*European Journal of Sustainable Development* (2026), **15**, 4, 397-414 ISSN: 2239-5938
*Doi: 10.14207/ejsd.2026.v15n4p397*

# Leadership in Distributed and Virtual Teams: Psychological Aspects, Motivation and Coordination Tools

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**ABSTRACT:**

The aim of the study was to determine how leadership style, digital communication structure, and psychologically meaningful language patterns were associated with interaction in remote work groups, as well as to define the limits of using communication data in personalized team formation and coordination. The study covered 18,742 depersonalized messages created by 118 employees in 12 remote and hybrid teams during April–June 2026. A separate message was the unit of content analysis, and the team was the unit of statistical comparison. The overall inter-coding consistency was 0.84. The most frequently recorded patterns were support – 8.6 cases per 100 messages, tension – 6.1, psychological safety – 5.2, trust – 4.9, emotional regulation – 3.7, and conflict – 2.3. In supportive teams, the frequency of support reached 12.4 cases, and psychological safety – 7.4 cases per 100 messages. In directive teams, tension was 9.4 cases, and the share of after-hours communication was 18.2%. Network centralization was positively correlated with tension, while uneven participation was negatively associated with psychological safety. Reciprocity of contacts, in contrast, was positively associated with a higher frequency of support. Given that the statistical unit was the team ($n$ = 12), these relationships were interpreted as exploratory. The results indicated that more favorable communication patterns were associated with distributed interaction, greater reciprocity, respect for temporal boundaries, and supportive leadership behavior. At the same time, message analysis could not substitute for psychological assessment; therefore, personalized team formation and coordination should be supplemented with validated assessments of emotional intelligence, psychological well-being, digital fatigue, and the risk of professional burnout.

*Keywords: psychological aspects of management, team interaction, emotional intelligence, digital fatigue, intrinsic motivation, psychological well-being, virtual leadership styles, prevention of professional burnout.*

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## 1. Introduction

The expansion of distributed and virtual teams makes interactions with management more extensive: employee coordination is often performed under conditions of spatial distance, digital dependence, and limited informal contact. Under such conditions, team performance is shaped not only by the functionality of technological tools, but also by the manager's capacity to sustain trust, intrinsic motivation, psychological safety, and employee resilience to digital stress. Simultaneously, the systemic nature of contemporary management requires coordination of organizational responsibility, the quality of managerial decisions, and team-member behavior, which has also been emphasized in research on complex interactions between state, business, and management systems (Abdullayev et al., 2026).

Modern approaches to the development of leadership competencies have emphasized adaptability, responsibility, and the ability of a leader to act under conditions of uncertainty. In particular, Ioffe et al. (2026) showed that managerial competence should be developed as a combination of strategic thinking, communication, and the ability to coordinate complex transformation processes. A similar logic applies to virtual teams, where crisis resilience depends on the maturity of the management system and readiness for non-standard situations (Dziadkowiec et al., 2024).

A separate problem is digital fatigue. Alkhayyal and Bajaba (2024) found that digital leadership and workplace learning could reduce technostress and support psychological well-being. Bahamondes-Rosado et al. (2023) likewise showed that technostress was associated with overload, blurring of work-life boundaries, and an increased risk of professional burnout. However, existing evidence still leaves an important methodological issue unresolved. Observable features of digital communication may indicate how coordination, support, control, or tension are manifested within a team, but they cannot by themselves establish employees' psychological states. This distinction is particularly important when behavioral digital traces are used to inform personalized approaches to virtual team formation and management (Panchyshyn et al., 2025).

The purpose of the study was to determine the relationships between virtual leadership styles, psychologically meaningful communication patterns, and the structure of digital interaction in distributed teams, as well as to substantiate the communicative level of a personalized approach to their formation and coordination.

To align this purpose with measurable variables, the research objectives were operationalized at the team and message levels. Virtual leadership style was measured by classifying managers' messages as directive, transformational, supportive, or delegating and identifying the predominant category within each team. Psychologically meaningful communication patterns were operationalized as standardized frequencies of support, trust, emotional regulation, psychological safety, tension, and conflict per 100 work-related messages. The structure of digital interaction was represented by network density, centralization, reciprocity of contacts, and inequality of participation measured by the Gini coefficient. Coordination characteristics were additionally assessed through median response time and the proportion of communication occurring outside established working hours. These indicators were selected because they capture observable behavioral

and structural characteristics of virtual interaction and can therefore be reproduced across teams using content and network analysis.

At the same time, the selected variables were not treated as direct measures of complex psychological constructs. In particular, frequencies of supportive, tense, or psychologically safe formulations cannot be equated with individual emotional intelligence, intrinsic motivation, psychological well-being, digital fatigue, or professional burnout. They were used as communication-level behavioral indicators rather than psychometric measures. Accordingly, the personalized component of the study concerned the identification of team communication profiles and coordination needs, whereas individual psychological assessment remained outside the empirical design and would require separate validated instruments.

