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# Reviewing the Contributing Factors and Benefits of Distributed Collaboration

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**Abstract:**

Distributed collaboration has become increasingly common across domains ranging from software development to information processing, the creative arts, and entertainment. As of early 2020, distributed collaboration has entered the limelight as the COVID-19 pandemic has forced employees across the world to work from home. However, while researchers have applied myriad terms to define these operations, we first address this issue by defining distributed collaboration in a way that represents all its forms. Existing research has identified several factors that contribute to distributed collaborations' success. Yet, researchers and practitioners typically discuss these factors in modular theoretical terms, which means that they often struggle to identify and synthesize literature that spans multiple domains and perspectives. In this paper, we systematically review the literature to synthesize core findings into one amalgamated model. This model categorizes the contributing factors for distributed collaboration along two axes 1) whether they are social or material and 2) whether they are endemic or relational. We also explicitly discuss the relationships between factors in the model. The model further links these contributing factors to different collaborative outcomes, specifically mutual learning, relationship building, communication, task completion speed, access to skilled personnel, and cost savings.

**Keywords:** Distributed Collaboration, Contributing Factors, Model, Success, Literature Review.

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# 1 Introduction

Digital technologies' growth has facilitated an uptake in distributed collaborations (Asatiani & Penttinen, 2019; Cheng, Fu, & Druckenmiller, 2016; Liu, Hull, & Hung, 2017; Tapscott & Williams, 2008). Researchers have used several synonyms to discuss distributed collaboration, and one can find the practice in various industries, such as virtual teams (Kanawattanachai & Yoo, 2007; Nordbäck & Espinosa, 2019), online communities (Hauser, Hautz, Hutter, & Füller, 2017; Park, Im, Storey, & Baskerville, 2019), and dispersed teams (Magni, Ahuja, & Maruping, 2018). These forms of online collaboration have become an increasingly viable and popular means of production (Faraj, Jarvenpaa, & Majchrzak, 2011; Grigore, Rosenkranz, & Sutanto, 2015).

However, not all historic attempts at adopting distributed collaboration have proven successful despite significant capital investment (Worthen, 2008). For example, Chinese companies have reportedly adopted distributed collaboration in response to COVID-19 lockdown measures but their employees have struggled to adjust their personal schedules, while organizations have found it difficult to monitor production to the same degree as in a co-located setting, which has led to "intrusive bosses" (Liang, 2020). Such issues have motivated researchers to find this failure's root cause to gain mass adoption (Butler, Bateman, Gray, & Diamant, 2014; Zhang, Hahn, & De, 2013). Even operational research on distributed collaboration means that we cannot likely attribute these failures only to unforeseen factors. Instead, it appears that research has not adequately supported practice because it has provided either too complex or too individually disconnected and incomplete theoretical models. Inadequate extant research has resulted in calls for further research to investigate the relationship among these factors and how these relationships influences distributed collaboration's performance (Asatiani & Penttinen, 2019; Cheng et al., 2016; Hauser et al., 2017).

The need to understand distributed collaboration's complexities has grown steadily over recent years as advancements in technology have made it a viable alternative to co-located teams (Gómez, Salazar, & Vargas, 2017; Gupta, Mattarelli, Seshasai, & Broschak, 2009). However, COVID-19's rapid development as a global pandemic in early 2020 has accelerated the rate in which industries across the world have adopted distribution collaboration as a mechanism to remain active and avoid total economic shutdown (Dubey & Tripathi, 2020). Furthermore, given this large-scale, synchronous adoption, we can reasonably believe that certain organizations will come to realize distribution collaboration's benefits and continue to engage in it after the crisis subsides. For instance, researchers have commonly suggested that distributed collaboration fails due to the difficulty in generating and sustaining contributions from members (Phang, Kankanhalli, & Sabherwal, 2009; Ransbotham & Kane, 2011). In this sense, the COVID-19 crisis represents an insightful case study since it has forced entire organizations to adopt distributed collaboration. Considering this unprecedented development, we believe that we need to thoroughly examine the factors that contribute to distributed collaboration's success. As such, with this research, we make a significant and timely contribution to the IS field.

In this paper, we focus on 1) consolidating different definitions of distributed collaboration into one synthesized definition, 2) building on an amalgamated model of the factors that predict distributed collaboration's success, and 3) detailing how these factors compliment and moderate one another. Accordingly, the paper proceeds as follows: in Section 2, we detail how we produced our definition of distributed collaboration. In Section 3, we systematically review the literature by using Webster and Watson's (2002) concept-centric matric approach to find recurring success outcomes and contributing factors for Distributed Collaboration. In Section 4, we discuss the factors that we identified. In Section 5, we examine the interactions between these factors. In Section 6, we discuss the benefits that can be derived from distributed collaboration. Finally, in Section 7, we discuss our findings' implications for theory and practice and conclude the paper.

# 2 Defining Distributed Collaboration

Collaborative groups have traditionally operated in a co-located environment as it offered better communication and coordination between team members (Gupta et al., 2009). However, advancements in information and communication technologies (ICT) led to the emergence and growth of distributed groups, which sacrificed face-to-face communication in favor of access to global expertise (Gupta et al., 2009; Vlaar, van Fenema, & Tiwari, 2008; Watson-Manheim, Chudoba, & Crowston, 2012). Distributed groups have attracted significant attention from researchers, who have framed these new dynamics in various ways (see Table 1). We reconcile these differences with a synthesized definition that combines the three common elements present in each:

1) Distributed members (“distributed participants”, “virtual space”, “different geographic locations”, “common platform”, “work across space, time, and organizational boundaries”, “online”).
2) ICT use for communication (“a combination of information and communication technologies”, “computer-supported”, “ICTs”, “the Internet”, “electronic means”, “social networks”).
3) A shared objective (“shared goal”, “shared purposes”, “joint outcomes”, “shared interests”, “common purpose”, “common interests, goals”).

Thus, we define distributed collaboration as the pursuit of a shared objective by groups that include non-proximate members, whose participation ICT facilitates.

**Table 1. Definitions of Synonyms for Distributed Collaboration**

| | | |
|---|---|---|
| Virtual teams | Groups of geographically and/or organizationally distributed participants who collaborate towards a shared goal using a combination of information and communication technologies (ICT) to accomplish a task. | Bjørn & Ngwenyama (2009) |
| Online communities | A collection of people who communicate and interact openly with each other in a computer-supported virtual space to seek some shared purposes. | Phang et al. (2009), Ren et al. (2012) |
| Dispersed teams | Collective of individuals who are distributed across different geographic locations and rely primarily on ICTs to communicate and collaborate with each other to achieve joint outcomes for which they are responsible. | Magni et al. (2018) |
| Online discussion communities | Groups of people with shared interests who communicate over the Internet through a common platform. | Butler et al. (2014) |
| Distributed teams | Groups of people who interact through interdependent tasks guided by a common purpose and who work across space, time, and organizational boundaries primarily through electronic means. | Majchrzak, Malhotra, & John (2005) |
| Virtual communities | Online social networks that allow people with common interests, goals, or practices to interact and share information and knowledge. | Bock, Ahuja, Suh, & Yap (2015), Porter, Devaraj, & Sun (2013) |

## 2.1 Forms of Distributed Collaboration

According to the definition that we present above, distributed collaboration encapsulates a large class of applications that service disparate purposes. We categorize and illustrate these different use cases in Figure 1 below.

We identified forms of distributed collaboration along two axes: 1) the range of collaboration participation and 2) the competition between inputs. The range of collaboration participation refers to the various skills and backgrounds that each new contributor introduces to a group. In Figure 1, we use open source software as an example of distributed collaboration with a relatively low range of collaboration participation. OSS benefits from the distributed collaboration as technology enables the best individuals to work together on developing software (Chou & He, 2011; Lin, 2006). However, all contributors require a background in software development. Applications such as Wikipedia benefit from distributed collaboration not only because it connects talented individuals but also because contributors often have assorted backgrounds and introduce novel perspectives (Kittur, Chi, Pendleton, Suh, & Mytkowicz, 2007; Tapscott & Williams, 2008).

Along the horizontal axis of Figure 1, we categorize distributed collaboration according to the level of competition between individuals’ inputs. Examples such as OSS and Wikipedia allow for individuals to build on top of one others’ contributions and create a product or service that contains multiple individual contributions (Howison & Crowston, 2014; Kyriakou, Nickerson, & Sabnis, 2017; Ransbotham & Kane, 2011). As the level of competition between inputs increases, individual contributions depend less on one another. For example, Threadless, an online t-shirt company, crowdsources the design process for its shirts through an ongoing online competition (Brabham, 2010). Each contribution is an individual design, and each contribution competes with the others to receive the highest number of votes. However, like OSS, this form of distributed collaboration requires a certain level of design competency. Walker’s “Do Us a Flavor" competition exemplifies distributed collaboration that includes competition between inputs and a range of collaboration participation (Forbes & Schaefer, 2017). Individual contributions compete to get the greatest number of votes. In such example, distributed collaboration allows multiple contributions from diverse backgrounds as contributors require no obvious prerequisite skills to suggest a new flavor.

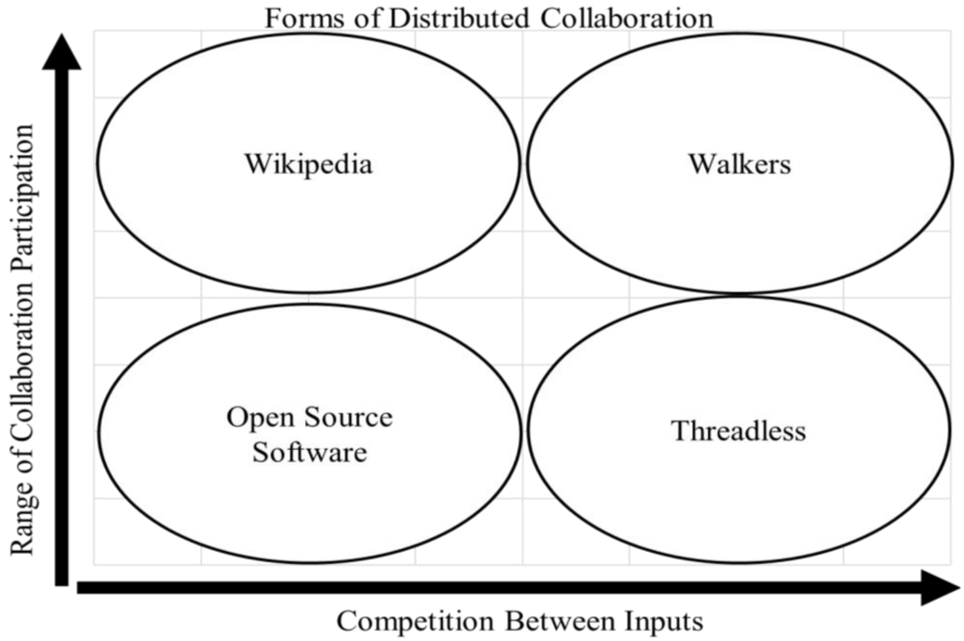


**Figure 1. Forms of Distributed Collaboration**

## 3 A Systematic Literature Review

We began our literature review by conducting a keyword search using the Web of Science, the AIS Electronic Library, and Google Scholar for papers published in Senior Scholars' basket of eight IS journals from January, 2000, to June, 2019—an approach that researchers have commonly adopted to gather the field's most respected research (Bernroider, Pilkington, & Córdoba, 2015; Dean, Lowry, & Humpherys, 2011). Of course, the keyword-centric approach suffers from the obvious "cold-start problem"; that is, one needs to identify applicable keywords (Levy & Ellis, 2006). We found identifying such keywords particularly challenging since researchers have used multiple terms to describe distributed collaboration. Thus, we created a keyword matrix to help uncover and keep track of emerging terms. We began with searches for "distributed" and "collaboration". Based on initial results, we created a list of synonyms for each term and then searched all pairings between these alternative terms. We used "dispersed", "global", "virtual", and "online" as synonyms for distributed and "team", "work", "group", and "community" as synonyms for collaboration (see Table 2).

From our searches, we initially identified 290 papers. We subsequently limited these papers to peer-reviewed papers and removed all duplicates, which resulted in 153 remaining papers. We provide more details concerning the numbers we retrieved for each keyword pair in Table 2. Building on these papers, we performed "backward searching"; that is, we reviewed the literature that the papers we obtained from the keyword search referenced (Levy & Ellis, 2006; Webster & Watson, 2002). From this process, we identified 20 more papers. At this point, we felt comfortable that we had reached a level of saturation in our literature search and that further searches would deliver either irrelevant papers, papers we had already included, or papers that would not add to the knowledge in the papers we had already identified (vom Brocke et al., 2015).

In the next refinement round, we discarded papers that defined distribution collaboration in a way that did not fit with our definition (e.g., we discarded papers that did not refer to any obvious shared objective or that referred to teams that operated in shared premises in their definition). As a result, we removed three papers, which meant we obtained 170 papers for theory amalgamation. In initially analyzing these papers, we focused on identifying contributing factors and outcomes, which we organized in an evolving concept matrix (Webster & Watson, 2002). By using a concept matrix, we could enhance our literature review by bringing a logical structure to how we discussed a topic's central ideas (Webster & Watson, 2002). After continued iterations, we gradually found that we could group the contributing factors according to whether they were endemic or relational and whether they were social or material. As a result, we created an overarching theoretical framework in which to position individual constructs, which we describe in Section 4.

