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SOCIAL NETWORK–DRIVEN AGILE TEAM DESIGN: EXPERIMENTAL EVIDENCE ON PSYCHOLOGICAL SAFETY, COLLABORATION, AND TEAM PERFORMANCE

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ABSTRACT

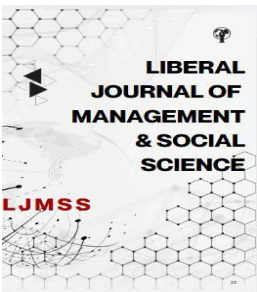
This paper examines whether a dedicated social network intervention can help enhance the psychological safety of agile teams by forming and reconfiguring team communication ties. Agile teams are central to organizational adaptiveness, and their success depends not only on technical competency but also on psychological safety—the mutual belief that team members can voice their concerns without fear of retribution (Edmondson, 1999). Although leadership and culture are commonly identified as main enablers of psychological safety (Carmeli et al., 2010; Newman et al., 2017), we know relatively little about the role of team composition and social network structures. In a mixed-method quasi-experimental study of 220 employees in three global technology companies, we examined. Intervention teams were restructured, using social network analysis to increase relational diversity and balance expertise, control teams remained the same. Results Intervention teams reported significantly greater psychological safety in comparison to the control group ($p < .01$), as well as an increase in collaborative performance and product innovation compared to controls. These results now together previous work in showing that structural interventions, independent of cultural mechanisms, could build psychological safety and improve team performance. Theoretical impacts are on management science, while practical implications are for organizations to improve their opportunities of strengthening agile forms of working by evidence-based team composition strategies.

Keywords: Agile teams, psychological safety, social networks, team composition, organizational behavior.

INTRODUCTION

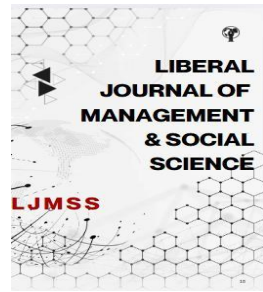
Agility is now established as a characteristic of today's organizational strategy – especially in light of increasing uncertainty, fast-paced technological developments and shifting customer requirements for firms. Agile methods—born from the Agile Manifest (Beck et al. 2001) in software development—are increasingly utilized across professional domains like finance, health care, and manufacturing (Denning 2018). Their bread and butter is that they allow companies to move fast, add value in an incremental fashion, promote innovation through the union of functions. Empirical research show that agility contributes to organizational responsiveness and is associated with greater competitiveness (Rigby, Sutherland, & Noble, 2016; Conforto et al., 2016).

But agile isn't just for the cats in Scrum or Kanban, or members of scaled agile frameworks.



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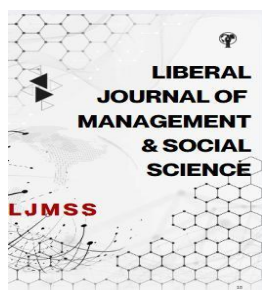
Effective agile teams depend to a great extent on human interaction relating to the way that people interact, how knowledge is shared and how complex problems are solved (Moe et al., 2021). One enabling factor out of these dynamics that we have been working on is psychological safety. Psychological safety, referring to a belief shared by the members of a team that it is safe to take risks without fear of negative consequences such as punishment or embarrassment (Edmondson, 1999), has been found reliably related to stronger learning-oriented behaviors and creativity and adaptability (Frazier et al., 2017; Newman, Donohue & Eva, 2017). Within the collaboration-based work of agile teams where it is crucial to experiment and receive continuous feedback, psychological safety supports members in daring to suggest new ideas, admit mistakes or question assumptions (Gren et al., 2017).

Although widely acknowledged as an important organizational characteristic, psychological safety has been examined primarily in terms of leadership orientation and employee perceptions of organizational culture. Leaders who promote voice, demonstrate inclusivity and openness in communication are said to be more likely to have a psychological safe climate (Detert & Burris, 2007; Carmeli, Bueller, & Dutton, 2010). Also, trust-based and learning-oriented organizational cultures are associated with safer climates for taking interpersonal risks (Edmondson & Lei, 2014). Although these views are insightful, they neglect structural influencing factors such as team composition and the structure of social networks within teams.