To achieve the goal, the following tasks were defined: to analyze the digital communication of distributed teams and identify psychologically significant patterns of support, trust, emotional regulation, psychological safety, tension, and conflict; to classify managers' messages according to directive, transformational, supportive, and delegating leadership styles; to compare teams with different predominant styles according to the frequency of communicative patterns, after-hours communication, and response time; to determine the network characteristics of team interaction, in particular, density, centralization, reciprocity of contacts, and uneven participation; to establish associations between the structure of the digital network and psychologically significant characteristics of communication; to substantiate the possibility of using communicative profiles as the first level of a personalized approach to forming and coordinating virtual teams; and to outline the limits of such an approach and the need to supplement it with validated methods for assessing emotional intelligence, intrinsic motivation, psychological well-being, digital fatigue, and the risk of professional burnout.

## 2. Literature Review

The digitalization of work processes has led to a shift from understanding the virtual team as a temporary organizational form to its interpretation as a sustainable system of interaction in which managerial, psychological, and technological mechanisms operate simultaneously. In this context, corporate culture was viewed not only as a set of common norms, but also as a social basis for trust, coordination, and adaptation of employees to remote work (Bielova & Bielov, 2023). Further development of this approach linked online leadership with maintaining organizational identity, communication consistency, and involvement of virtual team members (Bielov & Bielova, 2025). At the same time, this position left the question of how universal corporate rules correspond to the individual psychological characteristics of employees partially open.

In contrast to the organizational-cultural approach, transformational leadership research has focused on the behavior of a leader who is able to form a shared vision, maintain trust, and stimulate autonomous activity among team members. Greimel et al. (2023) found that transformational leadership could enhance the effectiveness of virtual teams, but its impact depended on the level of digital interaction, task structure, and team context. In the higher education sector, e-leadership was also associated with employee outcomes, but the nature of this relationship was determined by the quality of communication, organizational

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support, and the leader's ability to adapt management style to the remote environment (Maheshwari et al., 2025). Therefore, no leadership style could be considered equally effective across different virtual team contexts.

Two interlinked elements that underpin global virtual team collaboration are leadership behavior and the available stock of social capital. Social capital incorporates interrelated dimensions such as trust, shared norms, mutual understanding, and internal communication networks. Heubeck et al. (2024) showed that these dimensions facilitate the coordination of highly interdependent activities, while Lane et al. (2024) emphasized the dual role of technology in digital teamwork: communication platforms may support cooperation while simultaneously fragmenting interaction by altering the visibility and distribution of members' contributions. This duality makes the structure of digital communication itself relevant to understanding how leadership is enacted in virtual teams.

At the same time, the literature has not provided an unequivocal assessment of the psychological consequences of remote work. Ferrara et al. (2022) found mixed results regarding productivity and well-being, as flexibility and autonomy could coexist with social isolation, overload, and work-life balance difficulties. Similar ambiguity was found for workers' health: the effects of working from home depended on its intensity, workplace organization, personal resources, and employer support (Lunde et al., 2022). Hill et al. (2024) further clarified this duality by distinguishing the resources associated with virtual work, such as autonomy, from its demands, including isolation, continuous digital accessibility, and blurred work boundaries.

Against this backdrop, psychological well-being has increasingly been linked not to the format of work itself, but to a combination of individual and organizational conditions. For academic workers, teleworking outcomes have been linked to personal characteristics, job resources, and perceived organizational support (Capone et al., 2024). At the same time, self-structuring of work, proactivity, and task modification could support engagement and awareness of the significance of work (Costantini & Weintraub, 2022). However, shifting the responsibility for adaptation solely to the employee provides only a partial explanation, as professional stress, emotional exhaustion, and remote burnout are also associated with insufficient leadership, technological difficulties, and unstable work boundaries (Costin et al., 2023).

In contrast to models focused primarily on productivity, the concept of health-preserving leadership emphasizes managerial attention to employee workload, recovery, and psychological condition. The experience of virtual managers showed that the implementation of this approach was complicated by the limited visibility of signs of fatigue and the lack of informal contact, which increased the importance of regular communication and preventive management measures (Efimov et al., 2024). Taken together, the reviewed studies establish strong links between virtual leadership, communication quality, technostress, social capital, and employee well-being. However, these research streams remain only partially integrated. In particular, limited evidence explains how observable leadership behavior, psychologically meaningful language patterns, and the network structure of digital interaction operate simultaneously within the same teams. A further gap concerns the boundary between behavioral indicators derived from digital communication and psychological constructs that require validated assessment. Addressing this gap requires an approach that combines content and network

analysis while preserving a clear distinction between communication-level profiles and individual psychodiagnostics.

## 3. Methods and Materials

The study was conducted between April and June 2026 using quantitative content analysis of digital communication and social network analysis. The data comprised 18,742 depersonalized messages sent via Slack, Microsoft Teams, and corporate email from 12 distributed teams. The teams consisted of 6 to 14 employees, for a total of 118 people, including 12 managers and 106 team members. The unit of content analysis was an individual text message, while the unit of statistical comparison was the team. Accordingly, statistical inference was based on 12 team-level observations rather than on the total number of messages. This distinction was taken into account when interpreting the precision and generalizability of the statistical results.

