namely the flexibility and adaptability of their members and virtual configuration. Driving performance by way of effectiveness warrants two conditions—communication and coordination—both of which have been linked to the subjective meaning of effectiveness. Communication and coordination are embedded in the dimensions of the quantity and quality of output, members’ attitudes, and behavioral outcomes. Like any other team configuration, problems arise when communication and coordination are broken down. It creates confusion and chaos because of the complex nature of task completion via virtual technologies. Because members typically do not ever meet face-to-face in virtual team units, technology is the only mode of interaction to keep members connected (Cordery & Soo, 2008). If virtual members meet face-to-face, it is only for short sprints (Pangil & Moi Chan, 2014). Compared with the traditional team configuration, a virtual team configuration solely relies on technological tools as the primary interactive mechanism. The reliance on technology to communicate across boundaries lends itself to inherent challenges related to culture, language, and even perhaps accessibility to technology that would enable collaboration (DeRosa et al., 2004).

Virtual interaction between members, customers, and suppliers enhances global reach, which can be a competitive advantage and create many challenges. Therefore, new methods and technologies can position firms to meet new landscape challenges inherent in global team connectivity and interfacing processes, creating an enterprising culture. Team leaders meet these challenges through configurational gains and adopting tasks that match virtual human capital in virtual environments with organizational slake—that is, through flexible resources and equipment used to complement the virtual configuration in changing business landscapes. Indeed, much can be attributed to the virtual configuration closing the competitive gap among other non-configurated competitors. Hundley and Hansen (2012) put it in graphic terms by suggesting that an enterprising culture, despite the unintended challenges of virtual interactivity, is when “greater value is attached to the gains from innovative activities in market settings” (p. 250). Intended benefits of an enterprising virtual culture: The virtual team configuration provides efficiencies such as 24-hour production, lower costs per employee, speed-to-market product development, and member commitment to specialty areas in the productive process. Questions remain regarding the appropriate balance between technology and team member capabilities and the best use of interacting technologies to make decisions virtually.

Virtual team configurations fit four dimensions: geographic dispersion, electronic dependence, national diversity, and dynamic structure. These dimensions are significant factors in the changing overall structure of the workplace and crucial in maximizing virtual human capital related to innovativeness. Innovativeness can increase if virtual geographically dispersed

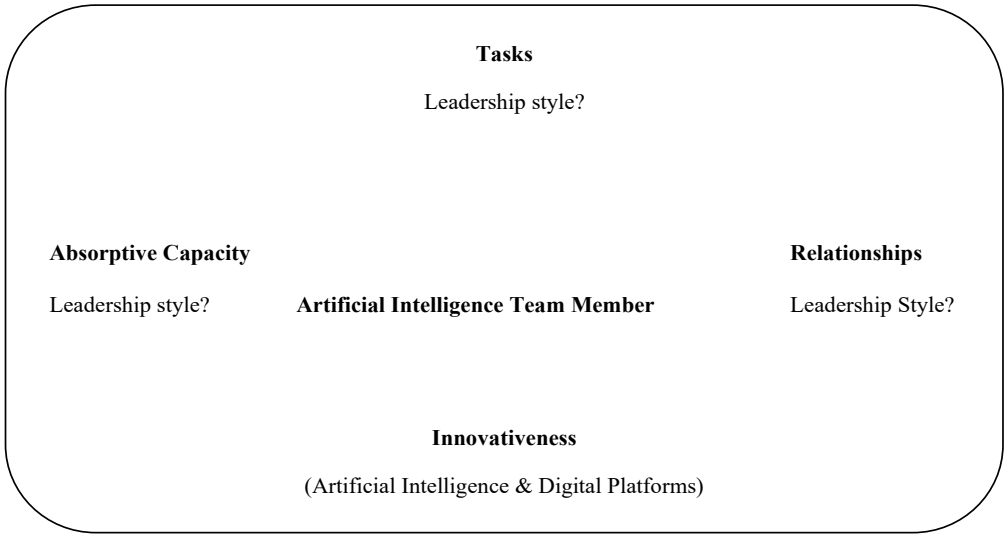
members, dependent on technology, can cultivate an enterprising virtual team climate that provides a psychologically safe communication outlet that harnesses ideas and creative methods with innovative intensity. Additionally, virtual teams can be placed into four configurations: temporal distribution, boundary spanning, life cycle, and member roles. These characterizations are pertinent in describing the inherent advantages of virtual team formation, boundaries, and member differences that correspond with team design, technical cohesion, communication, relationship building, and the eventual disbandment of virtual. Given the complexities related to distance and reliance on technology that is comparatively different in a virtual team than in face-to-face teams, member interpersonal relationships and task-related assignments require ongoing attention and monitoring. In a virtual configuration, it is inherently difficult for leaders to coordinate members' activities across geographic landscapes and to maintain member accountability considering members at a distance, members' continuous information needs, new knowledge diffusion, and ongoing feedback that closes the loop as interchanges between members happen simultaneously.