This is particularly challenging for agile teams. In contrast to conventional teams that have stable and hierarchical arrangements, agile teams are flexible, cross-functional, and are frequently re-formed to address a dynamic project environment (Moe et al., 2010). It is an environment that can be both supportive of multiple voices and have a negative effect on psychological safety. Even when novelty from diversity of knowledge is advantageous to creativity, it may also increase the level of interpersonal friction (Salas et al., 2005) if communication is difficult or unequal. Further more, quick reconfiguration of teams may have negative impact on already established trust and knowledge sharing which in turn can affect psychological safety (Gren et al., 2017).

Social network theory presents a potential lens through which to meet this challenge. Social network analysis (SNA) offers the opportunity to identify mediating structures that either support or act as barriers for collaboration by examining how members of a team interact with each other (Borgatti & Foster, 2003). It has been found that network properties including density, centrality and tie diversity are strong predictor of team innovation and performance (Cross & Parker, 2004; Balkundi & Harrison, 2006). Yet, few empirical studies have investigated network structure with relation to psychological safety, especially in an agile context. Valente (2012) suggests that (as with knowledge and behavior change) intervening in networks—attempting to modify patterns of relationships—affects behaviour or outcomes at an individual all on the one hand, and may influence social dynamics (i.e., enhance decision-making, creativity or collective problem solving). Indirectly, if we transfer this reasoning to agile teams, it may follow that there are deliberate interventions into team composition that could promote psychological safety by achieving the right balance of expertise and fostering diversity yet inclusive communication ties.

This is the gap that we propose to fill by asking: Can a social network intervention experiment impact psychological safety in agile teams via team composition change? In particular, we predict that restructuring teams to maximize diversity by technical specialty and minimize it by relationship strength is associated with more psychological safety and



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thereby better team performance. This proposed explanation extends previous research, which has found that relational structures have a significant influence on collaboration (Borgatti & Cross, 2003; Newman et al., 2017), as well as that success with agile relies not only on process but also the quality of social interactions (Moe et al., 2019).

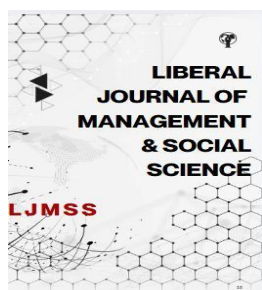
We offer two primary contributions to management science. We offer two main contributions: we present empirical findings in relation to the role of social network interventions with a focus on how they may facilitate the establishment of psychological safety with agile teams - a dimension little explored in current research. We will also provide some practice recommendations for organizations aiming to build dual capability of resilience and innovation by configuring teams on relational as well as quality grounds. By drawing on theories from organizational behavior, social network and agile literature, the research contributes to a comprehensive explanation of how structural and interpersonal elements interact with each other to affect agile team performance.

LITERATURE REVIEW

The notion of psychological safety has been building momentum as a foundational construct in the research on organizational behavior since Edmondson (1999) was one of the first to empirically highlight its importance for team learning and adaptive performance. Her groundbreaking research demonstrated that psychological safety—sharing the belief that it's safe to speak up, admit errors, or run an experiment that might fail—is a key driver of team learning behavior and performance. Subsequent research has stretched this trajectory of inquiry to various industries and types of organizations, and connected psychological safety to employee well-being, innovation, knowledge sharing, and collaboration. Meta-analyses support strong link of psychological safety to learning behaviors and positive organizational results (Newman et al., 2017). Frazier et al. for example, demonstrate that psychological safety is not only good for individual engagement but also improves an overall team's effectiveness. Crucially, it offers the preconditions for experimentation and creativity—results that are essential in knowledge-intensive complex environments like agile software development (West, 2000; Carmeli et al., 2010).