**Table 2. Keyword Search Results**

| **Keyword** | **Database** | **Initial results** |
|---|---|---|
| Distributed + collaboration OR team OR work OR group OR community | AIS Electronic Library | 3 |
| | Google Scholar | 13 |
| | Web of Science | 19 |
| Global + collaboration OR team OR work OR group OR community | AIS Electronic Library | 0 |
| | Google Scholar | 4 |
| | Web of Science | 11 |
| Dispersed + collaboration OR team OR work OR group OR community | AIS Electronic Library | 3 |
| | Google Scholar | 1 |
| | Web of Science | 1 |
| Virtual + collaboration OR team OR work OR group OR community | AIS Electronic Library | 21 |
| | Google Scholar | 37 |
| | Web of Science | 55 |
| Online + collaboration OR team OR work OR group OR community | AIS Electronic Library | 18 |
| | Google Scholar | 53 |
| | Web of Science | 51 |
| Initial results | | 290 |
| Results (minus duplicates) | | 153 |
| Papers removed for irrelevance | | 3 |
| Additional papers from backward searching | | 20 |
| **Total** | | **170** |

# 4 A Model of Distributed Collaboration Attributes and Collaboration Benefits

Figure 2 illustrates the final constructs we identified that we grouped according to the emerging theoretical framework. Social factors concern the attitudes, perceptions, and knowledge that team members possess, while material factors describe the perceived qualities of objects in the system. Endemic factors exist across various collaborative configurations, while relational factors vary according to which people and tools interact. Successful[1] distributed collaboration requires the participants to effectively manage these factors in unison with one another. We discuss this task's complexity in Section 5 when we detail the symbiotic relationship between many of these factors. We also discuss the resulting benefits that emerge from "successful" distributed collaboration.

[1] Note: we refer to a collaboration's "success" in relation to its stated shared objectives (see Section 2).

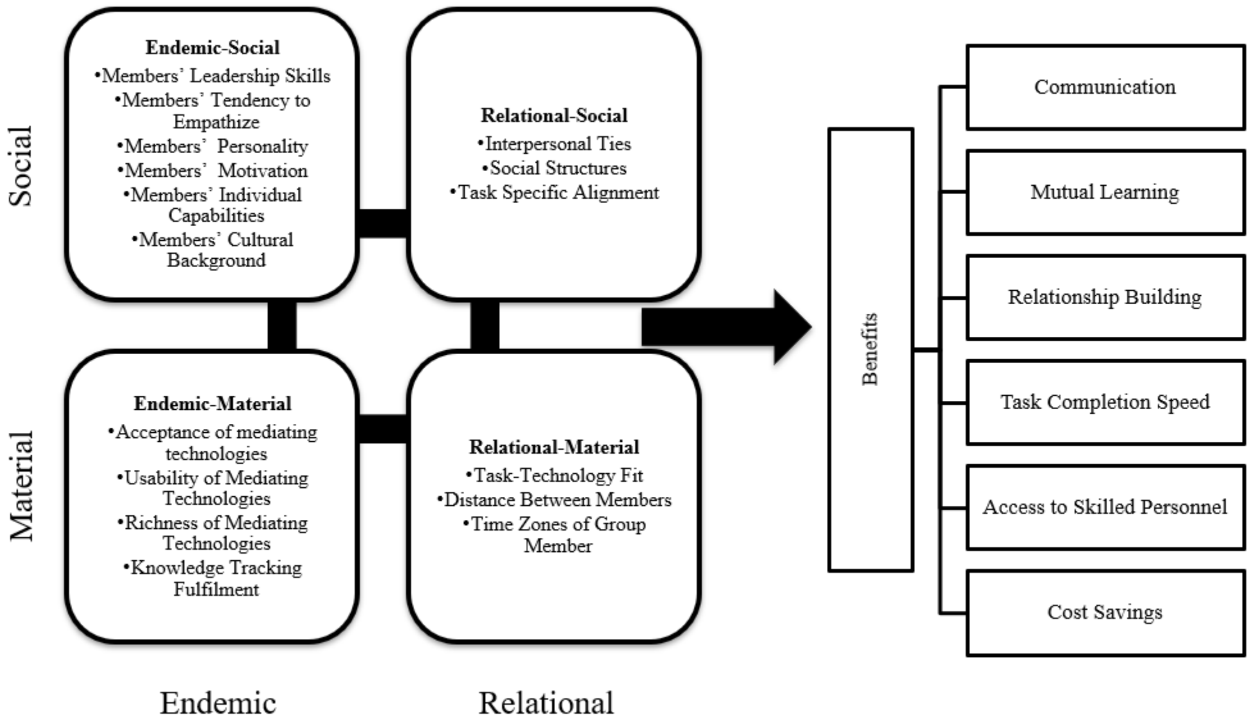


**Figure 2. A Model for Distributed Collaboration**

## 4.1 Endemic Social Contributing Factors

We use the term "endemic social" to describe collaborating members' recurring traits; that is, they do not pertain only to specific relationships (see Table 3). We identified sixth such factors: 1) members' leadership skills, 2) members' tendency to empathize, 3) members' personalities, 4) members' motivation, 5) members' individual capabilities, and 6) members' cultural backgrounds. We discuss the first five factors in this section and the sixth one in Section 5.

### 4.1.1 Members' Leadership Skills

Distributed collaboration requires leadership to define the group project's goal or vision, attract and retain members to the group, create effective communication, and promote active participation in the group (Oh, Moon, Hahn, & Kim, 2016; Pauleen, 2003). Traditional collaborations and distributed collaborations differ in that the leadership in a distributed environment represents a collective effort (Johnson, Safadi, & Faraj, 2015; Nordbäck & Espinosa, 2019). Leadership in distributed collaboration may be formal or informal as long as team members recognize some of their peers as being influential in the actions the group takes to achieve their shared objective(s) (Johnson et al., 2015; Nicholson, Sarker, Sarker, & Valacich, 2007; Nordbäck & Espinosa, 2019; Pauleen, 2003). Many scholars have argued that the continuous dynamic reconfigurations that occur in distribution collaboration make leadership in them more challenging (Faraj, Kudaravalli, & Wasko, 2015; Nicholson et al., 2007).

### 4.1.2 Members' Tendency to Empathize

Empathy plays an important role in whether distributed collaboration succeeds. Team members display empathy through social sensitivity in co-located groups, and it relates to group performance. However, the lack of visual cues in distributed collaboration makes empathy difficult to replicate in distributed collaboration (Barlow & Dennis, 2016).

### 4.1.3 Members' Personalities

Personality plays an important role in determining individuals' ability to establish individual roles and resolve conflict (Potter & Balthazard, 2002). Certain personality combinations will be more likely to be effective collaborators. Indeed, Brown, Poole, and Rodgers (2004) developed an interpersonal circumplex model to study participation in distributed collaboration and found that they could use their model to identify individuals who could likely collaborate effectively and individuals who would likely undermine collaboration.

#### 4.1.4 Members' Motivation

Distributed collaboration depends on members handing over knowledge to benefit the group as a whole, which requires that they see sufficient value in doing so (Wasko & Faraj, 2005). Extrinsic factors that motivate members include reputation, career advancement, while intrinsic factors may include ideology and a sense of collective reciprocation (Roberts, Hann, & Slaughter, 2006; Von Krogh, Haefliger, Spaeth, & Wallin, 2012; Zhang et al., 2013).

#### 4.1.5 Members' Individual Capabilities

The fact that ICT facilitates distributed collaboration means technical proficiency can act as a significant barrier to collaboration (Barlow & Dennis, 2016; Fuller et al., 2006). Group members' capabilities influence the way in which other members perceive them (Paul & McDaniel, 2004). Digital collaboration-specific competences can refer to 1) virtual self-efficacy (i.e., individuals' belief in their abilities), 2) virtual media skill (i.e., individuals' skill level in using communicative technologies), and 3) virtual social skill (i.e., individuals' ability to build social relationships in a virtual setting) (Wang & Haggerty, 2011). Many groups assist other members by providing some degree of training or support depending on the group structure (Pauleen & Yoong, 2001). Distributed collaboration requires such training/support since its demands may cause the group to lose "technophobes'" skills and knowledge (Paul, Samarah, Seetharaman, & Mykytyn, 2004). Instead, an overrepresentation of members with a positive predisposition to technology may dominate collaborations (Asatiani & Penttinen, 2019; Wang & Haggerty, 2011).

**Table 3. Endemic Social Contributing Factors for Successful Distributed Collaboration**

| Contributing factor | Definition | Sources |
|---|---|---|
| Members' leadership skills | The recognition of specific collaborators as positive influencers in pursuing some shared objective(s). | Faraj et al. (2015), Johnson et al. (2015), Kayworth & Leidner (2002), Nicholson et al. (2007), Oh et al. (2016), Zigurs (2003) |
| Members' tendency to empathize | The sensitivity with which collaborators interact with one another. | Bateman, Gray, & Butler (2011), Fan & Lederman (2018), Grigore et al. (2015), Johnson, Faraj, & Kudaravalli (2014) |
| Members' personality | Collaborators' values and interaction styles. | Brown et al. (2004), Cummings & Dennis (2018), Nicholson et al. (2007), Potter & Balthazard (2002) |
| Members' motivation | The intrinsic and extrinsic reasons for why individuals engage with the collaboration. | Ridings, Gefen, & Arinze (2006), Roberts et al. (2006), Von Krogh et al. (2012), Wasko & Faraj (2005), Zhao, Zhang, & Bai (2018) |
| Members' individual capabilities | The knowledge and skills that individual collaborators possess. | Barlow & Dennis (2016), Fuller, Hardin, & Davison (2006), Kayworth & Leidner (2002), Wang & Haggerty, 2011) |
| Members' cultural backgrounds* | Individual collaborators' different national and local cultures. | Porter et al. (2013), Posey, Lowry, Roberts, & Ellis (2010), Sarker & Sarker (2009), Shin et al. (2007), Vlaar et al. (2008) |

* We discuss this factor in in Section 5.

### 4.2 Endemic Material Contributing Factors

We use the term "endemic material" to describe tangible attributes (see Table 4) of the specific infrastructure that support the collaboration. We identified four such factors: 1) acceptance of mediating technologies, 2) usability of mediating technologies, 3) Richness of mediating technologies, and 4) Knowledge-tracking fulfillment. We discuss the first three factors in this section and the fourth one in Section 5.

### 4.2.1 Acceptance of Mediating Technologies

In distributed collaboration, technology provides a consistent link between group members (Gómez et al., 2017; Pauleen & Yoong, 2001). Thus, the technology group members choose plays a crucial role in capturing their assertions, thoughts, and experiences (Altschuller & Benbunan-Fich, 2013). Members may also have to factor the mediating technology in cost-benefit comparisons between various options (e.g., typing is simple to implement but takes more time and effort than speaking, while phone calls reduce the need to travel but lack naturalness compared to face-to-face meetings) (Bos, Olson, & Nan, 2009).

### 4.2.2 Usability of Mediating Technologies

Researchers consider increasing usability a critical design goal when forming distributed collaborations (Butler et al., 2014; Kankanhalli, Tan, & Wei, 2006; Sarker & Sarker, 2009). Technologies must provide virtual spaces that do not obstruct interactions if they will produce the types of sociable environments that meaningful collaboration requires (Phang et al., 2009). These capabilities include thread posting, real-time chat, private messaging, polling tools, communal calendars/scheduling, and social network applications (Bock et al., 2015).

### 4.2.3 Richness of Mediating Technologies

Media richness describes a communication channel's ability to capture different types of information and feedback rapidly and in parallel and, thus, reduce ambiguity and uncertainty between parties (Daft & Lengel, 1986). Media richness is socially constructed, which means that different individuals will perceive richness in different ways. Ultimately, media richness and how group members communicate depends on how the individuals interact with the technology (Dennis et al., 2008).

**Table 4. Endemic Material Contributing Factors for Successful Distributed Collaboration**

| Contributing factor | Definition | Sources |
|---|---|---|
| Acceptance of mediating technologies | The extent to which collaborators accept mediating technologies. | Gómez et al. (2017), Gupta et al. (2009), Ma & Agarwal (2007), Pauleen & Yoong (2001) |
| Usability of mediating technologies | The extent to which collaborators find mediating technologies effortless to use. | Lindberg, Berente, Gaskin, & Lyytinen (2016), Phang et al. (2009), Spagnoletti, Resca, & Lee (2015) |
| Richness of mediating technologies | The extent to which mediating technologies afford parallel communication and rapid feedback. | Cummings & Dennis (2018), Daft & Lengel (1986), Dennis, Fuller, & Valacich (2008), Watson-Manheim & Bélanger (2007) |
| Knowledge-tracking fulfilment* | The extent to which mediating technologies allow collaborators to track knowledge activities. | Altschuller & Benbunan-Fich (2013), Phang et al. (2009) |

*We discuss this factor in Section 5.

## 4.3 Relational Social Contributing Factors

Relational social contributing factors describe qualities that exist in the relationships between collaborators. The existing literature described these factors in a more complicated way than other contributing factors. Hence, we model them in this study as hierarchical constructs that comprise multiple constituent factors (see Table 5). In particular, we identified: 1) interpersonal ties (which comprised the factors personal relationships among specific group members, trust among specific group members, communication among specific group members, and prior work history between collaborating members), 2) social structures (which comprised the factors communication standards adopted in the group, the social network in the group, the governance structure, social norms, and subgroups), and 3) task-specific alignment (which comprised the factors shared understanding among group members, a coordination among specific group members, and mutual learning between members).

#### 4.3.1 Interpersonal Ties

**Interpersonal relationships among specific group members** allow group members to develop "synergistic knowledge" through group interactions (Griffith, Sawyer, & Neale, 2003). These relationships may exist in and across different organizations (Liu et al., 2017).

We can divide **trust among specific group members** into cognitive and affective trust (Fan & Lederman, 2018; Kanawattanachai & Yoo, 2002) whereby cognitive trust involves a cognitively assessing other members' competence, reliability, and dependability, while affective trust deals with emotional bounds, caring, and reciprocity (Altschuller & Benbunan-Fich, 2013; Fan & Lederman, 2018). Both dimensions affect whether distributed collaboration succeeds. However, distributed collaboration means members are dispersed and projects may not last very long; hence, cognitive trust often takes precedence (Altschuller & Benbunan-Fich, 2013; Liu et al., 2017).

**Communication among specific group members** affects the performance of distributed groups since group members will see other members who communicate more in a more positive manner (Bock et al., 2015; Pauleen, 2003; Sarker & Sahay, 2004).