The sample of teams was purposive and non-random. It consisted of teams that had worked remotely or in hybrid settings for a minimum of 6 months, had at least six members, had a manager or designated leader directly responsible for task coordination, and used digital communication platforms to assign tasks, coordinate activities, and provide feedback. Purposive selection was used because the research design required teams with an established history of remote or hybrid interaction and a sufficiently developed digital communication record for both content and network analysis.

This sampling strategy nevertheless introduced a potential selection effect. Teams that maintained stable digital communication practices and agreed to provide depersonalized communication records may differ systematically from teams with less formalized remote-work arrangements, weaker digital infrastructures, higher turnover, or different organizational cultures. Consequently, the sample was not intended to represent the statistical distribution of leadership styles across organizations or industries. The results therefore characterize relationships observed within the selected teams and should not be generalized directly to other sectors, national settings, organizational cultures, team sizes, or remote-working arrangements without additional validation.

The array contained a variety of messages with information about team task allocation, deadline agreement, discussion of work-related issues, performance monitoring, and team support. Push notifications, duplicates, promotional material, attachments without meaningful textual content, and messages unrelated to work activities were excluded. A total of 2,564 items were removed from the original corpus of 21,306 messages. Coding was performed using a predefined codebook. Support was recorded when a message contained help, encouragement, or acknowledgement of another team member; trust was coded when responsibility was transferred without excessive control; emotional regulation was identified through neutral reframing of difficult situations or attempts at de-escalation; psychological safety was coded when participants were allowed to express doubts, acknowledge mistakes, or propose alternative positions; tension was identified through demands, repeated reminders, or harsh formulations; and conflict was coded in cases of mutual accusations, explicit questioning of competence, or open confrontation. The frequency of each category was then normalized as the number of corresponding codes per 100 work-related team messages.

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Leaders' messages were classified as directive if they contained unilateral instructions, demands, and control; transformational if they explained the common goal, meaning of the task, and expected team outcome; supportive if they contained empathetic feedback, approval, or an offer of help; and delegative if they transferred the right to choose the method of completing the task and making decisions to the executor. The style to which the largest proportion of the leader's messages within the respective team was attributed was considered the predominant style. Thus, leadership style was operationalized through observable message content rather than through self-report or psychometric assessment.

Coding was performed in NVivo 14. A stratified random subsample was generated to test reliability, taking into account teams and digital channels. Independent re-coding covered 3,748 messages, which was 20% of the final array. Inter-coder consistency was assessed using Cohen's kappa coefficient. The reliability procedure evaluated the reproducibility of the coding scheme between coders; it did not establish the psychometric validity of the coded categories as measures of individual psychological characteristics.

In the social network analysis, nodes were team members, and a directed link was considered a message addressed by one member to another. The weight of a link was determined by the number of messages over the study period. Network density, centralization, and reciprocity of contacts were calculated in Gephi 0.10.1. The unevenness of participation was determined by the Gini coefficient, calculated based on the number of messages of each member. These indicators represented structural characteristics of team communication: density reflected the extent of realized communication links, centralization indicated the concentration of interaction around particular participants, reciprocity captured mutual exchange, and the Gini coefficient reflected inequality in communicative participation.

Statistical analysis was performed in IBM SPSS Statistics 29. The Kruskal-Wallis test was used to compare teams with different leadership styles in terms of frequency of support, tension, conflict, after-hours communication, and median response time. In the presence of statistically significant differences, pairwise comparisons were performed using Dunn's test with Holm's correction. Spearman's correlation was calculated between network centrality, the proportion of leader messages, the Gini coefficient, and the frequencies of psychologically significant communication patterns. Nonparametric criteria were chosen due to the small number of teams and the lack of confirmed normality of distributions. The threshold value for statistical significance was $p < 0.05$.

Because the effective statistical sample consisted of only 12 teams, inferential analyses were treated as exploratory. The small number of team-level observations reduces statistical power, increases the uncertainty of significance testing, and makes individual observations potentially influential. Therefore, statistical significance was not interpreted as sufficient evidence of a stable or causal relationship. The magnitude and direction of the observed associations were considered together with their $p$ values and substantive consistency across communication and network indicators. In particular, Spearman's $\rho$ was interpreted as an indicator of the strength and direction of monotonic association rather than as evidence of causation.

No additional formal robustness analysis was introduced because the available dataset contained only 12 independent team-level units and the original analytical design did not specify an independent validation sample. Introducing additional significance tests on the

same small sample could increase rather than reduce inferential instability. Confidence in the findings was therefore assessed through convergence between different forms of evidence, including content-analysis frequencies, leadership-style comparisons, network characteristics, and correlation patterns. These considerations also limit the extent to which statistically significant results can be generalized beyond the observed teams.

Digital communication was made available by authorized representatives of the organizations after obtaining written informed consent from all study participants. Prior to the delivery of the dataset to the researchers, all identifying information was removed, including employee and organization names, email addresses, project names, contact information, and other data that could directly or indirectly identify participants. Each participant and team received a conditional code. The full dataset was accessible only to researchers directly involved in coding and statistical analysis. Results were reported exclusively in aggregated form, and no message excerpts that could identify an employee or organization were reproduced. The analysis was restricted to the communicative patterns described in the data and was not used for psychological diagnosis, assessment of professional suitability, or personnel decisions concerning individual employees.