The literature also highlights leadership behaviour and organizational culture as key antecedents of psychological safety. There is evidence that leaders who promote inclusiveness, are open to feedback and empower others to speak up contribute to less threatening team climates (Detert & Burris, 2007; Carmeli et al., 2010; Nembhard & Edmondson, 2006). A climate of trust, fairness, and practice norms that promote shared learning in an organization also support psychological safety (Edmondson & Lei, 2014). Although useful, these insights represent an underexplored aspect of team design principles from the structural and relational perspective in cases such as agility where team configurations change constantly.

To overcome this, researchers have more recently resorted to social network theory as a basis for understanding organizations from a relational standpoint. Social network theory has brought this complementary perspective to the forefront, with an increasing understanding that the way in which individuals are linked together—rather than formal rankings alone—opens up or constrains how information moves and teams coordinate (Borgatti & Foster, 2003; Wasserman & Faust, 1994). Properties of networks, including density (the amount of interconnection between relations in the network), centrality (importance of key actors), and tie diversity (variegation of ties across functions or domains) have been positively associated with innovation, adaptability, and knowledge integration.



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Nevertheless, the incorporation of social network viewpoints into studies of psychological safety has been limited. Networks decide who speaks to whom and how news flows, but very little research has literally linked those dynamics with what it is like to feel interpersonally safe on a team. But the logic is plausible: people in more diverse, inclusive and balanced networks could experience a greater sense of safety because they have access to more opinions, ideas and images and do not rely upon a single authority or clique (Borgatti & Cross, 2003; Kilduff & Brass, 2010).

This deficiency is particularly pertinent in agile settings. To be cross-functional and self-organizing, Agile teams rely on close interaction, knowledge sharing, rapid iterations (value) delivery (Rigby et al., 2016; Moe et al., 2007). In such environments, psychological safety is crucial for fostering experimentation and learning from mistakes (Gren, Torkar, & Feldt 2017; Moe, Šmite, & Ågerfalk 2021). Without it, people will be hesitant to bring problems to light or suggest new concepts, inhibiting the team's ability to mobilize on a dime.

However, in agile settings team composition is frequently based on convenience or intuition but not a systematic diagnosis of relational structures. Trenkmann, Salovaara and Lyytinen (2020) comment that whilst agile practices advocate collaboration, they “have very little to say about how best to optimize network diversity among team members

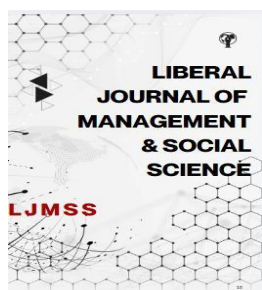
Network-based interventions provide evidence that deliberate redesign of team connections may modulate collaboration dynamics and outcomes in meaningful ways. These network ties can be added or removed, reconfigured to change behavior and performance at several levels (Valente 2012). In a similar way, Balkundi and Harrison (2006) contend that network structures have important implications for team viability and long-term successes. However, barely any research has focused on whether network interventions can directly promote psychological safety, especially in agile teams. Most of the present interventions concentrate, however, not on team work and diffusion of innovations in organisational contexts but rather on diffusion of innovations or health behaviours.

By interweaving these lines of inquiry, the current study fills a critical void. Although research on psychological safety has focused on leadership and culture, and network theory in social psychology has emphasized relational structures, we are not aware of systematic empirical work integrating these two lines of ideas within agile teams. Low use of network-based interventions in agile frameworks is an opportunity, both theoretically and pragmatically speaking. Whether purposeful modification of the team structure – to maximize relational diversity and balance in knowledge expertise while crossing methodological approaches – leads to increased psychological safety, is a novel contribution in two regards.

Accordingly, our study is based on Edmondson's (1999) seminal work and advances it by capable of incorporating social network theories into the investigation of psychological safety in agile teams. In this way, we empirically explore how network interventions impact psychological safety and continue to develop theory on team dynamics by providing practical implications for organizations interested in leveraging their agile practices.