Existing literature has cited **prior work history between collaborating members** as a consideration for distributed collaborative groups (Piccoli & Ives, 2003; Robert, Dennis, & Ahuka, 2008). Distributed collaborations often face logistical hurdles that co-located groups experience less frequently in that members will likely have no history of working with one another (Gu, Konana, Rajagopalan, & Chen, 2007; Kanawattanachai & Yoo, 2002).

#### 4.3.2 Social Structures

**Communication standards**, which researchers sometimes call genre rules, refer to the social structures that dictate how users should use communication tools (Bartelt & Dennis, 2014; Watson-Manheim & Bélanger, 2007). Communicative genres constitute distinctive types of communicative action, which socially recognized communicative purposes and common form aspects characterize (Moser, Ganley, & Groenewegen, 2013). Users intuitively adopt them as they communicate with one another, which further emphasizes distributed collaboration's self-structured nature (Bartelt & Dennis, 2014).

Establishing a **social network in the group** increases social presence, which refers to group members' perception that their social counterparts in virtual exchanges are real (Altschuller & Benbunan-Fich, 2013; Srivastava & Chandra, 2018). In turn, social presence creates social comparison, which promotes positive actions as group members begin to match their efforts to the efforts of other group members (Bhagwatwar, Massey, & Dennis, 2017). One can apply social capital theory and specifically structural capital to distributed collaboration when discussing the influence that social networks can have on the performance of distributed groups (Robert et al., 2008). Structural capital reflects the overall pattern with which group members interact with one another (Cummings & Dennis, 2018; Wasko & Faraj, 2005).

Distributed collaboration follows a different **governance structure** compared to traditional, hierarchical groups in an organization. Because distributed collaborations use communication technology, groups typically use self-organization as a governance mechanism and keep a detailed trace of the interactions between members in real time (Bauer et al., 2016; Crowston et al., 2007; Grigore et al., 2015). Group members establish and maintain distributed collaborations as a platform to share common interests and information relating to a topic without any organizational input (Hauser et al., 2017; Porter et al., 2013). Distributed collaborative groups implement their own content boundaries—individuals' perceptions about what materials and discussions form part the community and what do not (Butler & Wang, 2012). Researchers have shown the lack of formal structure in distributed collaboration to free collaborators from the pressure associated with social convention and hierarchy and to foster innovation at levels that one does not usually find in traditional organizational structures (Faraj et al., 2011).

**Social norms** refer to a group's informal rules and standards that emerge from social interactions and influence group members' social behavior without the force of laws (Huang, Chengalur-Smith, & Pinsonneault, 2019). Social norms develop over time in a group with repeated interactions, contributions, and exchanges (Bjørn & Ngwenyama, 2009).

**Subgroups** or cliques refer to subgroups in a network whose actors have closer and more intense ties to one another compared to other members in the entire network (Bock et al., 2015).

### 4.3.3 Task-specific Alignment

Distributed collaborations require all group members to share in understanding what they want to achieve in order to operate towards a common goal. The importance of shared goals and understanding in distributed collaboration draws on cognitive capital (i.e., the extent to which members share a common understanding about their teamwork and/or task) (Mathieu et al., 2000). Park et al. (2019) showed that shared understanding leads to "affective contagion" (i.e., a process in which a person or group influences the affect or behavior of another person or group through consciously or unconsciously inducing affect states and behavioral attitudes). In an effort to develop a shared understanding, distributed collaborations should avoid certain obstacles. First, they need to avoid confirmation bias (i.e., the tendency to search for or interpret information in a way that confirms one's preconceptions) (Minas, Potter, Dennis, Bartelt, & Bae, 2014). Second, group members cannot always develop a shared understanding, and many groups experience conflict among team members that they must resolve (Oshri, Van Fenema, & Kotlarsky, 2008; Windeler et al., 2015).

**Coordination among group members** occurs when members develop an understanding of others' activities. Coordination refers to managing dependencies among task activities. When multiple individuals' task activities need to interrelate in a synchronized fashion, they need to manage the corresponding interdependencies well (Espinosa et al., 2007). Prior literature has discussed the affect that coordination among group members has on the performance of distributed groups in detail (Lindberg et al., 2016; Moser et al., 2013; Yang et al., 2015), and understanding "who knows what" can improve the group's performance (Oshri et al., 2008).

**Mutual learning** (i.e., sharing, transferring, recombining, and reusing knowledge among parties) (Jarvenpaa & Majchrzak, 2010) constitutes a central activity in distributed collaboration; however, it can be extremely difficult to encourage users to participate (Ren et al., 2012). Distributed collaboration follows a power law distribution whereby a few top contributors provide most resources; for example, over 65 percent of Gnutella network users downloaded free music without ever contributing themselves (Gu et al., 2007). Researchers consider equal participation an important factor that affects group performance as groups need to integrate knowledge from as many group members as possible; if some members do not contribute, the group loses this potential knowledge (Barlow & Dennis, 2016).

**Table 5. Relational Social Contributing Factors for Successful Distributed Collaboration**

| Contributing factor | Attributes | Sources |
|---|---|---|
| Interpersonal ties | Relationships among specific group members | Goh & Wasko (2012), Kraut, Wang, Butler, Joyce, & Burke (2010), Liu et al. (2017), Paul & McDaniel (2004), Pauleen (2003), Pauleen & Yoong (2001) |
| | Trust among specific group members | Altschuller & Benbunan-Fich (2013), Cheng et al. (2016), Fan & Lederman (2018), Kanawattanachai & Yoo (2002), Ridings, Gefen, & Arinze (2002), Robert, Dennis, & Hung (2009) |
| | Communication among specific group members | Dennis et al. (2008), Kotlarsky & Oshri (2005), Ridings et al. (2006), Sarker, Ahuja, Sarker, & Kirkeby (2011), Zhang et al. (2013) |
| | Prior work history | Altschuller & Benbunan-Fich (2013), Cummings & Dennis (2018), Espinosa, Slaughter, Kraut, & Herbsleb (2007), Robert et al. (2009), Wu, Gerlach, & Young (2007) |
| Social structures | Communication standards adopted in group | Gu, Konana, Rajagopalan, & Chen (2007), Jarvenpaa, Shaw, & Staples (2004), Moser et al. (2013), Potter & Balthazard (2002), Sarker & Sahay (2004) |
| | Social network in group | Cummings & Dennis (2018), Garg, Smith, & Telang (2011), Kane & Ransbotham (2016), Robert et al. (2008), Sarker et al. (2011), Wasko & Faraj (2005) |
| | Governance structure of group | Bauer, Franke, & Tuertscher (2016), Crowston, Li, Wei, Eseryel, & Howison (2007), Faraj et al. (2011), Grigore et al. (2015), Hauser et al. (2017) |
| | Social norms | Bjørn & Ngwenyama (2009), Butler & Wang (2012), Park et al. (2019), Ridings & Wasko (2010), Sarker & Sahay (2004), Watson-Manheim et al. (2012) |

**Table 5. Relational Social Contributing Factors for Successful Distributed Collaboration**

| | | |
|---|---|---|
| | Subgroups | Bock et al. (2015), Bos et al. (2009), Gu, Konana, Raghunathan, & Chen (2014), O'Leary & Cummings (2007), Windeler, Maruping, Robert, & Riemenschneider (2015) |
| Task-specific alignment | Shared understanding among specific group members | Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers (2000), Ray, Kim, & Morris (2014), Robert et al. (2008), Sarker et al. (2011), Wasko & Faraj (2005), Windeler et al. (2015) |
| | Coordination among specific group members | Beranek, Broder, Reinig, Romano, & Sump (2005), Kanawattanachai & Yoo (2007), Lindberg et al. (2016), Moser et al. (2013), Robert et al. (2008), Yang, Tong, & Teo (2015) |
| | Mutual learning among specific group members | Faraj et al. (2011), Kane & Ransbotham (2016), Kotlarsky & Oshri (2005), Ma & Agarwal (2007), Oh et al. (2016), Posey et al. (2010), Ransbotham & Kane (2011), Ridings et al. (2006), Staples & Webster (2008), Wasko & Faraj (2005) |

## 4.4 Relational Material Contributing Factors

We use the term relational material to describe tangible factors that determine how group members interact with one another (Table 6). We identified three such factors: 1) task-technology fit, 2) distance between group members, and 3) time zones occupied by group members.

### 4.4.1 Task-technology Fit

Task-technology fit refers to the fit between the task requirements and the IT's capabilities to facilitate communication (Asatiani & Penttinen, 2019). IT coordinates the communication medium's features with the situation and the group's social context (Barlow & Dennis, 2016; Jarvenpaa et al., 2004), and the extant literature has discussed IT as contributing to collaborative success (Barlow & Dennis, 2016; Beranek et al., 2005; Figl & Saunders, 2011).

### 4.4.2 Distance between Group Members

When operating in distributed collaboration, groups must overcome geographical distance, which researchers have traditionally considered antithetical to successful coordination (Lindberg et al., 2016). Of course, groups can also harness distance to their advantage as virtual spaces lack geographical limitations, which means members can access the platform from any place, in any manner, and at any time (Spagnoletti et al., 2015).

### 4.4.3 Time Zones Occupied by Group Members

Extant research has highlighted time as "one of the most elusive concepts related to work" (Sarker & Sahay, 2004, p. 5). For distributed collaborative groups, as distance and group size increases, groups will likely experience difficulties with members working in different time zones (Kayworth & Leidner, 2002; Massey et al., 2003), which researchers have referred to as temporal dispersion (Colazo & Fang, 2010; O'Leary & Cummings, 2007) and considered an "internal boundary" for distributed groups (Espinosa et al., 2003).

**Table 6. Relational Material Contributing Factors for Successful Distributed Collaboration**

| Contributing factor | Attributes | Sources |
|---|---|---|
| Task-technology fit | The appropriateness of the mediating technology that the group adopts given the context of its operations. | Asatiani & Penttinen (2019), Bartelt & Dennis (2014), Faraj et al. (2011), Figl & Saunders (2011) |
| Distance between members | The geographic dispersion of group members. | Colazo & Fang (2010), Espinosa, Cummings, Wilson, & Pearce (2003), O'Leary & Cummings (2007), Sarker & Sahay (2004) |
| Time zones occupied by group members | The time zones in which collaborating participants in the group live in. | Colazo & Fang (2010), Espinosa et al. (2003), Massey, Montoya-Weiss, & Hung (2003), O'Leary & Cummings (2007), Sarker, Ahuja, & Sarker (2018), Sarker & Sahay (2004) |

# 5 Complimentary and Moderating Factors

Thus far, we detail the benefits that organizations or groups can reap from effective distributed collaboration and model the factors that groups must manage in order to produce such rewards. However, through reviewing existing literature, we found that many factors did not operate in isolation and that other factors complimented. Through retrospectively reviewing these complimentary factors after producing our model that we illustrate in Figure 2, we unsurprisingly found that some listed factors complimented or moderated others. In this section, we detail how the factors in our research model have a complimentary or moderating influence on one another.

## 5.1 Endemic Social

**Members' leadership skills** have a particularly dynamic nature due to the multidisciplinary and geographically **distance between members** in distributed collaboration (Eseryel & Eseryel, 2013). **Mutual learning**, **members' personality,** and **members' tendency to empathize** influence who members will choose as a leader. Factors that researchers have often found associated with a good leader include participation level (Faraj et al., 2015), strong leadership personality traits (Nicholson et al., 2007), or simply being considerate of others' feelings (Eseryel & Eseryel, 2013).

**Members' tendency to empathize** has a positive effect on the level of participation and, thus, improves **mutual learning** (Huang et al., 2019; Johnson et al., 2014; Leimeister, Ebner, & Krcmar, 2005). Showing empathy also **motivates** other members and encourages unselfish behaviors (Grigore et al., 2015). As we state above, empathy can also compensate for an absence of formal **leadership** whereby members assume the role of a mentor and develop their peers by listening and showing support (Wakefield, Leidner, & Garrison, 2008).

**Social networks** in a group can moderate **members' personalities** as distributed collaborations arguably make it more difficult to express one's personality due to the decrease in continuous exposure. Thus, certain personality traits, such as charisma, can become less effective in distributed collaboration if the member lacks proficiency in the necessary technical skills to allow them to express it (Windeler et al., 2015). Although much extant research has focused on the effect that individuals' personality has on their role in distributed collaboration, it has also examined the converse relationship and found that **mutual learning** and participation in distributed collaboration can negatively influence individuals' **personalities** (e.g. if the pressures of working in a distributed group interfere with an individual's work-life balance) (Sarker, Sarker, & Jana, 2010).

Researchers have shown that increasing **members' motivation** can complement **mutual learning** as having a sense of belonging in a group increases information exchange and cooperation in the group (Cummings & Dennis, 2018). Members with greater commitment to the group will stay with it longer and contribute more (Kraut et al., 2010; Yan, Leidner, & Benbya, 2018). Commitment level plays a key role in regulating members' behavior such as reading posts, posting replies, and moderating discussions (Bateman et al., 2011). Many group members in open environments typically start as "lurkers" who must be motivated to become more actively involved by showing them the potential value from active participation (Ridings et al., 2006).

**Members' cultural backgrounds** present a continuous challenge in distributed collaboration (Sarker & Sarker, 2009). The mix of national and local cultural backgrounds often has a strong influence on **communication**, **shared understanding**, and **leadership** in the group as members require greater communication skills to avoid misunderstandings or cultural biases (David, Chand, Newell, & Resende-Santos, 2008; Kayworth & Leidner, 2002; Pauleen & Yoong, 2001; Vlaar et al., 2008). Group members from different cultures may interact with their peers in contrasting ways. For example, Nordbäck & Espinosa (2019) showed that members from high power-distance cultures are more likely to accept an unequal power distribution, which makes them less equipped and less likely to assume leadership roles. On the other hand, team members from low power-distance cultures are more likely to favor less centralized leadership approaches. Similarly, mixed cultures in a group can influence how members develop **interpersonal relationships** and share the knowledge the group needs for **mutual learning** as different cultures may have different attitudes about self-disclosure (Posey et al., 2010), and members from an individualistic culture will tend to have loose interpersonal ties versus collectivists, which will tend to be cohesive and well integrated (Paul et al., 2004; Posey et al., 2010; Shin et al., 2007).