Theoretical Development

Between virtual team members, leadership materializes but at a distance from its members. For leadership to be effective, styles must positively impact and correlate with the virtual team's adequate dimensions: relationships, tasks, absorptive capacity, and innovativeness. These effectiveness dimensions were created in current research and conceptualized based on the model developed by Ziek and Smulowitz (2014) that depicts virtual team skills and a competencies requirement. In no specific order, the effectiveness skills and competencies developed by Ziek and Smulowitz are (a) direction, (b) goal setting, (c) communication, (d) facilitates teamwork, (e) motivating and inspiring, (f) empowering, (g) boundary spanning, (h) mentoring, and (i) resource allocation. These skills/competencies are culled to create a compilation of constructs to form the effectiveness dimensions in Figure 1.

Figure 1 reflects the interdependency of leadership styles, member behaviors, and effectiveness dimensions through an integrative model, predicting theoretical links from the leadership domain to team effectiveness dimensions. These styles drive effectiveness, positively affecting performance factors such as team goal acquisition, knowledge transfers, and technological iterations. Accordingly, Figure 1 does not show performance as an effectiveness dimension; researchers who have compared face-to-face teams and virtual teams have maintained that virtual teams quite often outperform face-to-face teams (Berry, 2011). Effectiveness, as it relates to team performance, can be increased or decreased based on the frequency of interaction incidents in the virtual team. Performance interaction incidents are shortened in virtual teams because technology supplements them, and mental mode transfers decrease over time. As a result, there is an increase in incidents and mental mode transfers virtually. The complexity of virtual teams makes effectiveness via interaction incidents as communication mechanisms challenging if the role of leadership is not viewed as a driving force.

Figure 1. Leadership styles link with Virtual Team Effectiveness Dimensions (VTED).



Transformational Style on Virtual Team Effectiveness

The transformational style is oriented to relationships between members, which is realized by providing vision and member acceptance of the vision, transcending organizational and socially constructed borders. This style offers consideration to employees through guidance and tends to support employees as they find and adapt enterprising methods to solve complex problems. Transformational leadership cultivates long-lasting relationships by creating strong bonds between members, and these members contribute more to the organization than those who experience the transactional style. The transformational style positively influences the relationship dimension of team effectiveness, primarily due to its relationship orientation. This style is even more meaningful in the virtual configuration where members depend on each other for task completion because of task complexity and building trusting relationships with minimum face-to-face interaction since the only interaction method is via technology. Virtual team members orbit around shared goals, each pursuing a common vision through culminating vision and goals. Thus, leaders who employ the transformational style weaves goals, purpose, and skills into a common thread that fosters a climate of growth and trust among virtual team members.