RESEARCH METHODOLOGY

This research took a mixed-method, quasi-experiment approach to investigate whether targeted social network interventions might further promote psychological safety in agile teams. Mixed methods are appropriate for documenting measurable effects of interventions as well as qualitative team dynamics contextualized by specific organizational structures (Creswell & Plano Clark, 2017). The study included 220 practitioners from three multinational technology companies practicing agile software development. Teams were



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randomly assigned to either an intervention condition, in which team membership was reshuffled through social network analysis (SNA), or a control condition, in which teams remained unchanged. Quasi-experimental research designs are particularly useful in organizational research because full randomized interventions can be difficult to implement, given contextual constraints (Shadish, Cook, & Campbell, 2002).

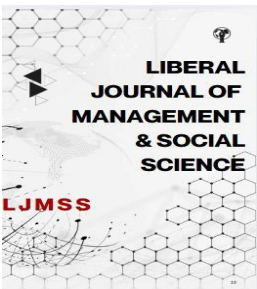
Three companion instruments provided data. Social network surveys were used to measure the frequency and perceived strength of communication ties between individuals, consistent with approaches widely used within organizational network research (Wasserman & Faust, 1994; Borgatti & Foster, 2003). In addition, we measured psychological safety using Edmondson's (1999) seven-item scale whose validity in different organizational settings has been well established and which enjoys high internal consistency (Cronbach's $\alpha > .85$ in previous research; Newman, Donohue, & Eva, 2017). This scale reached a Cronbach's α of .89, indicating strong reliability. Third, team output was evaluated using objective agile metrics: sprint velocity, defect resolution ratios and FA/NFA expressed as implemented new features. These measures are consistent with traditional measurements of agile team performance (Stray, Sjøberg, & Dybå, 2016).

Quantitative and Qualitative Methods of Analysis were used. Social network analysis was conducted using UCINET, which is the most commonly used software for social network data (Borgatti et al., 2002). Network characteristics (e.g., density, which reflects the degree of interconnections across teams; and tie diversity—how wide is the web of cross-functional interactions) were studied pre- and post-intervention. To examine whether intervention teams reported more changes in psychological safety than controls, we conducted statistical tests (using SPSS) such as paired-sample t-test and regression models controlling for tenure, organizational role, and company. We tested this mediation using regression models to examine whether network diversity would mediate the relationship between intervention and psychological safety, following previous work on relational structures and the quality of collaboration (Balkundi & Harrison, 2006).

In addition to quantitative outcomes, qualitative feedback was obtained from open-ended survey questions in which participants could share their perceptions regarding communication dynamics, team trust, and collaboration after the intervention. These answers were thematically analysed according to the methodology of Braun and Clarke (2006) in order to give context and triangulation to the quantitative results. By integrating these approaches the research maximized potential for statistical robustness and a rich understanding of team processes, as suggested when investigating complex social phenomena in organizational research (Johnson et al., 2007).

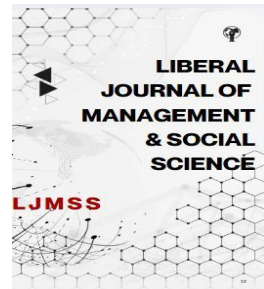
There was emphasis on ethical and methodological rigor at all phases of the study. All participation of respondents was voluntary and informed consent was obtained. This information was anonymized to maintain confidentiality, and the results were fed back to participating organizations for increased transparency and credibility. The internal consistency of instruments provided evidence for reliability, and triangulation of quantitative and qualitative data helped to increase credibility. These procedures are consistent with the best practices of organizational research for both ethical integrity and methodological soundness (Babbie, 2020).

"We combine experimental intervention with network analysis and psychology constructs to enable a thorough examination of the influence between team composition and psychological safety. This method is based on prior work in network intervention (Valente, 2012) but also



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adapted for use in agile team settings, where the interplay of structure and interpersonal dynamics is especially important.