We summarize these relationships in Figure 3.

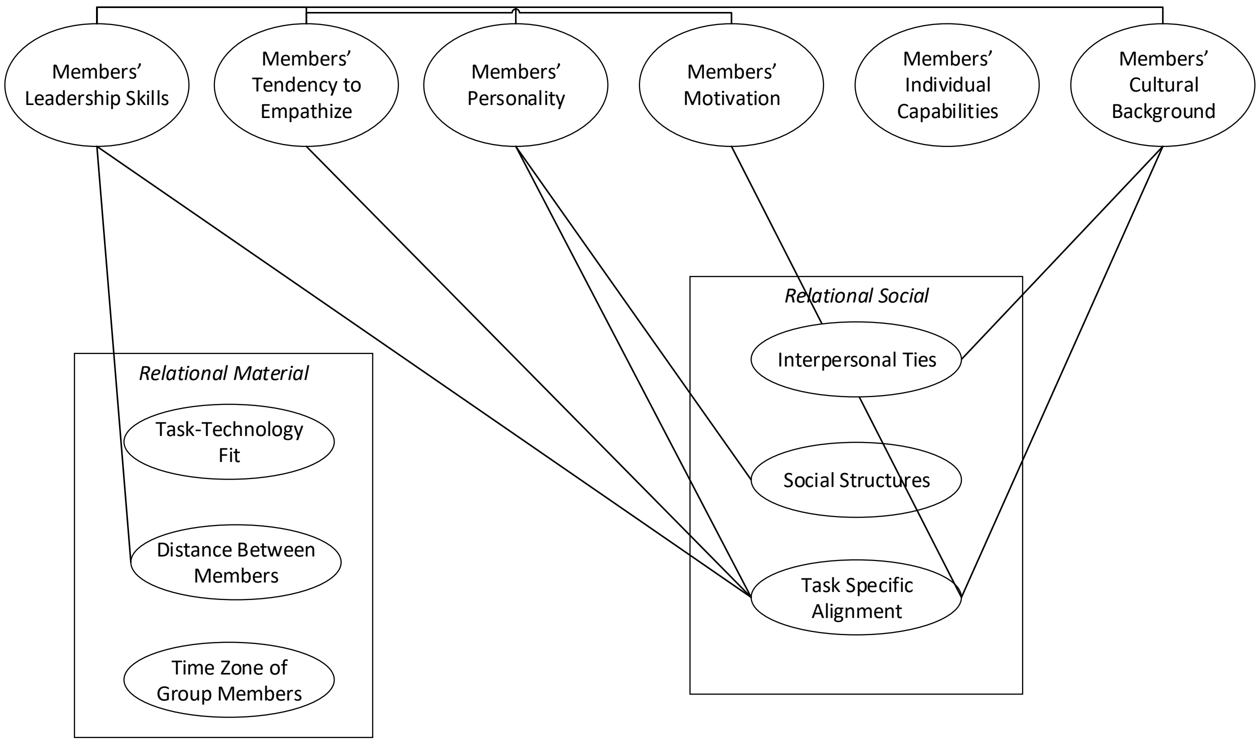


**Figure 3. Complimentary and Moderating Relationships between Endemic Social and Other Factors**

## 5.2 Endemic Material

**Acceptance of mediating technologies** directly influences the level of **communication** between members. For example, secondary compatibility issues can emerge (e.g., people in China cannot freely access some communication tools, such as Google+ and Facebook, and U.S. members may not be accustomed to using WeChat) (Cheng et al., 2016).

Second, the **usability of mediating technologies** impacts **mutual learning** as technology needs to allow group members to share digital content in multiple formats in order to collaborate properly (Spagnoletti et al., 2015). For example, platforms such as GitHub provide a comprehensive suite of communication and collaboration features that support users in effectively coordinating their work (Lindberg et al., 2016).

Third, mediating technologies' richness can either compliment or negatively impact **communication** between members and play a significant role in whether distributed collaboration succeeds or fails as less rich media slows and inhibits complex communication between collaborating members (Kayworth & Leidner, 2002).

Finally, **knowledge-tracking fulfillment** describes the extent to which members believe the technology that the group uses can fulfill their need to track knowledge activities (Phang et al., 2009). Distributed collaboration systems can enable knowledge-tracking fulfillment by maintaining a digital record of member contributions and contributors, so improving **relationships** in the group as increased public awareness encourages members to build relationships (Altschuller & Benbunan-Fich, 2013). Knowledge-tracking fulfillment can also act as a **motivation** tool as it plays an important role in reputation-building and group acknowledgement (Wasko & Faraj, 2005; Wasko, Faraj, & Teigland, 2004).

We summarize these relationships in Figure 4.

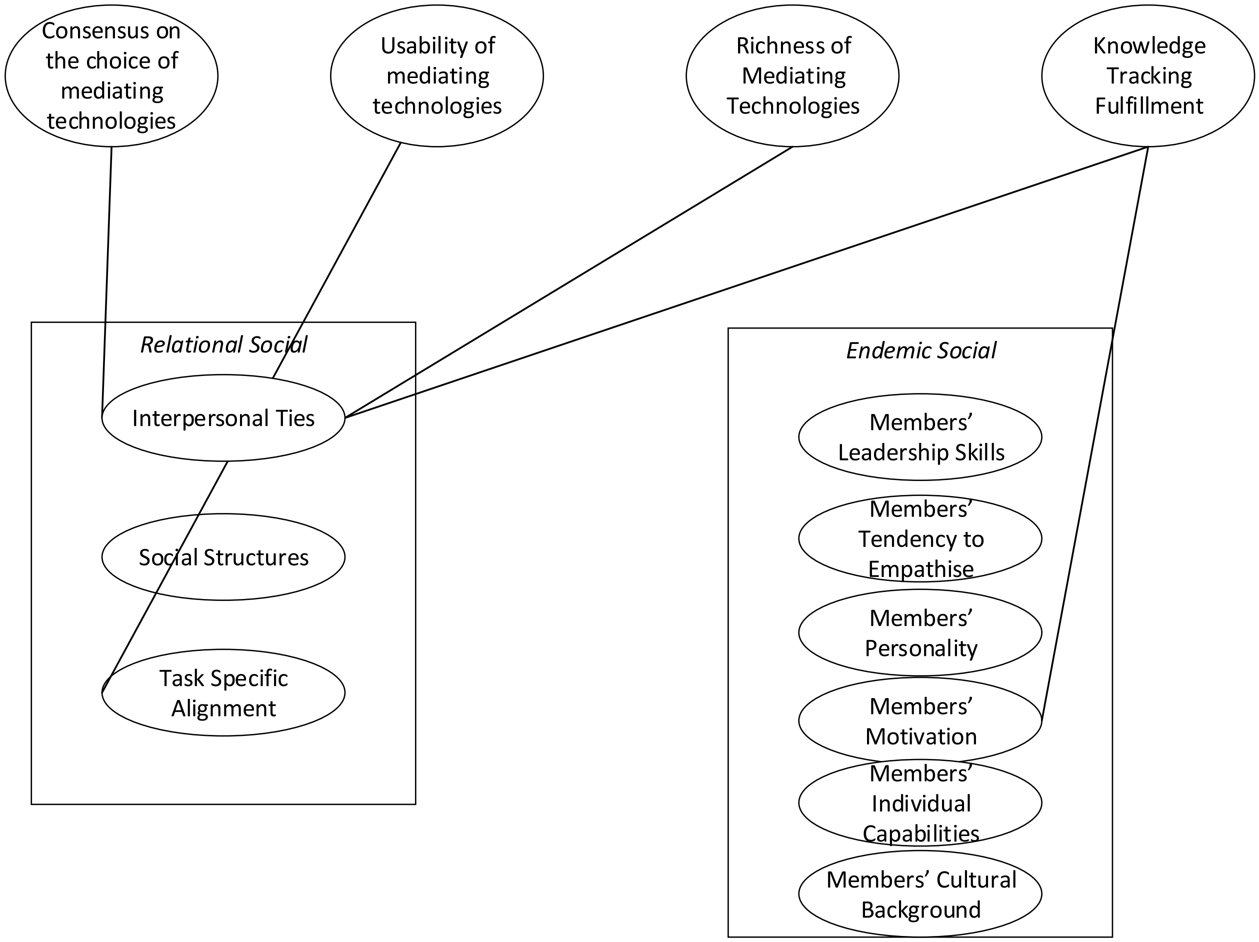


**Figure 4. Complimentary and Moderating Relationships between Endemic Material and Other Factors**

## 5.3 Relational Social

First, **interpersonal relationships among specific group members** form the basis for group members to develop **trust and communication** (Cummings & Dennis, 2018; Paul & McDaniel, 2004; Pauleen, 2003; Windeler et al., 2015).

Second, members in distributed collaboration can find it difficult to develop **trust** given that they lack established **relationships** or a **prior work history**. Accordingly, they must often rely on "swift trust", a presumptive form of trust that allows individuals to begin collaborating as quickly as possible (Robert et al., 2009). Once individuals have established trust, **mutual learning** follows as they are more likely to share information, make contributions, and accept others' information and contributions (Robert et al., 2008; Zhang & Watts, 2008).

**Communication among specific group members** depends on whether group members trust other one another when they communicate; otherwise, members see high communication levels as wasteful "babbling" (Sarker et al., 2011). **Usability of technology** can improve communication between members as individuals can differentiate communications according to their "rehearsability" (i.e., the extent to which users can reread and edit communications before sending them) (Dennis et al., 2008). Accordingly, individuals can not only avoid making mistakes or offending people but also alleviate some social pressures that people experience in synchronous or face-to-face communication (Ray et al., 2014).

Having no **prior history working between members** does not mean that they cannot develop trust but, as we discuss above, it does necessitate whether members develop swift trust (Robert et al., 2009). Researchers have shown a satisfactory prior collaborative experience to encourage continued participation and, therefore, improve **mutual learning** (Wu et al., 2007). The lack of a prior work history can influence how members view one another: members not only rarely have a history of working together but also rarely meet in person during a collaboration, which would help them to establish a relationship (Cummings & Dennis, 2018). The lack of familiarity between group members means they struggle to develop relationships and routines over time (Barlow & Dennis, 2016), which makes it difficult for them to develop a shared understanding (Windeler et al., 2015), decreases communication between members, and, thus, increases the likelihood that conflict will occur in the group (Oshri et al., 2008).

**Communication standards** naturally have a direct influence on the **communication** between group members. Distributed collaboration requires effective communication, and, by establishing genre rules, a group can increase the ease with which they can communicate, reduce communication costs, and improve communication's efficiency and effectiveness (Espinosa et al., 2007). Previous studies have recommended that distributed collaborations even make explicit agreements for how quickly members should respond to emails to dramatically improve overall communication (Bos et al., 2009). Explicitly implementing such communication standards can help overcome **trust** issues between members as research has shown that, for communication responsiveness, a group member with high trust in their peer will attribute slow responsiveness to an external factor; however, without trust, a group member will interpret the delay in response as non-cooperative behavior (Jarvenpaa et al., 2004). Establishing communication standards can also overcome **cultural** differences as previous research has highlighted the difference in communication culture between different nationalities (Sarker & Sahay, 2004).

**Social networks in the group** rely on the **richness of the mediating technology** and distance **between members** as distance has an effect on communication, and the social influence that the exchange has on group members depends on the communication media's richness (media richness theory) (Dennis et al., 2008). Rich media better suit ambiguous tasks, whereas lean media better suit information processing (Asatiani & Penttinen, 2019). Interestingly, a strong social presence in a group results in social proof, a **motivation** tool whereby members engage in an activity as they believe that others in the group also do so (Posey et al., 2010). Groups with decentralized networks do not have a history in which a small number of members dominated discussions; therefore, higher structural capital increases the likelihood that more members will contribute, share, and use information from all members (**mutual learning**) (Robert et al., 2008). Interestingly, although members in distributed collaborations may not have prior work experience, these collaborations often display homophily, which refers to the propensity to seek interactions with others who have similar beliefs (Gu et al., 2014), and members have a tendency to discover the same information due to their shared interests (Garg et al., 2011).

**Governance structure** has a unique impact on leadership. Unlike in traditional organizations, in keeping with distributed collaboration's free structure, leaders emerge informally via natural selection, or members who actually do the work in the group determine who should take certain responsibilities (Eseryel & Eseryel, 2013). By establishing some degree of control in the group, group members regulate one another's behavior, which increases the probability that the group will reach its shared goals (Dennis, Robert, Curtis, Kowalczyk, & Hasty, 2012). The shared governance structure also improves perceptions of fairness among team members in terms of rewards, input expectations, resource support, recognition, and so on (Magni et al., 2018). Moderators who play a crucial role in sustaining a group (Phang et al., 2009), and **trust** and good **relationships** between group members (Pauleen, 2003) maintain governance structures.

**Social norms** emerge on a voluntary basis, moderate contributors' interactions, and ensure quality contributions. In this way, they improve mutual learning (Butler & Wang, 2012; Gu et al., 2007; Ridings & Wasko, 2010). Social norms can help members develop a shared understanding and motivate participation (Sarker & Sarker, 2009; Zhao et al., 2018)—which researchers consider a form of relational social capital (Robert et al., 2008). However, for various reasons, distributed collaborative groups find it difficult to establish social norms (e.g., cultural difference between members can cause conflict in a group, which inhibits group members from developing norms) (Sarker & Sahay, 2004; Wakefield et al., 2008). Furthermore a lack of **past work experience**, established **relationships**, or even **social cues** that appear in face-to-face interactions present a challenge (Barlow & Dennis, 2016; Robert et al., 2009). Failing to establish social norms can lead to poor group cohesion or, worse, members believing they have established a **shared understanding** while remaining oblivious to misunderstandings (Watson-Manheim et al., 2012).