Transactional Style on Virtual Team Effectiveness

Numerous sources suggest that the transactional style has positive links with citizenship behavior and employee commitment because of its foci on task–goal completion, which comprises of the following dimensions: clarification of task–goals, management of expectations, and exchange of praises or rewards for goal attainment (Bass, Avolio, et al., 2003). On the other end of the spectrum, this leadership style emphasizes members' mistakes when deviation from objectives occurs or when leaders anticipate deviation from stated objectives. The question for the leader who employs this style virtually becomes when and how to intervene in employees' processes in virtual configurations. As outlined by Bass (1997), transactional style has three dimensions that link well with virtual task completion and increasing absorptive capacity at the

team level; these are (a) contingent reward, (b) active management by exception, and (c) passive management by exception. The two factors of active management by exception and passive management by exception monitor employees' task deviation; however, passive management by exception fails to intervene until a deviation has occurred. Because leadership styles are related to strategic thinking, it suggests that active management by exception maintains continuity between tasks and alleviates task ambiguity between leader and subordinate in complex virtual configurations.

Burke et al. (2006) explained how "boundary spanning was not only associated with successful technology implementation within teams, but was more effectively done by the leader than by the team" (p. 292). However, absorptive capacity is a team-level function expressing itself via knowledge sharing in virtual configurations. For instance, when knowledge has been accumulated between individuals, groups, and teams organizationally, the knowledge is defused among members for further development. As Cohen and Levinthal contended, knowledge is transferred, transmitted, and transmuted across organizational units; this increases absorptive capacity in virtual teams. Similarly, virtual team members increase absorptive capacity in critical path areas by adding new members to a virtual team, increasing knowledge accumulation. Cohen and Levinthal (1990) once stated that the whole notion of absorptive capacity "is that the organization needs prior related knowledge to assimilate and use new knowledge" (p. 129). As noted, when increased, absorptive capacity leads to higher performance and competitive advantages for the individual and the firm, particularly when the virtual environments foster knowledge workers (Bachmann et al., 2024). Knowledge workers in a virtual environment must be keen on the multi-directional use of their resources and the ability to use problem-solving techniques often. "If knowledge workers face multiple team contexts combined with high problem-solving demands, their resource reservoir may become overstretched," as Bachmann et al. (2024) agreed. But. However, Backmann et al. pointed out the dark side of a virtual environment with highly absorptive captivity, which they say creates a situation where the individual goes into a self-preservation mode, depletes the individual's resources, and thus drops the performance. Moreover, they went on to say:

High problem-solving demands exacerbate the adverse effects of multiple team contexts on the relationship between time spent in a focal team and absorption in that team. From a managerial perspective, high problem-solving demands on a given day amplify the negative moderating effect of many different team contexts on the relationship between daily time spent on the focal team and daily absorption in that team context. As far as virtual teams, the contingent reward dimension of the transactional leadership style offers praise and rewards for performance, thereby increasing absorptive capacity when subordinates are rewarded for learning through experience and acquiring new knowledge. Learning and then diffusion are catalysts in transforming potential capabilities into realized capabilities. Bass, Avolio, et al. (2003) maintained that contingent reward has been positively linked with employee commitment and citizenship behavior. Moreover, contingent reward is associated with personnel training, allocation of resources, and providing subordinate feedback. The contingent reward is an enhancing factor when considering virtual absorptive capacity through member virtual capabilities when employed by virtual team units across geographic distances.

Laissez-Faire Style on Virtual Team Effectiveness

The laissez-faire leadership style has been discussed in the literature primarily in the context of face-to-face and collocated team environments. Laissez-faire style is often described as the inaction of leaders when leadership is needed—an action that is not provided to remedy problems or situations. The laissez-faire style does not reinforce accepted or unaccepted behavior—poor or desired behaviors are not noticed or acknowledged. Hinkin and Schriesheim (2008) explained that if poor behavior were acknowledged, it would not necessarily change to a more desired subordinate behavior based on leadership intervention. Laissez-faire style is often connoted as those who show a lack of engagement and tend to be unsympathetic to employees' needs; however, if viewed in the virtual team context, laissez-faire can be viewed as in absentia—that is, there is not a lack of leadership per se, but due to distance and heavy reliance on technological interfacing methods, it would be difficult to apply a hands-on leadership.