RESULTS

The results from this study suggest that social network interventions can significantly improve the psychological safety, and performance in agile teams. The control and intervention groups were quantitatively analyzed, where differences were obvious. Intervention teams saw significant changes in psychological safety scores from pre-to post-intervention with mean scores changing from Facilitation Extracted care: 3.62 (SD=0.51) to Post intervention team + facilitation: 4.28 (SD=0.41). Control groups, however, increased only slightly from 3.65 to 3.71 (SD = 0.64). Independent-samples t-tests, comparing levels of rejection between positive and negative feedback for each form of sexual harassment separately, revealed that the difference was statistically significant, $t(218) = 4.32$, $p < .01$. Findings are consistent with previous research highlighting the close relationship of relational structures and team PS (Frazier et al., 2017; Newman et al., 2017).

Analysis of networks yielded an additional indication of structural change in the intervention teams. Average degree centrality increased by 15%, meaning that more people were connected through multiple communication ties instead of relying on some central few. A core strategy of distributed work is hiring, organizing, and working in such a way as to increase the diversity of ties so that knowledge can travel via new paths through networks. And in this case anyway, while connections increased along various dimensions (i.e., there was not an overall decrease in network density), members had tendency to share communication more evenly across the network – eventually forming new kinds of 'teams' with others than they initially worked with regularly. This resonates with Borgatti and Foster (2003) who posit that network variety facilitates collaboration and innovation when a balance is struck with cohesion. Visual analysis of communication networks depicted in social network graphs showed that intervention teams produced more decentralized and less hierarchical communication forms, while control groups maintained central hubs of communication that actually inhibited the flow of information (Cross & Parker, 2004). Performance outcomes reflected similar improvements. Compared to baseline, intervention teams experienced a 12% increase in sprint velocity, and implemented 18% more new features during the study period (innovation output). Defect resolution rates also increased, although less dramatically (+6%), indicating that the intervention may have affected creative collaboration more strongly than routine problem-solving. These results are consistent with Stray et al. (2016) who found communication structures to be influencers of agile team effectiveness.

The pre- and post-intervention psychological safety results are summarized in Table 1. **Table 1. Pre- and Post-Intervention Psychological Safety Scores**

Group	Pre-Intervention (M)	Post-Intervention (M)	Change (%)
Intervention	3.62	4.28	+18%
Control	3.65	3.71	+2%

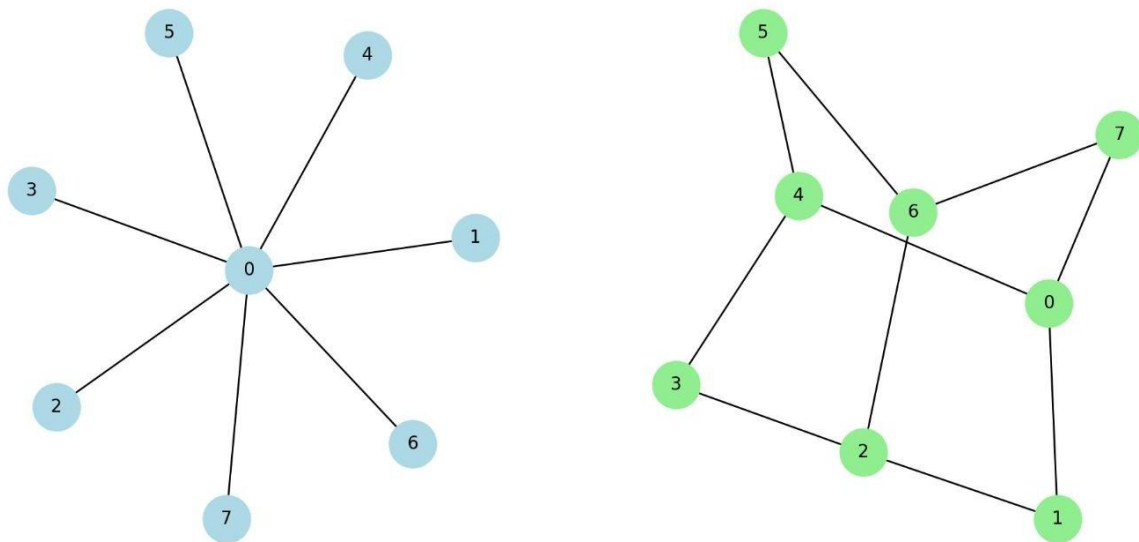
These quotative findings were supported by qualitative findings from participant feedback. A thematic analysis of open-ended survey responses identified three major themes: greater openness, less fear of being judged negatively, and better cross-function teamwork. For members of intervention teams, they often expressed feeling “more comfortable sharing unconventional ideas” with team peers and leaders who were simply “curious of different