Distributed collaboration allows members to form **subgroups** via two mechanisms. First, the **choice of mediating technology** and its technical infrastructure as emails and communication tools can support both collective and subgroup communication (Magni et al., 2018; Thomas & Bostrom, 2010). Second, distributed collaborations create homophily, which refers to people's propensity to seek interactions with similar others (Gu et al., 2014) to collaborate on a **shared topic or goal** (Park, Konana, Gu, Kumar, & Raghunathan, 2013). Therefore, members find that they identify with particular subgroups (Robert et al., 2009), which may increase their motivation and, thus, improve **mutual learning** through increased participation (Bos et al., 2009). However, groups should cautiously monitor subgroups as researchers have found that they can restrict a group from developing **trust** (Windeler et al., 2015) and increasing the likelihood that conflict will occur (i.e., a lack of shared understanding) (O'Leary & Cummings, 2007).

In particular, distributed collaborations need to develop **shared understanding** itself since members are geographically dispersed and may not have the same opportunities to **communicate** with one another (Sarker et al., 2011; Vlaar et al., 2008). Therefore, along with forming strong **interpersonal ties,** group members require a **shared understanding** and sense of belonging, mutual responsibility, and a sense of obligation toward one another (Ray et al., 2014; Vlaar et al., 2008). This cognitive capital facilitates efficient **member communication and coordination** in a distributed collaboration (Robert et al., 2008; Wasko & Faraj, 2005). As we discuss above, distributed collaboration constitutes a fluid object where members can come and go as they please, which creates the potential for confirmation bias (Faraj et al., 2011; Yan et al., 2018); however, distributed collaboration's strength lies in the variety in expertise and **individual capabilities** it affords (Lindberg et al., 2016; Zhao et al., 2018). We view conflict as the absence of shared understanding. Hauser et al. (2017) describe conflict as an interaction relationship between two or more parties that pursue mutually exclusive or incompatible goals. The likelihood of conflict increases with members' **geographic distance** and dispersion (Windeler et al., 2015).

Creating and maintaining this **coordination among specific group members** reduces the effort the group needs to expend to coordinate tasks and resources. Once group members develop such coordination through **communication** and via working as a group, their familiarity can help them anticipate others' actions (Beranek et al., 2005; Nordbäck & Espinosa, 2019). When distributed collaborations have a shared understanding, they begin to develop shared mental models, which members require to effectively exchange and integrate information (**mutual learning**) and enable high-performing groups to coordinate themselves without **communicating** too much (Beranek et al., 2005; Robert et al., 2008; Yang et al., 2015). Maintaining coordination among group members requires particular attention in distributed rather than co-located collaborations as, in the latter, people can "bump into" one another, which can remind them about tasks that they need to complete (Bos et al., 2009). Instead, distributed collaborations rely on transactive memory systems (TMS), which combine individual memory systems and communication between individuals (Oshri et al., 2008). In particular, the literature on TMS highlights that the awareness of knowledge specialization among team members is vital in distributed groups as awareness of knowledge's location improves team performance (Kanawattanachai & Yoo, 2007). Distributed collaborations must develop awareness of knowledge specialization among team members as members may not have close **personal relationships** but come together to facilitate **mutual learning** (Kotlarsky & Oshri, 2005).

Researchers have also applied social exchange theory when studying **mutual learning** in distributed groups (Posey et al., 2010; Ridings et al., 2006). They have applied social exchange theory in this context as a subjective cost-benefit perspective to compare intangible costs such as contributing to the group with intangible benefits such as the respect one will receive (Posey et al., 2010). Existing literature shows that members require **trust** (Staples & Webster, 2008) and the belief that they will enhance their reputation (Wasko & Faraj, 2005) to **motivate** them to contribute (Posey et al., 2010). Members in a distributed collaboration operate on a somewhat voluntary basis, which means that they (and, thus, their contributions) are more volatile (Oh et al., 2016). The literature has shown that distributed collaborations have high membership volatility (Faraj et al., 2011). Member retention and **motivation** to participate represent a constant struggle and crucially affects whether a distributed collaboration will survive and succeed (Ransbotham & Kane, 2011). However, other studies suggest that a volatile membership can be a positive factor as it increases group size, and therefore, information quality (Kane & Ransbotham, 2016). Distributed collaborations naturally have more difficulty in encouraging mutual learning due to the lack of face-to-face **communication** (Griffith et al., 2003; Ma & Agarwal, 2007). Distributed collaborations invest heavily in **media-rich** communication tools to support mutual learning; however, breakdowns and other challenges can still emerge (Kotlarsky & Oshri, 2005).

Of course, members also need to exchange tacit and not just explicit knowledge (Wang, Noe, & Wang, 2014), although they can find doing so in a distributed setting with limited interpersonal **communication** difficult (Gupta et al., 2009). Therefore, members rely on repeated interactions to contextualize their questions and validate answers (Johnson et al., 2015). Knowledge creation theory indicates that, in order to encourage mutual learning, individuals require a high degree of social interaction. Because individuals create knowledge, groups should look to create "communities of interaction" to improve mutual learning (Yan et al., 2018).

We summarize these relationships in Figure 5.

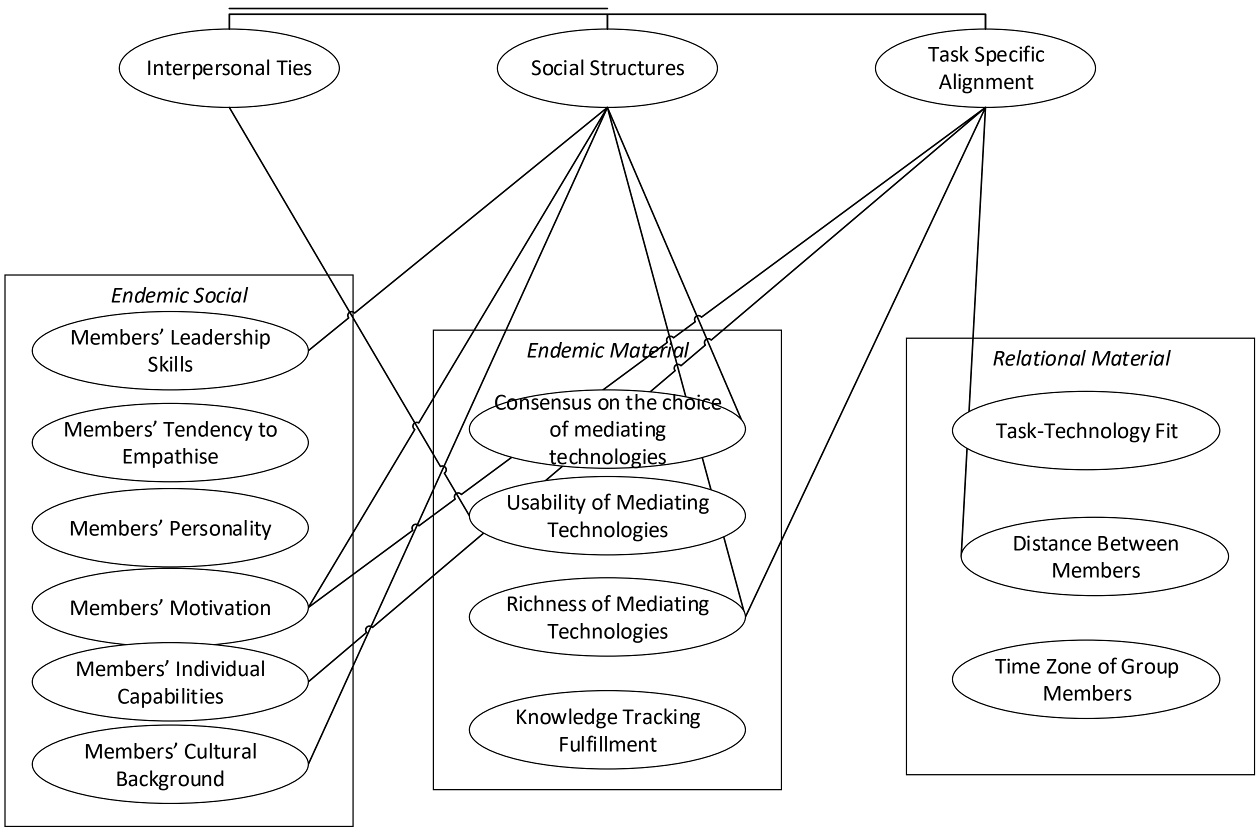


**Figure 5. Complimentary and Moderating Relationships Between Relational Social and Other Factors**

## 5.4 Relational Material

**Task-technology fit** also has a close relationship with **coordination among group members** as individuals should be aligned with tasks, technology, and the group structure to achieve optimal performance (Wang & Haggerty, 2011). Distributed collaborations should give task-technology fit as much consideration as the technology itself to ensure they do not waste their investment in collaborative tools. While an increase in available communicative technology means that **communication** *can* occur, it does not mean that it *will* (David et al., 2008). Technology can alleviate **cultural**, **temporal**, and **geographic** issues; however, a suboptimal fit between task and technology can amplify these issues (Asatiani & Penttinen, 2019).

Dispersed group members present a challenge with how best to distribute work, responsibilities, and **leadership** and then re-integrate them into the group as a whole (David et al., 2008). Greater **distance** between group members reduces **communication** intensity, particularly when members face problems with media that cannot substitute face-to-face communication (Kotlarsky & Oshri, 2005).

Different **time zones** also complicate how easily group members can **communicate**. In particular, synchronous communication becomes difficult to arrange (Cheng et al., 2016; Kankanhalli et al., 2006) because individuals experience unproductive waits for responses, which can lead to inefficiencies, more work, and, ultimately, work outside regular hours (Sarker et al., 2018). For example, in their study on GLOBALIS, David et al. (2008) observed that meetings took place at 8:00 a.m. in the Eastern Time Zone and, thus, 1:00 p.m. in Ireland, 7:00 p.m. in India, 7:00 a.m. in Texas, and 6:00 a.m. in Utah. Thus, people on America's east coast started their day with a meeting, Irish workers had their day interrupted with a meeting, and members in Texas, Utah, and India had to work outside their normal hours to participate in meetings. Such schedules have also caused conflict in distributed collaborative groups and led to complaints that meeting times favor certain groups or that certain groups receive better assignments (Magni et al., 2018). Indeed, while 24-hour service has benefits, it also comes with costs, such as these coordination issues (Kankanhalli et al., 2006).

We summarize these relationships in Figure 6.

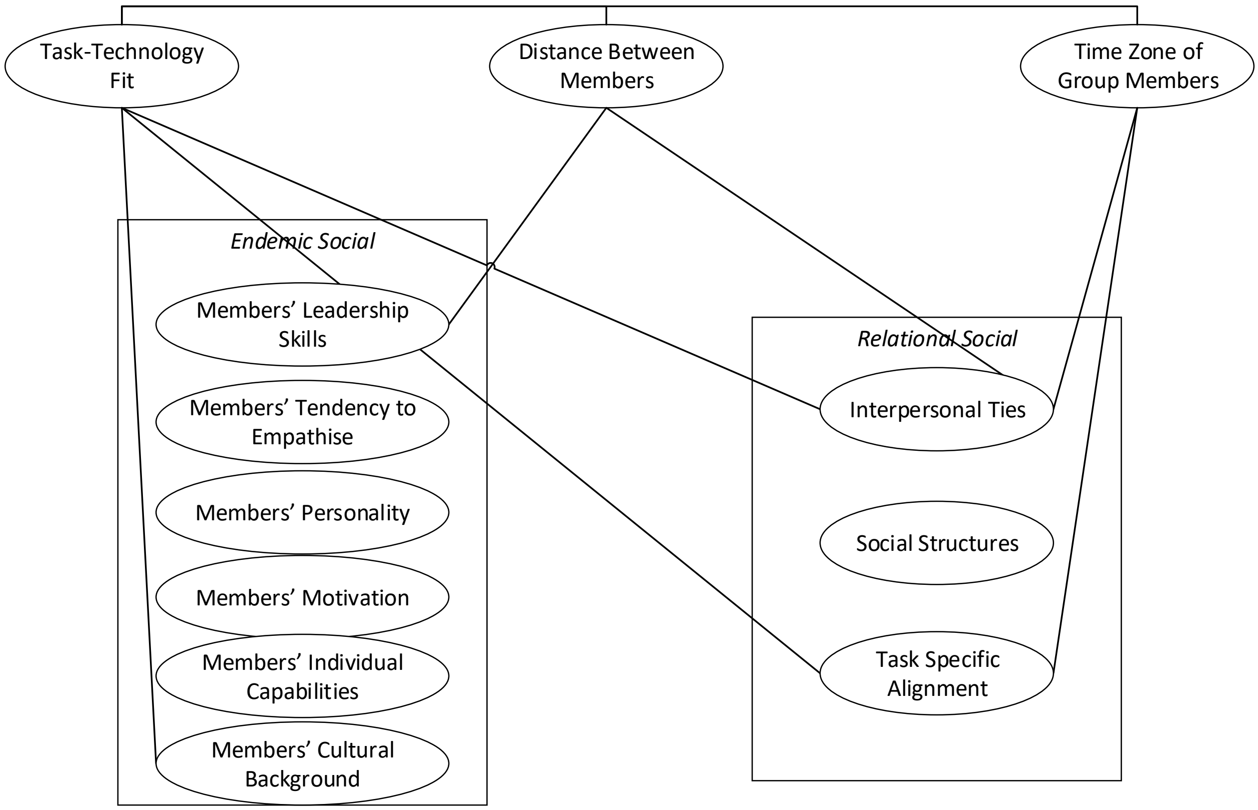


**Figure 6. Complimentary and Moderating Relationships between Relational Material and Other Factors**

# 6 Distributed Collaboration Benefits

Distributed collaborations that successfully coordinate the contributing factors that we discuss in the Sections 4 and 5 can reap several benefits. We identified sixth such benefits: 1) communication, 2) mutual learning, 3) relationship building, 4) task-completion speed, 5) access to skilled personnel, 6) cost savings. We discuss each benefit in turn before we summarize them in Table 7.