Laissez-faire leadership style has a negative connotation for as long as the style was label as such in the early phases of leadership development. However, many of the artificially intelligence embedded networks and advanced systems requires hands-off approaches to management. LLM's (Large Language Models) use has shifted to mundane tasks and human roles in the workplace, but some human involvement in certain tasks are still required. For example, virtual member accountability as such makes laissez faire, among other styles, a style that does not effectively monitor members' activity to minimize deviations. If laissez-faire were viewed another way, it could be linked to innovativeness—a virtual team effectiveness dimension. Also, there is a potential link between laissez-faire style and innovativeness, which aligns with research by Yang (2015), who redefined laissez-faire, in his sense, to unconstrain this style's situational benefits and effectiveness. Innovativeness is originally a dimension of entrepreneurial orientation that describes how firms develop and realize ideas generated from employees, units, work groups, and teams. Entrepreneurial orientation reflects the strategy view of the firm and supports the ability of firm members to deviate from the mundane to find new ways of doing things. This type of intrapreneurial behavior requires autonomy, technology, and freedom to generate and implement ideas to diffuse through capabilities (potential and realized) and can be deployed to market.

Case and Point

Today's firms are faced with immense challenges and opportunities concerning how the virtual environment and tools might hinder or exceed performance levels within team environments; therefore, it is proposed in this research that leadership styles are likely to have the most impact on virtual team entrepreneurial effectiveness. For example, many firms encounter market uncertainty and technological competition from AI sources and tools (Dennis, Lakhiwal, Sachdeva (2023) investigated an artificially intelligent (AI) teammate and recorded negative performance between the team-related results of highly task-driven. If, for example, leadership decides that the best potential human capital is dispersed in another geographical area, it would behoove the firm's leadership to employ virtual interfacing technologies supporting virtual interaction. Tasks communicated to individual members or an entrepreneurial network via technology need support and encouragement. Another challenge is low levels of ACAP, where new or otherwise knowledge is not readily acquired from entrepreneurial team members. The

inability of firm leadership to increase ACAP will prohibit firm members from assimilating and transforming new knowledge into existing processes within the firm to exploit better and commercialize products or expand service offerings. This can be asserted through human capacity and with the assistance of artificial intelligence. However, not everyone may be positive about how AI is applied in team environments. Moreover, Dennis, Lakwal, and Sachdeva (2023) observed the following interaction between teamwork groups and the addition of an artificial intelligence teammate:

The presence of an AI team member resulted in lower process satisfaction. When the AI team member performed well, participants perceived less conflict than a human team member with the same performance, but there were no differences in perceived conflict when it performed poorly. Under an environment where AI is a teammate, what leadership styles would create effectiveness amongst team members? Dennis, Lakhiwal, and Sachdeva showed the effect of AI on team engagement, but there is a missing leadership component that needs further assessment. Also, in what areas will AI make the team tasks, inventiveness, relationships, and the softer side of team collaboration? Members of the firm who are geographically dispersed reap the benefits of the distance of space and time due to firm-level outsourcing strategies if so pursued by management. Laissez-faire leadership style across distance does little as a conduit for intergroup communication as a whole, but it does increase communication and collaboration between members with expertise; however, Gross (2017) said that laissez-faire can psychologically and structurally support innovativeness and associative innovative behavior (i.e., idea generation, idea exploration, idea implementation, and idea championing). Members' dispersion may seem challenging as ideas are absorbed as leaders think strategically. Still, under the virtual pretense, the virtual entrepreneurial spirit pushes leadership to seek out new members, where new knowledge and ideas are sought that are not possessed at any given time. Likewise, a laissez-faire style of leadership supports a climate that requires AI as an agent on a team or between humans sharing experiences with others in search of new opportunities (Forsström-Tuominen et al., 2017). Even though there are major positive implications for the use of AI as a team member, there are common perceptions that team members have that can bias AI's algorithm, tipping into algorithm aversion. The perception of teammates if the decrease in error, what is the difference when AI is in error as opposed to a human team member?