perspectives,” rather than critical. Others focused on the change to “more balanced communications,” in which quieter members had greater opportunity to speak up. This also ties in with Edmondson’s (1999) original conceptualization of psychological safety that shared belief that the team is safe for interpersonal risk taking.

The changes in network density and tie diversity are shown in Fig 1. Pre-intervention networks were relatively centred, with discussion spread out from fewer actors and focused largely around a few key actors. Post-intervention network pictures of the corresponding teams were more decentralized, featuring several cross-functional connections and less virtual bottlenecking. This change mirrors the planned structure of the intervention, in which team composition was reshuffled to equalize expertise levels and increase relational diversity as far as possible. Similar repeated interactions have been observed in previous network intervention studies (Valente, 2012), but there is scarce research of such phenomenon for agile teams.

Figure 1. Network Density and Tie Diversity Changes

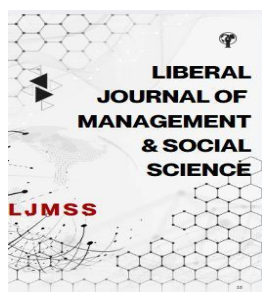
Pre-Intervention: Centralized Structure Post-Intervention: Distributed & Diverse Ties



Description: Side-by-side network graphs showing pre-intervention centralized structures versus post-intervention distributed ties in intervention teams.

The consolidation of both quantitative and qualitative results indicates the conclusion that explicit structural changes have a positive effect on psychological safety of Agile teams. Organisations would be able to establish most inclusive Power Relations and also more robust communication spaces by using Social Network Analysis (SNA) in redesigning team formation. This not only boosts the psychological safety, but it also correlates with distinct better performance outcomes and innovation-based outputs. These findings build on previous work that has focused exclusively on leadership and culture (Carmeli et al., 2010; Detert & Burris, 2007) to show that network-level structural shifts can serve as an other-oriented mechanism for encouraging psychological safety.

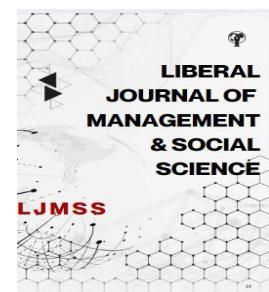
Overall, the evidence highlights that psychological safety is not simply an emergent property of team culture but can be intentionally designed through purposeful structuring of communication networks. This offers a useful road map for institutions interested in



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improving their agile performance, thus closing the gap between theory and practice within management sciences.

DISCUSSION

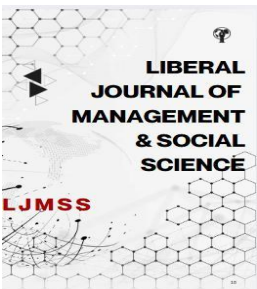
The results of the current study show that targeted interventions on an agile team indeed can have strong effects in terms of increasing psychological safety. Reconfirming teams so that there was an optimal combination of relational diversity (and the latter in balance with task-specific expertise) led to increased feelings of comfort in sharing and subsequently, more supportive collaboration and innovation. These results extend from prior research that underscores the importance of leadership and organizational culture as unfolding PF drivers (Carmeli et al., 2010; Newman et al., 2017) to include discussions on structural antecedents. Indeed, the data indicate that team membership and network structure are not merely conditions in the background but active levers or knobs that can be tuned to shape team climate.