## 6.1 Communication

Online social technologies afford low-cost and easy to access communication media (Hauser et al., 2017). However, such technologies can benefit distributed collaborations not only in communication quantity but also communication quality. Individuals in these environments often communicate primarily via text, which carriers particular learning advantages as it allows the user to read, reflect, write, and revise their thoughts before they post their contributions (Minas et al., 2014). Groups can mediate communication either synchronously (e.g., a chat room) or asynchronously (e.g., a discussion board) (Massey et al., 2003; Piccoli & Ives, 2003; Spagnoletti et al., 2015). Nuanced benefits result from each type of distributed communication. Groups that use synchronous text-based communication generally share more unique information as text-based communication helps contributors overcome the selective information search bias that commonly occurs in face-to-face groups (Minas et al., 2014). Asynchronous communication affords team members the time to consider both the information they receive and the response they give in return (Colazo & Fang, 2010). Good communication can also enhance other benefits such as mutual learning and relationships (Hauser et al., 2017; Yang et al., 2015), which we discuss in Sections 6.2 and 6.3.

## 6.2 Mutual Learning

Researchers have often considered mutual learning the major attraction for members or organizations to participate in Distributed Collaboration (Kotlarsky & Oshri, 2005; Ridings et al., 2006; Wang et al., 2014). Mutual learning differs from communication as it focuses on not only exchanging information but also changing group members' perspectives through sharing, transferring, recombining, and reusing knowledge (Jarvenpaa & Majchrzak, 2010). Distributed collaborations succeed the most when members not only share their unique knowledge and integrate that knowledge across the group as a whole but also generate new ideas and understanding as they contrast and compare perspectives and interpretations (Robert et al., 2008). Indeed, in adopting open innovation models, many large multinational firms, such as Procter and Gamble, Fiat, and IBM, have reflected mutual learning's value (Gómez et al., 2017). These companies have adopted such models largely due to the prevailing perception that adopting strategies such as open innovation and virtual teams provide knowledge-transfer opportunities at low marginal costs (Griffith et al., 2003).

## 6.3 Relationship Building

Individuals who participate in distributed collaboration may often benefit by finding people for emotional support, instrumental aid, companionship, a sense of belonging, and encouragement (Huang et al., 2019; Ridings et al., 2006). They may also enjoy a new platform for entertainment or to discuss social and political issues (Bateman et al., 2011; Kraut et al., 2010). We can see such relationships particularly in online health communities where relationship-building provides strong emotional support for individuals who may struggle with illnesses' personal and social demands of illness (Mein Goh, Gao, & Agarwal, 2016). Furthermore, researchers have found evidence that the stronger the relationship, the more likely members will trust shared information as they work towards some common purpose (Barrett, Oborn, & Orlikowski, 2016).

## 6.4 Task-completion Speed

Mutual learning and relationship building constitute primarily social benefits. However, distributed collaboration also produces tangible outputs. Distributed collaboration means groups can work either simultaneously or separately to collaborate on a task at any time. Such features prove particularly beneficial with groups that contain geographically dispersed members that span multiple time zones (Kanawattanachai & Yoo, 2002; O'Leary & Cummings, 2007; Yang et al., 2015). Furthermore distributed collaboration provides increased flexibility, which customers desire. Groups can now offer round-the-clock service to customers and rapid response to global market demands as members in different time zones allow themselves to easily adapt to changing environmental conditions (Kankanhalli et al., 2006; Massey et al., 2003; Yang et al., 2015).

## 6.5 Access to Skilled Personnel

Compared with co-located groups that face limitations in the members they can choose due to geography, distributed groups have a greater capacity to choose members with the ideal skill sets for the specific task at hand (Beranek et al., 2005). Therefore, distributed collaboration can deliver significant strategic flexibility (Piccoli & Ives, 2003). This flexibility provides research and development (R&D) advantages in particular since distributed groups can develop partnerships with new members to access specialized know-how on demand (Gómez et al., 2017). Despite these obvious benefits, it can also be a difficult task to manage a large dynamic group (Goh & Wasko, 2012). However, Ransbotham and Kane (2011) have suggested that even the membership turnover experienced in distributed collaboration can prove to be favorable as it allows new information and abilities to enter the group while retaining the content that individuals who depart generate.

## 6.6 Cost Savings

The opportunities above explain that distributed collaboration can achieve more than traditional arrangements with a similar commitment of resources. As such, distributed collaboration also creates opportunities to achieve similar results with fewer resources. Organizations that operate via distributed collaborations can produce significant cost savings due to the user-friendly, low-tech, and low-cost manner with which they can manage dynamic requirements—one which can expand and contract in size and scale (Bauer et al., 2016; Ferguson & Soekijad, 2016; Hauser et al., 2017). Breu and Hemingway

(2004) have advised that, by moving work to the worker rather than vice versa, organizations can achieve significant cost savings. Others have pointed out that distributed collaboration allows people and organizations to share information more systematically, which reduces R&D expenditure through duplication and rework (Gómez et al., 2017).

**Table 7. Distributed Collaboration Benefits**

| Benefit | Definition | Sources |
|---|---|---|
| Communication | The synchronous and asynchronous transfer of information between collaborators. | Bartelt & Dennis (2014), Sarker et al. (2011) |
| Mutual learning | The transfer of useful knowledge and skills between collaborators. | Gupta et al. (2009), Oshri et al. (2008), Ridings et al. (2006), Robert et al. (2008) |
| Relationship building | The development of reusable and reciprocal relationships between collaborators. | Bateman et al. (2011), Kraut et al. (2010), Paul & McDaniel (2004), Robert et al. (2008) |
| Task-completion speed | The speed with which a given task can be completed. | Colazo & Fang (2010), Massey et al. (2003), Sarker & Sahay (2004) |
| Access to skilled personnel | The ability to include specialized or highly skilled collaborators as needed. | Fuller et al. (2006), Ransbotham & Kane (2011), Wang & Haggerty (2011) |
| Cost savings | The reduction of costs when transferring or maintaining resources | Asatiani & Penttinen (2019), Breu & Hemingway (2004), Gómez et al. (2017) |

# 7 Discussion and Conclusions

In this study, we comprehensively review the current literature on distributed collaboration and, in doing so, better explain its contributing factors and benefits. We conducted this study due to the increasing move towards distributed collaboration as advancements in technology facilitate this arrangement in many industries (Gómez et al., 2017; Gupta et al., 2009). This research has become increasingly important today as the COVID-19 crisis has forced organizations across the world into remote working (Dubey & Tripathi, 2020).

First, we define distributed collaboration as the pursuit of a shared objective by groups that include non-proximate members, whose participation ICT facilitates. We developed this definition by synthesizing several other synonyms such as virtual teams, online communities, dispersed teams, online discussion communities, virtual communities, and distributed teams that extant research has used. In defining distributed collaboration, we provide clarify to both researchers who study how this approach operates and practitioners who look to adopt it.

We took a systematic approach to searching academic databases by first developing a keyword search matrix to overcome the challenge in comprehensively searching for studies in a multidisciplinary field. Once we gathered the literature and removed duplicates, we began reviewing the material and developed a concept-centric matrix to capture the contributing factor factors that distributed collaborations need to succeed and the benefits that result from these collaborations (Webster & Watson, 2002). We illustrate this concept-centric matrix in our core research model (see Figure 2).

With this study, we contribute to the existing body of research by providing a single, core model for distributed collaboration that researchers can adopt and build on in the future research and that practitioners can apply in their organizations. While existing research has focused on specific factors and the role they play in distributed collaboration, such as trust (Jarvenpaa et al., 2004; Ridings et al., 2002), leadership (Eseryel & Eseryel, 2013; Johnson et al., 2015; Kayworth & Leidner, 2002), and communication (Bartelt & Dennis, 2014; Sarker et al., 2011), we did not discover a comprehensive model for successful distributed collaboration in analyzing the existing literature.

Our model makes several significant contributions to both theory and practice. First, we distinguish both contributing factors and benefits as being either “social” or “material”—an important distinction to make considering the way we define distributed collaboration highlights the reliance on ICT to facilitate this type of working arrangement. Therefore, our model stresses that one must examine both technology and structural factors (“material”) and factors that pertain to the members in the group and how they interact with one another (“social”).

The second axis of our model divides the contributing factors as being either endemic or relational. Again, referring to the way we define distributed collaboration, groups comprise geographically dispersed members who work towards a common goal or shared interest. Therefore, dispersed workers will carry their own personal attributes, which we call social endemic, and we categorize all factors that relate to how members perform in the group as social relational. Similarly, we found that we could categorize material factors as either endemic (factors that relate to the specific technology implementation) or relational (structural factors in place that dictate the group's composition).

Second, in addition to illustrating a comprehensive model of the contributing factors for successful distributed collaboration and categorizing each factor, we also detail the interactions between these factors and how they can complement or regulate one another. Thus, we address calls in prior research to investigate the relationship among individual factors and how they influence distributed collaboration's performance (Asatiani & Penttinen, 2019; Cheng et al., 2016; Hauser et al., 2017). This model may prove particularly beneficial to practitioners as it provides valuable insights into how one can efficiently integrate all the elements in the model.

Third, we draw attention to factors that researchers have not sufficiently explored. While researchers have examined factors such as trust (Jarvenpaa et al., 2004; Ridings et al., 2002), leadership (Eseryel & Eseryel, 2013; Johnson et al., 2015; Kayworth & Leidner, 2002), and communication (Bartelt & Dennis, 2014; Sarker et al., 2011), they have not examined other factors such as empathy and knowledge-tracking fulfillment to the same extent. While our discussion highlights their role primarily as complimentary and moderating factors, we believe they contribute to a comprehensive distributed-collaboration model, which justifies their inclusion. We explicitly outline not only the importance of these infrequent factors but also the role they play in distributed collaboration's overall success. Knowledge-tracking fulfillment has particular importance given developments in communication technology. Future research should examine the role of knowledge-tracking fulfillment in the context of emerging technologies that facilitate this ability, such as blockchain technology's ability to capture data in a secure, immutable, and publicly verifiable manner (Beck, Müller-Bloch, & King, 2018).

As for future research directions in this domain, we highlight several potential avenues for researchers to explore. First, we present a synthesized definition of distributed collaboration that encapsulates various terms that researchers have applied to describe similar forms of collaborative groups. We believe future research should explore the dynamics of distributed collaboration further to categorize what distinguishes different flavors of this type of working arrangement. Second, future researchers could adopt the model we present and evaluate its accuracy against an established distributed-collaboration use case.

Finally, we limited the scope of our literature search to papers published between 2000 and 2019 in order to maintain a degree of relevance to advancements in contemporary communicative technologies. Although we believe that this study represents the current state of distributed collaboration, we also must acknowledge the pace with which new communicative technologies emerge, such as virtual and augmented reality and its application in collaboration (Venkatesh & Windeler, 2012). Additionally, the COVID-19 pandemic has resulted in a large-scale, synchronous adoption of distributed collaboration. Prior research has noted the difficulty of generating and maintaining user contributions as a factor that has led to the failure distributed collaboration in the past (Phang et al., 2009; Ransbotham & Kane, 2011); therefore, this mandatory–adoption period could have lasting effects. Thus, future research should iterate this study to capture how emerging technologies contribute to how we collaborate in distributed groups and the influence that COVID-19 has on distributed collaboration.

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# Appendix

## Benefits of Distributed Collaboration

**Table A1. Concept-centric Matrix for Benefits of Distributed Collaboration**

| Papers | Communication | Mutual learning | Relationship building | Task-completion speed | Access to skilled personnel | Cost savings |
|---|---|---|---|---|---|---|
| Fan, Lederman, Smith, & Chang (2014) | | x | | | | |
| Beranek et al. (2005) | | | | | x | |
| Ridings et al. (2006) | | x | x | | | |
| Fan & Lederman (2018) | | x | | | | |
| Posey et al. (2010) | | x | x | | | |
| Sarker et al. (2010) | | | | | | x |
| Altschuller & Benbunan-Fich (2013) | | | | x | | |
| Gasson & Waters (2013) | | x | | | | |
| Asatiani & Penttinen (2019) | | | | | | x |
| Rafaeli & Ravid (2003) | | x | | | | |
| Watson-Manheim et al. (2012) | | | | | x | x |
| Kraut et al. (2010) | | x | x | | | |
| Pavlou & Gefen (2004) | | | | x | x | |
| Gu et al. (2007) | | x | | | x | |
| Barrett et al. (2016) | | x | x | | x | |
| Gómez et al. (2017) | | x | | | x | x |
| Zhao et al. (2018) | | x | | | | |
| Sarker & Sarker (2009) | | x | | x | x | x |
| Park et al. (2013) | | x | | | | |
| Bauer et al. (2016) | | x | | | x | x |
| Jarvenpaa & Majchrzak (2010) | | x | | | | |
| Schultze & Orlikowski (2010) | | x | | | | |
| Kane & Ransbotham (2016) | | | | | x | |
| Zhang et al. (2013) | | x | | | | |
| Raghuram, Tuertscher, & Garud (2010) | | | | | x | |
| Bateman et al. (2011) | | x | x | | x | |
| Robert et al. (2008) | | x | | x | | |
| Faraj, von Krogh, Monteiro, & Lakhani (2016) | | x | x | | | x |
| Ray et al. (2014) | | x | | | x | |
| Butler & Wang (2012) | | x | | | x | |
| Johnson et al. (2015) | | x | x | | x | |
| Stanko (2016) | | x | | | x | |
| Nicholson et al. (2007) | | | | | x | |
| Curşeu (2006) | | x | | | | |