Accordingly, indicators such as support, tension, psychological safety, after-hours communication, or network centralization were interpreted as behavioral and structural characteristics of digital interaction. They were not treated as direct measures of emotional intelligence, intrinsic motivation, psychological well-being, digital fatigue, or professional burnout. Assessment of these constructs would require separate validated psychological instruments and an independent research procedure.

## 4. Results

### 4.1 Formation and structure of the digital communication corpus

In the first stage, data extraction from 12 distributed teams produced an initial corpus of 21,306 digital messages from April to June 2026. The data were retrieved from Slack using the native workspace export function, which stored messages and associated metadata in structured files. The exported fields were interpreted according to Slack Technologies, LLC documentation (n.d.-a, n.d.-b). Microsoft Teams content was also exported via Teams Export APIs, Microsoft Graph, and Microsoft Purview eDiscovery (Microsoft, 2026a, 2026b, 2026c). Corporate email messages and associated metadata were exported from Google Vault using the formats specified in the service documentation (Google, n.d.-a, n.d.-b).

After receiving the data, the corpus was cleaned. A total of 2,564 units, or 12.0%, were removed from the initial corpus. The largest category of excluded material consisted of automatic notifications – 1,084 messages. In addition, duplicates, advertising and system messages, attachments without meaningful text, and units that were not related to work interaction were removed. The results of the formation of the final corpus are given in Table 1.

**Table 1:** Formation of the digital communication corpus of distributed teams

| Stage of corpus formation | Number of messages | Share of the initial array, % |
|---|---|---|
| Initial array | 21,306 | 100.0 |

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| | | |
|---|---|---|
| Automatic notifications | 1,084 | 5.1 |
| Duplicates | 536 | 2.5 |
| Attachments without meaningful text | 421 | 2.0 |
| Advertising and system messages | 307 | 1.4 |
| Non-work-related messages | 216 | 1.0 |
| **Final corpus** | 18,742 | 88.0 |

Note: Exclusion categories are mutually exclusive. Proportions are calculated from the original corpus, which contained 21,306 messages.
Source: Compiled by the authors based on the results of exporting and cleaning corporate digital communications using procedures described by Google (n.d.-a, n.d.-b), Microsoft (2026a, 2026b, 2026c), and Slack Technologies, LLC (n.d.-a, n.d.-b).

Thus, 18,742 messages were included in the further content analysis. Of these, 8,116 items, or 43.3%, were obtained from Slack, 7,214 items, or 38.5%, from Microsoft Teams, and 3,412 items, or 18.2%, from corporate email. Managers created 5,021 messages, or 26.8% of the final corpus. The 106 team members accounted for 13,721 messages, or 73.2%.
The largest number of messages was recorded in Slack, although its share was only 4.8 percentage points higher than that of Microsoft Teams. No inferential test was applied to compare platform shares, so this difference was interpreted descriptively rather than statistically. Corporate email was used less frequently and mainly for formalized agreement of deadlines, results, and responsibilities. The distribution of the corpus by digital channels is shown in Figure 1.

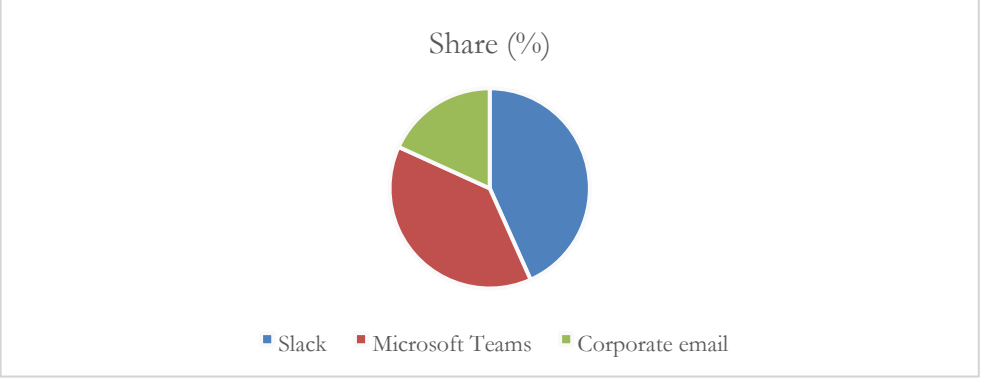


***Figure 1:*** *Distribution of research corpus messages by digital channels, %*
*Note: Shares calculated from the final corpus of 18,742 messages. Slack – 43.3%; Microsoft Teams – 38.5%; Corporate Email – 18.2%.*
*Source: developed by the authors based on the results of content analysis of digital communication.*

The data in Figure 1 showed that 81.8% of the analyzed communication occurred on operational team interaction platforms. This was of methodological importance, as Slack and Microsoft Teams captured a substantial proportion of routine digital coordination, including response sequences, repeated clarification, and horizontal contacts, while email mainly represented more formalized exchanges. The inclusion of three communication

channels also broadened the observable communication environment and reduced dependence on a single platform when constructing the analytical corpus.