Conclusion

This current research sought to ascertain the most impactful links between management and leadership and technological advances within the domain of team effectiveness. This research is not meant to be an exhaustive presentation but provides a baseline for how leadership technology such as AI and AI platforms enhance or detract from human leadership and management in virtual team members behavior. This endeavor provides a sophisticated view of how leadership styles can cut across the virtual team effectiveness dimensions. The role of leadership in team environments is to mediate member relationships and tasks. The strategic use of management and leadership in a virtual context increases virtual effectiveness and member innovativeness, which results in a virtual entrepreneurial culture. A one-to-one match of leadership style and virtual effectiveness dimension is not well founded in reality, as there is a need for further assessment. Given the virtual environment, these virtual effectiveness links function comparatively differently in collocated or cross-cultural virtual teams. Leadership in a

virtual team configuration is an emerging process—one in which leaders develop through technical mechanisms related to growth and influence with other members despite numerous challenges, not only in strategy making and managing performance across networks but also in supporting team members across global spaces. At the virtual level of analysis, effectiveness is subjective and difficult to define; in a virtual environment, losses and gains are based on the configuration and leadership employed. Relational challenges can be overcome by leaders employing a transformational style in a virtual context.

Implications and Future Research

Some implications affect analysis, association, and correlation between variables and constructs. In this case, the focus is primarily on the virtual level. The implications, however, of leadership styles have been the focus of many other studies. Still, when leadership is dichotomized into styles (or full range), it is easier to estimate its linkage strength on virtual team effectiveness. Virtual team leaders and members are configured to support the goals and tasks of the team. Therefore, based on the full-range leadership theory, the practical implication is that team leaders can deploy a style that aligns with member relationships, innovative projects, product releases, and product development communicated through a technology agent. The geographical configuration of virtual teams is vastly different from collocated configurations. As with virtual teams, there is minimal face-to-face interaction, forcing team leaders to rely solely on either member's ability to self-direct or take a leading role in one of the four effectiveness dimensions. Depending on team members' abilities and technical proficiencies, this may lend to ascribing to a leadership style that corresponds with an effectiveness dimension to reach maximum gains. What can be understood here is that new start-ups and entrepreneurial ventures connecting via a virtual team configuration can increase entrepreneurial orientation corresponding to a leadership style and effectiveness. Geographically dispersed entrepreneurial teams can effectively capitalize on members' ideas and share them while simultaneously using them to create either discontinuous or dynamically continuous innovations in real-time with interactive AI agents. Leadership in virtual teams similarly aids problem-solving, strategic thinking, and vision-setting, including platforms operated on artificial intelligence. Theoretically, effectiveness (e.g., tasks, relationships, absorptive capacity, and innovativeness) includes several constructs representing a bundle of factors related to optimal performance. The constructs comprising the effectiveness of work teams are related to member behaviors, which are associated with performance and optimal engagement between technological platforms. Performance in the enterprising orientation of team members is linked to member behavior explicitly, especially in turbulent market environments where competitiveness and innovativeness between firms hinge upon dynamic entrepreneurial capabilities.

These new theoretical links open new avenues for future research development so that more can be gleaned about leadership's role and managerial performance in geographically dispersed team configurations. First, future research should attempt to test leadership styles in virtual environments with other moderators and mediators explicating determinates associated with organizational functions at the individual or team level of analysis which might also include artificial intelligence and its constituting components. Second, there is a need to understand if leadership styles function similarly or differently and to what extent in project and implementation management processes. Virtual or collocated product and process implementation leaders are ideal for testing leadership styles' influence on team behaviors

compared to nonvirtual and collocated team configurations. Future research should focus on the long-term effects of style on virtual team members from a cultural integrative perspective. This focus can be instrumental in investigating cultural interactions in virtual teams based on relationships, task completion, and cohesiveness. Quantitatively testing the orientation of the virtual team strategy, focusing on entrepreneurial orientation and cultural proclivities, would be profitable.

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