**Table A1. Concept-centric Matrix for Benefits of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Kotlarsky, Oshri, van Hillegersberg, & Kumar (2007) | | x | | | x | x |
| Breu & Hemingway (2004) | | | | | x | x |
| Ferguson & Soekijad (2016) | | | | x | x | x |
| Pauleen & Yoong (2001) | | | | | | x |
| Porter et al. (2013) | x | x | | | | |
| Massey et al. (2003) | | | | | x | |
| Kankanhalli et al. (2006) | | | | x | x | x |
| Yan et al. (2018) | | x | | | x | |
| Magni et al. (2018) | | x | | | x | |
| Fuller et al. (2006) | | x | | | x | x |
| Chen, Baird, & Straub (2019) | | x | x | | | x |
| Guo, Guo, Fang, & Vogel (2017) | | x | | | | |
| Wang & Haggerty (2011) | | | | | x | |
| Kayworth & Leidner (2002) | | | | x | x | x |
| Chen et al. (2011). | | x | | | | |
| Yan & Tan (2017) | x | x | | | | |
| Bieber et al. (2002) | | x | | | | |
| Cheng et al. (2016) | | | | x | | |
| Khansa, Ma, Liginlal, & Kim (2015) | | x | | x | x | |
| Minas et al. (2014) | x | | | | x | |
| Kordzadeh & Warren (2017) | x | x | | | | |
| Yang et al. (2015) | x | x | x | x | x | |
| Venkatesh & Windeler (2012) | | x | | | | |
| Eservel (2014) | | | | | x | |
| Park et al. (2019) | | x | | | | x |
| Ridings & Wasko (2010) | | x | x | | | |
| Bock et al. (2015) | | x | x | | | |
| Boughzala, De Vreede, & Limayem (2012) | x | | | x | | x |
| Goh & Wasko (2012) | | x | | | x | |
| Paul & McDaniel (2004) | | | x | | x | x |
| Butler et al. (2014) | | x | | | x | |
| Vlaar et al. (2008) | | | | x | x | x |
| Tsai & Bagozzi (2014) | | | | | x | |
| Johnson et al. (2014) | | x | | | x | |
| Faraj et al. (2015) | | x | | x | x | |
| Ransbotham & Kane (2011) | | x | | x | x | |
| Huang et al. (2019) | | x | x | | | |
| Majchrzak, Rice, Malhotra, King, & Ba (2000) | | x | | x | x | |
| Mein Goh et al. (2016) | | x | | | | x |
| Piccoli & Ives (2003) | | | | | x | |

**Table A1. Concept-centric Matrix for Benefits of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Han et al. (2012) | | x | | | | |
| Cummings & Dennis (2018) | | x | | | | |
| Griffith et al. (2003) | | x | | x | x | x |
| Wasko & Faraj (2005) | | x | | | x | |
| Ramasubbu, Mithas, Krishnan, & Kemerer (2008) | | | | | | x |
| Faraj et al. (2011) | | x | | | x | |
| Dong & Wu (2015) | | x | | | x | |
| Kanawattanachai & Yoo (2002) | | x | | x | x | |
| Hauser et al. (2017) | | x | | | | x |
| Gupta et al. (2009) | | | | | x | x |

## Endemic Social Contributing Factors

**Table A2. Concept-centric Matrix for Endemic Social Factors of Distributed Collaboration**

| Papers | Members' leadership skills | Members' tendency to empathize | Members' personality | Members' motivation | Members' individual capabilities | Members' cultural Backgrounds |
|---|---|---|---|---|---|---|
| Grigore et al. (2015) | | x | | x | | |
| Fan et al. (2014) | | x | | x | | |
| Beranek et al. (2005) | | | | | x | x |
| Ridings et al. (2006) | | | | x | | |
| Sarker & Sahay (2004) | | | | | x | x |
| Fan & Lederman (2018) | | x | | x | | |
| Posey et al. (2010) | | | | | | x |
| Kotlarsky & Oshri (2005) | | | | | | x |
| Thomas & Bostrom (2010) | x | | | | x | |
| Sarker et al. (2010) | | | x | x | | x |
| Altschuller & Benbunan-Fich (2013) | | | | | | x |
| Gasson & Waters (2013) | x | | | x | | x |
| Campbell, Holz, Cosgrove, Harlick, & O'Sullivan (2019) | x | | | | | |
| Asatiani & Penttinen (2019) | | | | | x | x |
| Rafaeli & Ravid (2003) | | | | | x | |
| Xu, Xu, & Li (2016) | | | | x | | |
| Oshri et al. (2008) | | | | | | x |
| Watson-Manheim et al. (2012) | x | | | | x | x |
| Liu et al. (2017) | x | | | | | x |
| Bjørn & Ngwenyama (2009) | | | x | | x | x |
| Ren & Kraut (2011) | | | x | x | | |
| Pavlou & Gefen (2004) | x | | | | x | x |
| Gu et al. (2007) | | | x | x | | |
| Bhagwatwar et al. (2018) | | | | x | x | |

**Table A2. Concept-centric Matrix for Endemic Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Zhao et al. (2018) | | | | x | | |
| Sarker & Sarker (2009) | | | | | x | x |
| Park et al. (2013) | | | | x | | |
| Bauer et al. (2016) | | | | x | | |
| Majchrzak et al. (2005) | | | | x | | |
| Jarvenpaa & Majchrzak (2010) | | | x | x | | |
| Wakefield et al. (2008) | x | x | | | x | x |
| Zhang et al. (2013) | | | | x | | |
| Oh et al. (2016) | x | | | x | | |
| Raghuram et al. (2010). | | | | x | | x |
| Bateman et al. (2011) | x | x | | | | |
| Dennis et al. (2012) | | | x | x | | |
| Faraj et al. (2016) | | | | x | x | |
| Ray et al. (2014) | | | x | x | | |
| Johnson et al. (2015) | x | | | x | | |
| Ma & Agarwal (2007) | | | x | x | | |
| Stanko (2016) | | | | x | | |
| Jarvenpaa et al. (2004) | | | | x | | x |
| Nicholson et al. (2007) | x | | x | x | | x |
| Spagnoletti et al. (2015) | | | | x | | |
| Kotlarsky et al. (2007) | | | | | x | x |
| David et al. (2008) | | | | | | x |
| Breu & Hemingway (2004) | x | | | x | | x |
| Ferguson & Soekijad (2016) | | | | x | | |
| Pauleen & Yoong (2001) | x | | | | x | x |
| Potter & Balthazard (2002) | | | x | | x | x |
| Porter et al. (2013) | | | | x | | x |
| Pauleen (2003) | x | x | | x | | x |
| Kankanhalli et al. (2006) | | | x | | | x |
| Leimeister et al. (2005) | | x | | | x | |
| Yan et al. (2018) | x | | | x | x | |
| Magni et al. (2018) | x | | | | x | |
| Nordbäck & Espinosa (2019) | x | | | | | x |
| Fuller et al. (2006) | x | | | x | x | |
| Franceschi et al. (2009) | | | | x | | |
| Chen et al. (2019) | | x | | x | | |
| Guo et al. (2017) | | | | x | | |
| Robert et al. (2009) | | | x | | x | |
| Wang & Haggerty (2011) | | | | x | x | |
| Brown et al. (2004) | x | | x | | | x |
| Kayworth & Leidner (2002) | x | | | | x | x |
| Chen et al. (2011) | | | | x | | |

**Table A2. Concept-centric Matrix for Endemic Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Barlow & Dennis (2016) | | x | | | x | |
| Espinosa et al. (2003) | | | | | x | x |
| Espinosa et al. (2007) | | | | | | x |
| Bieber et al. (2002) | | | | | | x |
| Cheng et al. (2016) | x | | | x | | x |
| Khansa et al. (2015) | | | | x | | |
| Kordzadeh & Warren (2017) | | x | | x | | |
| Windeler et al. (2015) | | | x | | x | x |
| Colazo & Fang (2010) | | | | x | | |
| Yang et al. (2015) | | | | x | | |
| Venkatesh & Windeler (2012) | x | | x | x | | |
| Eservel (2014) | x | | | | | |
| Park et al. (2019) | | x | | | | |
| Ridings & Wasko (2010) | | | | x | | |
| Bock et al. (2015) | | | | x | | |
| Boughzala et al. (2012) | | | x | x | x | |
| Goh & Wasko (2012) | x | | | x | | x |
| Sarker & Sahay (2003) | | | | | x | x |
| Phang et al. (2009) | | | | x | | |
| Paul & McDaniel (2004) | | x | | | x | |
| Butler et al. (2014) | x | | x | x | | |
| Vlaar et al. (2008) | | | | | x | x |
| Tsai & Bagozzi (2014) | | | x | x | | x |
| Johnson et al. (2014) | | x | | x | | |
| Chen et al. (2017) | | | | x | | |
| Faraj et al. (2015) | x | | | | | |
| Ransbotham & Kane (2011) | x | | | | | |
| Huang et al. (2019) | | x | | x | x | |
| Majchrzak et al. (2000) | | | | | | x |
| Mein Goh et al. (2016) | | | | x | | |
| O'Leary & Cummings (2007) | | | | | | x |
| Cummings & Dennis (2018) | | | x | x | | |
| Griffith et al. (2003) | | | | | | x |
| Wasko & Faraj (2005) | x | | | | x | |
| Ramasubbu et al. (2008) | | | | | x | x |
| Faraj et al. (2011) | | | | x | | |
| Eseryel & Eseryel (2013) | x | | | x | x | |
| Pan & Leidner (2003) | | | | | | x |
| Hauser et al. (2017) | | | x | | | |

## Endemic Material Contributing Factors

**Table A3. Concept-centric Matrix for Endemic Material Factors of Distributed Collaboration**

| Papers | Acceptance of mediating technologies | Usability of mediating technologies | Richness of mediating technologies | Knowledge-tracking fulfilment |
|---|---|---|---|---|
| Ridings et al. (2006) | x | | | |
| Sarker & Sahay (2004) | | x | | |
| Kotlarsky & Oshri (2005) | x | | x | |
| Thomas & Bostrom (2010) | x | x | | |
| Altschuller & Benbunan-Fich (2013) | x | | x | x |
| Asatiani & Penttinen (2019) | x | x | x | |
| Watson-Manheim et al. (2012) | | x | x | |
| Liu et al. (2017) | x | | x | |
| Bjørn & Ngwenyama (2009) | x | x | x | |
| Kraut et al. (2010) | | | x | |
| Pavlou & Gefen (2004) | x | | x | |
| Bhagwatwar et al. (2018) | | x | x | |
| Lindberg et al. (2016) | x | x | x | |
| Barrett et al. (2016) | x | | | |
| Gómez et al. (2017) | x | | x | |
| Sarker & Sarker (2009) | x | x | x | |
| Bauer et al. (2016) | x | | x | |
| Majchrzak et al. (2005) | | x | x | |
| Schultze & Orlikowski (2010) | | | x | |
| Wakefield et al. (2008) | x | x | x | |
| Raghuram et al. (2010) | | x | x | |
| Dennis et al. (2012) | | | x | |
| Faraj et al. (2016) | | | x | |
| Ray et al. (2014) | x | | | |
| Butler & Wang (2012) | | x | x | |
| Ma & Agarwal (2007) | x | | x | |
| Stanko (2016) | x | | | |
| Jarvenpaa et al. (2004) | | x | | |
| Nicholson et al. (2007) | x | | | |
| Spagnoletti et al. (2015) | x | x | x | |
| Curşeu (2006) | x | | x | |
| Kotlarsky et al. (2007) | | x | x | |
| David et al. (2008) | x | | | |
| Breu & Hemingway (2004) | x | x | | |
| Ferguson & Soekijad (2016) | x | | | |
| Pauleen & Yoong (2001) | x | | x | |
| Bos et al. (2009) | x | | x | |
| Potter & Balthazard (2002) | | | x | |
| Pauleen (2003) | x | | | |

**Table A3. Concept-centric Matrix for Endemic Material Factors of Distributed Collaboration**

| | | | | |
|---|---|---|---|---|
| Massey et al. (2003) | x | | | |
| Kankanhalli et al. (2006) | x | x | | |
| Leimeister et al. (2005) | x | | | |
| Magni et al. (2018) | | x | x | |
| Fuller et al. (2006) | x | | | |
| Franceschi, Lee, Zanakis, & Hinds (2009) | x | | x | |
| Robert et al. (2009) | | x | | |
| Wang & Haggerty (2011) | | | x | |
| Brown et al. (2004) | | x | | |
| Kayworth & Leidner (2002) | x | x | x | |
| Garg et al. (2011) | x | x | x | |
| Espinosa et al. (2003) | | x | | |
| Espinosa et al. (2007) | x | x | | |
| Bieber et al. (2002) | | x | | |
| Cheng et al. (2016) | x | | | |
| Zhang & Watts (2008) | | x | x | |
| Windeler et al. (2015) | | | x | |
| Colazo & Fang (2010) | | x | | |
| Venkatesh & Windeler (2012) | | | x | |
| Eservel (2014) | x | x | | |
| Ridings & Wasko (2010) | x | | | |
| Bock et al. (2015) | x | x | | |
| Boughzala et al. (2012) | | | x | |
| Goh & Wasko (2012) | x | x | x | |
| Sarker & Sahay (2003) | x | | x | |
| Phang & et al. (2009) | | x | | x |
| Paul & McDaniel (2004) | x | | | |
| Butler et al. (2014) | x | x | | |
| Vlaar et al. (2008) | | x | x | |
| Tsai & Bagozzi (2014) | x | x | x | |
| Faraj et al. (2015) | x | | | |
| Ransbotham & Kane (2011) | | | x | |
| Bartelt & Dennis (2014) | | | x | |
| Huang et al. (2019) | | x | | |
| Majchrzak et al. (2000) | x | | x | |
| Cummings & Dennis (2018) | | x | x | |
| Griffith et al. (2003) | x | | x | |
| Wasko & Faraj (2005) | x | x | x | |
| Ramasubbu et al. (2008) | | x | | |
| Faraj et al. (2011) | x | x | x | |
| Pan & Leidner (2003) | x | | | |
| Kanawattanachai & Yoo (2002) | x | | x | |
| Gupta et al. (2009) | x | x | | |