### 4.2 Reliability of coding communicative patterns

The reliability of the codebook was tested on a stratified random subsample of 3,748 messages, which constituted 20.0% of the final corpus. The subsample proportionally covered all 12 teams and three digital channels. The overall Cohen's kappa value was $\varkappa = 0.84$, indicating high inter-coder consistency. The highest value was obtained for the conflict category – $\varkappa = 0.90$. The consistency of the coding of tension and support was also high. The lower value of emotional regulation ($\varkappa = 0.76$) may reflect the greater contextual ambiguity of neutral reframing, which could perform either a de-escalating or a purely informational function. The results of the test are presented in Table 2.

**Table 2:** Inter-coder consistency by content-analysis category

| Communicative category | Cohen's kappa, $\varkappa$ | Interpretation of consistency |
|---|---|---|
| Support | 0.86 | High |
| Trust | 0.80 | High |
| Emotional regulation | 0.76 | Acceptable |
| Psychological safety | 0.82 | High |
| Tension | 0.87 | High |
| Conflict | 0.90 | High |
| Overall score | 0.84 | High |

Note: Coefficients were calculated based on independent recoding of 3,748 messages by two coders. Categories characterized text patterns and were not used to psychodiagnose participants. Source: compiled by the authors based on the results of recoding in NVivo 14.

The obtained consistency confirmed that the text indicators defined in the codebook could be reproducibly applied by different coders. At the same time, even a high value of $\varkappa$ did not transform the categories into psychometric indicators. In particular, the frequency of supportive messages was not interpreted as a measure of individual empathy, and the frequency of tense formulations was not interpreted as evidence of an employee's professional burnout or digital fatigue. The reliability coefficients therefore support the reproducibility of the coding procedure, but not the psychometric equivalence of communication categories and individual psychological constructs.

### 4.3 Frequency of psychologically significant communicative patterns

Category frequencies were standardized as the number of codes per 100 work-related team messages. This ensured comparability across teams with significantly different communication volumes. The most common category was support – 8.6 cases per 100 messages. Tension was recorded with a frequency of 6.1 cases, psychological safety – 5.2, trust – 4.9, emotional regulation – 3.7, and conflict – 2.3 cases per 100 messages. A total of 2,604 messages were sent outside established working hours, or 13.9% of the corpus. At the level of individual teams, the proportion of such communication ranged from 6.4% to 21.7%. Urgent demands, repeated reminders, and harsh language were descriptively more frequent in teams with a higher proportion of after-hours messages.

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**Table 3:** Frequency of psychologically significant communicative patterns

| Category | Number of coded cases | Frequency per 100 messages |
|---|---|---|
| Support | 1,612 | 8.6 |
| Tension | 1,143 | 6.1 |
| Psychological safety | 975 | 5.2 |
| Trust | 918 | 4.9 |
| Emotional regulation | 693 | 3.7 |
| Conflict | 431 | 2.3 |

Note: A single message could contain more than one communicative pattern. Frequencies are standardized to 100 messages of the final corpus.
Source: compiled by the authors based on the results of quantitative content analysis in NVivo 14.

The prevalence of support over conflict did not mean the absence of psychologically unfavorable communication patterns. Tense messages occurred approximately 2.7 times more often than open conflict. Thus, potentially adverse coordination patterns were more frequently observable through urgent demands, repeated control, shortened deadlines, and communication outside working hours than through explicit confrontation. Such patterns may be important as communication-level signals of potentially intensive or imbalanced coordination, although they do not provide grounds for diagnosing digital fatigue or burnout in an individual employee.

### 4.4 Virtual leadership styles and team communication

The predominant leadership style was determined by the largest proportion of the leader's messages classified into one of four categories. In four teams, the supportive style prevailed, in three – transformational, in three – directive, and in two – delegative. Teams with a supportive style had the highest frequency of support and psychological safety. Directive teams were characterized by higher rates of tension, open conflict, and communication outside working hours. At the same time, these teams had the shortest median response time. Comparative results are presented in Table 4.

**Table 4:** Communicative indicators of teams with different virtual leadership styles

| Indicator | Directive style, n = 3 | Transformational style, n = 3 | Supportive style, n = 4 | Delegating style, n = 2 |
|---|---|---|---|---|
| Support per 100 messages | 5.1 | 9.2 | 12.4 | 6.8 |
| Trust per 100 messages | 3.2 | 5.7 | 6.1 | 5.3 |
| Psychological safety per 100 messages | 3.1 | 6.3 | 7.4 | 4.5 |
| Tension per 100 messages | 9.4 | 5.4 | 3.8 | 6.1 |
| Conflict per 100 messages | 3.6 | 1.9 | 1.2 | 2.5 |
| After-hours communication, % | 18.2 | 12.5 | 9.1 | 15.7 |
| Median response time, min | 14 | 21 | 24 | 35 |

Note: n denotes the number of teams with the corresponding **predominant** style. The frequencies of communicative categories are standardized to 100 messages. The indicators are not the results of psychological diagnostics.
Source: compiled by the authors based on the results of content analysis of digital communication.