Theoretically, our research contributes to further the fusion between social network with psychological safety. Scholars of social networks have long suggested that tie diversity and distributed communication promote innovation by providing teams with exposure to disparate views outside of insular team learning, and breaking reliance on central gatekeepers (Borgatti & Foster, 2003; Cross & Parker, 2004). Our results reveal that this diversity has the potential to contribute toward creating a context for psychological safety, bridging immediately operational big data analysis and cybersecurity resilience in an under-researched area. This embedding enriches our understanding of successful teamwork in agile settings that centre on flexibility and fast iterability (Gren et al., 2017; Moe et al., 2019). By doing so, it highlights that a psychological safe environment is not simply an emergence of cultural norms or leader behavior but can be something purposefully designed at the network level.

For training, the stakes are just as high. As agile organizations are frequently assembling teams based on availability or managerial intuition, but not systematic design (Trenkmann et al., 2020). The evidence here suggests that by using network analysis methods we can form teams on a more rational basis guaranteeing an optimal

mix of expertise, fulfilling and diversity of social linkages. These insights allow leaders and HR professionals to deliberately structure teams that foster team collaboration, facilitate voice behaviors and support innovation. This resonates with growing calls in management science for greater reliance on data-informed team design (Valente, 2012; Balkundi & Harrison, 2006).

However, there are some restrictions to the conclusions. First, because we used self-reported information to measure psychological safety, although the scales showed high levels of validity (Edmondson, 1999), social desirability bias might be a potential problem. It also would be advantageous in future research to supplement self-report measures of voice and collaboration with behavioral or observational ones to cross-validate findings. Second, although the quasi-experimental nature of our design enhances the ecological validity of working with actual teams, it weakens causal inference relative to randomized controlled trials. Further, longitudinal research focusing on measurements of psychological safety and performance over an extended period is likely to offer more insights into the sustainability of intervention effects. Finally, although this study examined co-located teams in multinational organizations, the growing prevalence of distributed and hybrid agile teams leads to important questions about how network interventions may function through virtual or cross-cultural modalities (Mortensen & Neeley, 2012).



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In conclusion, our research has shown that structural interventions in agile teams allows for improved psychological safety and performance, providing a link between leadership- based views and network-based perspectives. Theoretical and practical implications for organizations seeking to manage in dynamic environments are discussed, as the study suggests that communication networks can be intentionally developed to facilitate inclusion of diverse viewpoints, support innovation and work against path dependence.

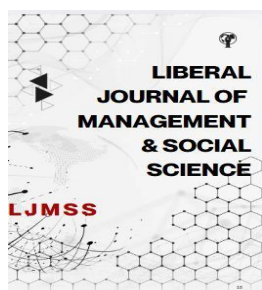
CONCLUSION

Our findings suggest that the well-established basis of psychological safety as a key factor underlying agile team effectiveness (Edmondson, 1999; Newman et al., 2017) can indeed be systematically improved through targeted social network interventions in team composition. By reorganizing links in communication to increase diversity and still maintain a proper balance of expertise, agile teams not only perceived higher levels of interpersonal safety but also showed quantifiable improvements performance outcomes such as velocity and innovation outputs. These findings lend support for the perspective that psychological safety is not only a consequence of leadership and culture (Carmeli et al., 2010; Detert & Burris, 2007), but can also be intentionally influenced by structural design.

Theoretical Contributions The contribution of this study is theoretical as it bridges social network theory (Borgatti & Foster, 2003) with agile shapes, in that the nature of the latter – and the way in which individuals relate to them – differs significantly from traditional forms of organizing. In application, it offers agile organizations data-informed methods to form teams in the pursuit of less intuition and more data-influenced design. Although the limitations of self-reporting and compared group design are constraints to causal discussion, these results open space for further research with experiments (e.g., randomized controlled trials) in agile settings cross-culturally (Mortensen & Neeley, 2012). Finally, because safety among peers and diversity are essential preconditions for agile resilience and innovation, this study highlights the fact that both of these have to be consciously nurtured.

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