## Relational Social Contributing Factors

**Table A4. Concept-centric Matrix for Relational Social Factors of Distributed Collaboration**

| Papers | Relationships among specific group members | Trust among specific group members | Communication among specific group members | Past/future work with other members | Communication standards adopted in group | Social network in group |
|---|---|---|---|---|---|---|
| Grigore et al. (2015) | | | | | | |
| Fan et al. (2014) | x | x | | x | | x |
| Beranek et al. (2005) | | | x | | | |
| Ridings et al. (2006) | | x | x | | | |
| Sarker & Sahay (2004) | x | | x | | x | x |
| Fan & Lederman (2018) | x | x | | | | x |
| Posey et al. (2010) | x | x | | | | |
| Kotlarsky & Oshri (2005) | | x | x | | | |
| Thomas & Bostrom (2010) | | x | x | | x | x |
| Sarker et al. (2010) | x | | x | | | |
| Altschuller & Benbunan-Fich (2013) | | x | x | x | | x |
| Gasson & Waters (2013) | | | x | | x | x |
| Moser et al. (2013) | x | | x | | x | x |
| Campbell et al. (2009) | x | x | x | | | |
| Asatiani & Penttinen (2019) | | | x | | | x |
| Rafaeli & Ravid (2003) | | | x | | | |
| Xu et al. (2016) | | | | | | |
| Oshri et al. (2008) | x | x | x | x | x | |
| Watson-Manheim al. (2012) | x | | x | | x | |
| Liu et al. (2017) | x | x | x | x | | |
| Bjørn & Ngwenyama (2009) | | | x | | x | |
| Ren & Kraut (2011) | x | | | | | |
| Kraut et al. (2010) | x | | x | | | x |
| Pavlou & Gefen (2004) | | x | x | | | |
| Gu et al. (2007) | x | | | x | x | x |

**Table A4. Concept-centric Matrix for Relational Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Bhagwatwar et al. (2018) | | | x | | | x |
| Lindberg et al. (2016) | x | | x | | | |
| Barrett et al. (2016) | x | | | | | x |
| Gómez et al. (2017) | x | x | | | | |
| Zhao et al. (2018) | x | x | x | | | x |
| Sarker & Sarker (2009) | x | | x | | x | |
| Park et al. (2013) | | | | | | |
| Bauer et al. (2016) | x | | | | | |
| Majchrzak et al. (2005) | x | x | x | | x | |
| Jarvenpaa & Majchrzak (2010) | | x | x | | | |
| Schultze & Orlikowski (2010) | | | x | | | |
| Wakefield et al. (2008) | x | | x | | x | |
| Kane & Ransbotham (2016) | | | | | | x |
| Zhang et al. (2013) | x | x | x | x | | x |
| Oh et al. (2016) | x | x | | | | x |
| Raghuram et al. (2010) | x | x | x | | | |
| Gu et al. (2014) | | | | | | |
| Bateman et al. (2011) | x | x | | | | |
| Dennis et al. (2012) | | x | x | | | |
| Robert et al. (2008) | x | x | x | x | x | x |
| Faraj et al. (2016) | | x | x | | x | x |
| Ray et al. (2014) | x | | x | | x | x |
| Butler & Wang (2012) | | | x | | x | x |
| Johnson et al. (2015) | | | x | | x | |
| Ma & Agarwal (2007) | x | | x | | | x |
| Stanko (2016) | x | | x | | | |
| Jarvenpaa et al. (2004) | | x | x | x | x | |
| Nicholson et al. (2007) | | x | x | | | |

**Table A4. Concept-centric Matrix for Relational Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Spagnoletti et al. (2015) | x | x | x | | | x |
| Curşeu (2006) | x | x | x | | | x |
| Kotlarsky et al. (2007) | | x | x | | | |
| David et al. (2008) | | x | x | | | |
| Breu & Hemingway (2004) | x | x | x | x | x | x |
| Ferguson & Soekijad (2016) | | | x | | x | |
| Pauleen & Yoong (2001) | x | | x | | | |
| Bos et al. (2009) | x | x | x | | x | |
| Potter & Balthazard (2002) | x | x | x | | x | x |
| Porter et al. (2013) | x | x | x | | | |
| Pauleen (2003) | x | x | x | | | |
| Massey et al. (2003) | x | | x | | | |
| Kankanhalli et al. (2006) | x | | x | | | |
| Leimeister et al. (2005) | x | x | | x | | |
| Yan et al. (2018) | x | | | | | x |
| Magni et al. (2018) | x | x | x | | x | |
| Nordbäck & Espinosa (2019) | | x | x | | | |
| Fuller et al. (2006) | | x | x | | | |
| Franceschi et al. (2009) | x | | x | | | x |
| Chen et al. (2019) | x | x | x | | x | x |
| Guo et al. (2017) | x | x | | | | |
| Robert et al. (2009) | x | x | x | x | | x |
| Wang & Haggerty (2011) | x | x | x | | x | x |
| Brown et al. (2004) | x | x | | | | |
| Kayworth & Leidner (2002) | | | x | | | x |
| Garg et al. (2011) | | x | x | | | x |
| Chen et al. (2011) | | | | | | |
| Barlow & Dennis (2016) | | | x | x | | x |
| Espinosa et al. (2003) | | | | | | |
| Espinosa et al. (2007) | | | x | x | x | |

**Table A4. Concept-centric Matrix for Relational Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Havakhor & Sabherwal (2018) | x | x | x | | | x |
| Yan & Tan (2017) | | | | | | x |
| Sarker et al. (2011) | | x | x | x | | x |
| Bieber et al. (2002) | x | | x | | | |
| Cheng et al. (2016) | x | x | x | | | |
| Khansa et al. (2015) | | | | | | x |
| Zhang & Watts (2008) | | x | | x | | |
| Kordzadeh & Warren (2017) | x | | | | | x |
| Windeler et al. (2015) | x | x | x | x | | x |
| Colazo & Fang (2010) | | | x | | | |
| Yang et al. (2015) | | | x | x | | |
| Venkatesh & Windeler (2012) | x | x | x | x | | x |
| Eservel (2014) | | | | | | x |
| Park et al. (2019) | | x | x | | | x |
| Ridings & Wasko (2010) | x | | x | | | x |
| Bock et al. (2015) | x | x | x | | | x |
| Boughzala et al. (2012) | | x | x | | | |
| Goh & Wasko (2012) | x | x | | x | x | |
| Sarker & Sahay (2003) | x | x | x | x | x | |
| Phang et al. (2009) | | | | | | |
| Paul & McDaniel (2004) | x | x | x | | | x |
| Butler et al. (2014) | | | | | x | x |
| Ren et al. (2012) | x | | x | | | |
| Vlaar et al. (2008) | x | | x | | | x |
| Tsai & Bagozzi (2014) | x | | x | | | x |
| Mangalaraj et al. (2014) | | | | | | |
| Johnson et al. (2014) | x | | | | | x |
| Chen et al. (2017) | | | | | | |
| Kim et al. (2018) | | | | | | x |
| Nan & Lu (2014) | | | | | | |

**Table A4. Concept-centric Matrix for Relational Social Factors of Distributed Collaboration**

| | | | | | | |
|---|---|---|---|---|---|---|
| Faraj et al. (2015) | x | x | x | | x | x |
| Ransbotham & Kane (2011) | | | | | x | x |
| Bartelt & Dennis (2014) | | | | | x | |
| Huang et al. (2019) | x | x | x | | x | x |
| Majchrzak et al. (2000) | | | | x | | |
| Mein Goh et al. (2016) | | x | | | | |
| Kanawattanachai & Yoo (2007) | | x | x | x | | |
| O'Leary & Cummings (2007) | | | x | | | x |
| Piccoli & Ives (2003) | | x | x | x | | |
| Han et al. (2012) | x | | | | | |
| Cummings & Dennis (2018) | x | x | x | x | | x |
| Griffith et al. (2003) | | | x | | x | x |
| Wasko & Faraj (2005) | x | x | x | x | | |
| Ramasubbu et al. (2008) | | | x | | | x |
| Faraj et al. (2011) | x | | | | x | x |
| Eseryel & Eseryel (2013) | | | x | | | x |
| Pan & Leidner (2003) | x | | | | | |
| Kanawattanachai & Yoo (2002) | | x | x | x | | |
| Hauser et al. (2017) | x | x | x | | x | x |
| Gupta et al. (2009) | | x | x | | | |

## Relational Material Contributing Factors

**Table A5. Concept-centric Matrix for Relational Material Factors of Distributed Collaboration**

| Papers | Task-technology fit | Distance between members | Time zones of group members |
|---|---|---|---|
| Beranek et al. (2005) | | | x |
| Sarker & Sahay (2004) | | x | x |
| Kotlarsky & Oshri (2005) | | x | x |
| Thomas & Bostrom (2010) | x | | x |
| Sarker et al. (2010) | | x | x |
| Altschuller & Benbunan-Fich (2013) | | | x |
| Asatiani & Penttinen (2019) | x | x | x |
| Oshri et al. (2008) | | x | x |
| Watson-Manheim et al. (2012) | | x | x |
| Liu et al. (2017) | | x | |
| Bjørn & Ngwenyama (2009) | | x | |
| Lindberg et al. (2016) | x | x | x |
| Gómez et al. (2017) | | x | |
| Sarker & Sarker (2009) | x | x | x |
| Bauer et al. (2016) | | x | |
| Majchrzak et al. (2005) | x | x | |
| Wakefield et al. (2008) | | x | x |
| Raghuram et al. (2010) | | x | x |
| Jarvenpaa et al. (2004) | x | | |
| Sarker et al. (2018) | | x | x |
| Nicholson et al. (2007) | | x | |
| Spagnoletti et al. (2015) | | x | |
| Curşeu (2006) | x | | |
| Kotlarsky et al. (2007) | | x | x |
| David et al. (2008) | x | x | x |
| Pauleen & Yoong (2001) | | | x |
| Bos et al. (2009) | | x | |
| Potter & Balthazard (2002) | x | | |
| Pauleen (2003) | | x | x |
| Massey et al. (2003) | | | x |
| Kankanhalli et al. (2006) | | | x |
| Magni et al. (2018) | | | x |
| Nordbäck & Espinosa (2019) | | x | x |
| Fuller et al. (2006) | | x | x |
| Robert et al. (2009) | | x | x |
| Wang & Haggerty (2011) | x | | |
| Brown et al. (2004) | | x | |
| Kayworth & Leidner (2002) | | | x |
| Barlow & Dennis (2016) | x | | |
| Espinosa et al. (2003) | | x | x |

**Table A5. Concept-centric Matrix for Relational Material Factors of Distributed Collaboration**

| | | | |
|---|---|---|---|
| Espinosa et al. (2007) | | x | x |
| Sarker et al. (2011) | | x | |
| Cheng et al. (2016) | | x | x |
| Khansa et al. (2015) | | x | x |
| Windeler et al. (2015) | | x | x |
| Colazo & Fang (2010) | | x | x |
| Yang et al. (2015) | | | x |
| Venkatesh &Windeler (2012) | | x | |
| Goh & Wasko (2012) | | x | x |
| Sarker & Sahay (2003) | | x | x |
| Phang et al. (2009) | x | | |
| Paul & McDaniel (2004) | | x | |
| Vlaar et al. (2008) | | x | |
| Faraj et al. (2015) | | x | |
| Bartelt & Dennis (2014) | x | | |
| Majchrzak et al. (2000) | x | x | x |
| Mein Goh et al. (2016) | | x | |
| O'Leary & Cummings (2007) | | x | x |
| Griffith et al. (2003) | x | x | x |
| Wasko & Faraj (2005) | | x | |
| Ramasubbu et al. (2008) | | x | |
| Faraj et al. (2011) | x | | |
| Pan & Leidner (2003) | | x | |
| Gupta et al. (2009) | | x | x |

## About the Authors

**Kevin O'Leary** is a Senior Post-Doctoral Researcher with FintechNext, a collaborative research programme between University College Cork (UCC) and Fexco, supported by Science Foundation Ireland researching emerging Fintech opportunities. He graduated with a PhD in 2020, having been based out of the State Street Advanced Technology Centre in UCC. His research interests focus on Distributed Collaboration as well as Fintech, including Blockchain and other emerging technologies. He has applied his research expertise with emerging Fintech startups, he was Head of IT for Trustap, a secure online transaction platform, and a Blockchain consultant with Claru, a technology company looking to leverage Blockchain for food traceability. He also previously worked as a Software Quality Assurance Analyst for American Tower Corporation.

**Rob Gleasure** is Associate Professor at the Department of Digitalization, Copenhagen Business School. He received his PhD from University College Cork in 2013 and his interests focus on online communities, digitally-mediated collaboration, and open platforms. His research has appeared in outlets such as *Information Systems Research*, the *Journal for the Association of Information Systems*, the *European Journal of Information Systems*, *Information Systems Journal*, the *Journal of Information Technology*, the *Journal of Strategic Information Systems*, and *MIT Sloan Management Review*. He employs a range of qualitative and quantitative methods and is especially interested in exploring how systems can be designed to leverage intuition and interpersonal learning for social good.

**Philip O'Reilly** is Professor of Financial Technologies and Information Systems at Cork University Business School, University College Cork (UCC). He is the Science Foundation Ireland (SFI) approved Principal Investigator of FINTECHNEXT, a multi-year, multi-million Euro research collaboration between UCC and Fexco. He has been conferred with the title of Senior Visiting Fellow in the University of New South Wales (UNSW) Business School, whose Information Systems & Technology Management group is ranked 4th in the world by the AIS for publications in the top eight journals in the information systems field. His research focuses on the transformative power of emerging information systems on Financial Services. His work has been published in leading journals in the information systems field including the *European Journal of Information Systems*, *Journal of Information Technology*, *Journal of Strategic Information Systems*, and *Information Technology and People*. Furthermore, his work has been presented at the leading information systems conferences in the world.

**Joseph Feller** is the Bank of Ireland Professor of Business Information Systems in the Cork University Business School, University College Cork. His research on open source software, open innovation, crowdfunding, and other forms of distributed collaboration, has been funded by the European Commission, Irish Research Council, Science Foundation Ireland, Lewis Foundation (USA), and others. His work has appeared in *Information Systems Research*, *Journal of the Association of Information Systems*, *Journal of Information Technology*, *Information Systems Journal*, *European Journal of Information Systems*, *Journal of Strategic Information Systems*, *Information and Organization*, and other peer-reviewed journals and conferences. In 2015-2016, he served as Founding President of the Special Interest Group on Open Research and Practice (SIGOPEN) of the Association of Information Systems.