The Kruskal-Wallis test indicated differences among the four groups in the frequency of support, $H(3) = 8.62$, $p = 0.035$; tension, $H(3) = 8.10$, $p = 0.044$; and the proportion of after-hours communication, $H(3) = 7.94$, $p = 0.047$. The between-group difference in conflict frequency did not reach the predefined significance threshold, $H(3) = 7.52$, $p = 0.057$. The median response time also did not differ significantly among leadership-style groups, $H(3) = 3.18$, $p = 0.365$.
Pairwise comparisons using Dunn's test with Holm's correction indicated that the frequency of support was higher in supportive teams than in directive teams (adjusted $p = 0.041$). Tension was higher in directive teams than in supportive teams (adjusted $p = 0.048$). The proportion of after-hours communication was also higher in directive teams than in supportive teams, and this contrast remained significant after Holm correction (adjusted $p = 0.049$).
To complement significance testing, the magnitude of these contrasts was examined directly using the standardized descriptive indicators. Supportive teams recorded 12.4 support codes per 100 messages compared with 5.1 in directive teams, a difference of 7.3 cases per 100 messages. By contrast, tension reached 9.4 cases per 100 messages in directive teams and 3.8 in supportive teams, a difference of 5.6 cases. After-hours communication was 18.2% in directive teams compared with 9.1% in supportive teams, corresponding to a difference of 9.1 percentage points. These descriptive contrasts indicate that the statistically identified differences were accompanied by substantively visible differences in communication patterns within the observed sample.
However, the leadership-style groups contained only two to four teams each. Accordingly, the Kruskal-Wallis and pairwise results were interpreted as exploratory evidence of between-group differentiation rather than as stable population estimates. Median response time was descriptively shortest in directive teams, but the absence of a statistically significant group difference means that response speed cannot be distinguished reliably among the four leadership-style groups in this sample. Directive teams nevertheless combined shorter median responses with more tense formulations and a higher proportion of communication beyond established working hours. By contrast, supportive teams combined longer median response times descriptively with greater support and more frequent communication signals of psychological safety.

### 4.5 Network structure of team interaction

Social network analysis showed that the average density of the communication network was 0.42, and its value in individual teams ranged from 0.28 to 0.61. The average centralization was 0.48, and the reciprocity of contacts was 0.63. The Gini coefficient, which characterized the unevenness of communicative participation, was 0.31 on average. Directive teams had the highest mean centralization – 0.68. A significant part of the messages in them went through the leader, while horizontal contacts between team

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members were less intense. Supportive teams were characterized by the lowest mean centralization, the highest reciprocity, and the most uniform participation.

**Table 5:** Network characteristics of teams with different leadership styles

| Network indicator | Directive style | Transformational style | Supportive style | Delegating style |
|---|---|---|---|---|
| Network density | 0.36 | 0.46 | 0.48 | 0.39 |
| Centralization | 0.68 | 0.41 | 0.35 | 0.47 |
| Reciprocity of contacts | 0.51 | 0.69 | 0.72 | 0.61 |
| Gini coefficient | 0.42 | 0.27 | 0.24 | 0.33 |

Note: The figures are averages for teams with the respective dominant style. A higher Gini coefficient indicates greater unevenness in communicative activity.
Source: compiled by the authors based on the results of social network analysis in Gephi 0.10.1.

The results of Table 5 descriptively indicated that teams with a supportive leadership style combined favorable communication content with a more distributed interaction structure. In such teams, employees more often communicated without the direct mediation of the leader. Directive teams, by contrast, were characterized by a more centralized structure in which the leader represented the principal information node. These are descriptive group-level differences and, given the small number of teams within each style category, should not be interpreted as evidence that a particular leadership style caused a specific network structure.
To visualize these differences, Figure 2 presents the networks of two contrasting teams – one with a directive and one with a supportive style. Including diagrams of all 12 teams would overload the section and would not create additional analytical value.

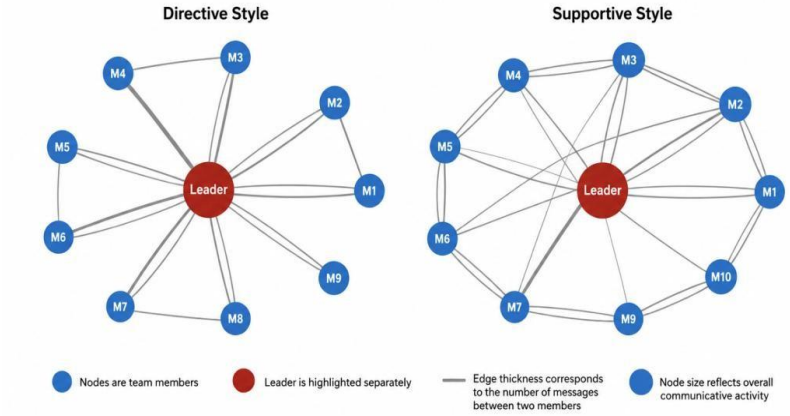


***Figure 2:*** *Comparison of digital interaction networks of teams with directive and supportive leadership styles*
*Note: Nodes are team members; the leader is highlighted separately. The thickness of a directed connection corresponds to the number of messages between two members. The size of the node reflects the overall communicative activity.*
*Source: developed by the authors in Gephi 0.10.1 based on the results of social network analysis.*

In the directive team network, the main connections were centered around the leader, and direct contacts between employees remained fragmented. In the supportive team, connections were distributed more evenly, and the leader did not act as the sole center of information transmission. Thus, the two illustrative networks differed both in message content patterns and in the distribution of digital interaction. The visualization supports the descriptive contrast observed in the aggregated network indicators but does not constitute an independent statistical comparison.

**4.6 Relationships between network and communication indicators**

Correlation analysis identified several statistically significant monotonic associations between network structure and communication patterns at the team level. Centralization was positively correlated with the proportion of manager messages ($\varrho = 0.79$, $p = 0.002$) and tension ($\varrho = 0.67$, $p = 0.017$). The Gini coefficient was negatively associated with psychological safety ($\varrho = –0.71$, $p = 0.010$), meaning that greater inequality in communicative participation was associated with fewer coded signals of psychological safety. Contact reciprocity was positively related to support ($\varrho = 0.64$, $p = 0.025$), while communication outside working hours was associated with greater tension ($\varrho = 0.74$, $p = 0.006$). The proportion of manager messages was negatively associated with trust ($\varrho = –0.58$, $p = 0.049$).

The absolute values of the statistically significant coefficients ranged from 0.58 to 0.79. Within the observed sample, the strongest association was between centralization and the proportion of manager messages ($\varrho = 0.79$), followed by the association between after-hours communication and tension ($\varrho = 0.74$) and the inverse association between participation inequality and psychological safety ($\varrho = –0.71$). These coefficients indicate substantively notable monotonic relationships in the sample, although their precision is constrained by the small number of independent team-level observations.

In sum, more manager-centered communication was associated with greater tension; greater inequality of participation was associated with fewer signals of psychological safety; higher reciprocity was associated with more support; and a greater proportion of after-hours communication was associated with greater tension. These relationships describe covariance between team-level characteristics and do not establish causal direction.

The team was the statistical unit of analysis ($n = 12$). Therefore, all correlation results were treated as exploratory. With several relationships examined in a small sample and without an independent validation sample, the reported $p$ values should be considered together with the direction and magnitude of $\varrho$ rather than as stand-alone evidence of stable population effects. Replication in larger team samples is required to determine whether these associations remain consistent across organizational settings.

**4.7 Communication profiles of virtual teams**

Based on a combination of the dominant leadership style, network indicators, and coded patterns, four team profiles were described. The centralized-demanding profile encompassed three directive teams. It was characterized by high centralization, quick responses, a significant proportion of manager messages, increased tension, and more frequent after-hours communication.

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The goal-integrative profile corresponded to three transformational teams. In them, the explanation of the common goal was combined with relatively high reciprocity of contacts and moderate centralization. The supportive-distributed profile covered four teams. It was characterized by the highest frequency of support and psychological safety, more even participation, and developed horizontal ties. The autonomous-variable profile included two delegating teams. The transfer of the right to make decisions did not always coincide with even interaction. In one team, coordination was distributed between several participants, while in the other, the communicative load was concentrated on an informal coordinator.

These four profiles represent descriptive combinations of observed communication and network characteristics rather than validated psychological or personnel typologies. At the first, behavioral-communicative level, they can be used to characterize differences in the amount of feedback, the extent of autonomous and horizontal interaction, and team-level responses to centralized coordination. They should not be used to infer an individual employee's psychological characteristics from message behavior alone.

Individualized psychological assessment constitutes a separate second level and would require validated methods for measuring emotional intelligence, intrinsic motivation, psychological well-being, digital fatigue, and the risk of professional burnout. Such instruments were not used in the present study. Consequently, the empirical results establish communication profiles only at the behavioral and structural levels. They do not demonstrate that the observed digital patterns are equivalent to emotional intelligence, fatigue, burnout, or other psychological constructs.

Therefore, the formed profiles characterized the communication behavior of teams and could not be used as a psychological diagnosis, assessment of professional suitability, or an independent basis for personnel decisions. Their possible application to personalized virtual team formation should consequently be understood as a preliminary communication-level screening framework that requires separate psychological validation and appropriate ethical safeguards before any individual-level personnel use.

## 5. Discussion

The findings indicated that virtual leadership style was related not only **to** the content of messages, but also **to** the structure of digital interaction. In directive teams, communication was more concentrated around the leader, whereas supportive teams showed denser horizontal ties, higher reciprocity, and a more even distribution of communicative activity. This suggested that leadership style was associated not only with communication tone, but also with patterns of information exchange and participant autonomy. The greater frequency of support and psychological safety in supportive teams was in line with the results of Schmitt (2024), who attributed the well-being of remote workers to the quality of feedback received, the availability of the leader, and the management of digital workload. The present findings confirm this relationship at the communication level and extend it by showing that supportive interaction was also accompanied by lower centralization and stronger horizontal connectivity.

At the same time, directive teams had a shorter median response time. Thus, centralized coordination was descriptively associated with faster responses, but it was accompanied

by a higher frequency of tense wording and after-hours communication. This duality was consistent with Zheng et al. (2024), who argued that team virtuality may simultaneously facilitate rapid coordination and intensify risks related to overload, isolation, and constant digital availability. The identified relationship between after-hours communication and tension was also consistent with Singh et al. (2022), who found that digital platform-induced stress was associated with technology exhaustion and reduced subjective well-being. Digital fatigue was not directly measured in this study, but frequent urgent messages after working hours may be interpreted as a communication-level signal of an intensive coordination regime rather than as evidence of fatigue itself. Thus, the findings support previous evidence on technostress while specifying one observable communication pattern through which such risks may emerge.

The positive relationship between reciprocity of contacts and support was consistent with the concept of distributed leadership. Mayer et al. (2023) showed that the joint performance of leadership functions in virtual teams could increase the satisfaction and productivity of participants. The results obtained extend this conclusion by indicating that distributed interaction was observable not only through formal delegation, but also through actual horizontal communication links and reciprocal exchanges. At the same time, the delegating style did not always ensure uniform interaction. In one delegating team, an informal central coordinator was formed. This finding qualifies the assumption that delegation alone necessarily produces distributed coordination: without a sufficiently developed network of mutual contacts, communicative load may simply shift from the formal leader to another participant.

The results also had implications for understanding the role of emotional intelligence. Warrier et al. (2024) found that emotional intelligence enhanced the effectiveness of virtual communication and decision-making. Emotional intelligence was not assessed psychometrically in the present study, but messages aimed at de-escalation, support, and recognition of contribution may reflect behavioral manifestations of emotionally competent leadership. This interpretation remains provisional because communication patterns cannot be treated as validated measures of emotional intelligence. Future studies should therefore combine digital communication analysis with validated psychological scales and larger samples to test whether such behavioral indicators correspond consistently to emotional intelligence, psychological well-being, digital fatigue, and burnout. Longitudinal designs would also make it possible to determine whether changes in communication patterns precede, accompany, or follow changes in these psychological outcomes. The practical significance of the results is that personalized approaches to virtual team formation should not rely exclusively on professional competencies. Communication-level characteristics such as the need for feedback, preference for autonomous interaction, participation in horizontal coordination, and response to intensive digital control may provide an additional layer of information. At the same time, communicative patterns cannot replace psychological diagnostics.

Thus, the results support the view that psychologically favorable patterns of virtual interaction are associated with supportive communication, distributed contacts, and greater respect for temporal boundaries. However, these relationships should not be interpreted as causal effects of leadership style. The small number of teams ($n$ = 12), purposive non-random sampling, and the small number of observations within each

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leadership-style group limited statistical power and restrict generalizability across industries, organizational cultures, team sizes, and national contexts. Teams willing and able to provide structured digital communication records may also differ from less digitally organized teams, which introduces a possible selection effect. Therefore, the established relationships should be considered exploratory. Further research should combine digital footprint analysis with validated psychometric assessment, larger and more heterogeneous samples, and longitudinal observation to test the stability of the identified associations and the practical validity of the proposed personalized team-building approach.

## 6. Conclusions

Leadership effectiveness in distributed and virtual teams was found to be associated not only with the frequency of digital communication but also with its content, structure, and distribution among participants. Analysis of 18,742 messages from 12 teams indicated that a supportive leadership style tended to be linked to more frequent support, trust, and psychological safety, whilst directive leadership was associated with higher tension, after-hours communication, and greater centralization of information flows around the leader. Directive teams, however, had a shorter median response time, although this difference was not statistically significant, indicating that faster responses alone should not be interpreted as more effective coordination. Analysis of social networks showed that more favorable communicative patterns were associated with higher reciprocity of contacts and more even participation. The positive association between reciprocity and support and the negative association between uneven participation and psychological safety indicated the relevance of horizontal interaction to virtual team functioning. Particular attention was given to the association between the proportion of after-hours messages and tension. This allowed after-hours communication to be considered a potential organizational signal of intensive digital coordination, although digital fatigue, psychological well-being, and professional burnout were not measured directly in the study.

The applicability of the findings provides a basis for the development of a two-level approach to virtual team formation and coordination. The first level may describe observable communicative behavior in terms of feedback needs, autonomy, participation in horizontal coordination, and responses to centralized control. The second level should involve validated techniques for assessing emotional intelligence, intrinsic motivation, psychological well-being, digital fatigue, and burnout risk. These two levels should complement rather than replace each other, because message-based indicators cannot substitute for psychological assessment.

Managerial implications should therefore be distinguished from the empirical findings. Based on the observed patterns, managers may consider reducing unnecessary after-hours communication, maintaining horizontal contacts, distributing coordination responsibilities, and periodically reassessing the communication burden of individual employees. At the same time, communication data should be depersonalized and should not be used independently for psychological diagnosis, assessment of professional suitability, or personnel decisions. The primary limitations of this study included a small number of teams, a non-random sample, data analysis based on written interaction only,

and the absence of direct psychometric measurement of psychological characteristics. Further studies are warranted in larger and more heterogeneous cross-industry samples, combining digital footprints, validated psychological measures, and longitudinal observation of changes in motivation, well-being, digital fatigue, burnout risk, and team performance.

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