

**The Differences in Displayed Leader-Follower Dynamics in Effective and Less
Effective Teams in a Public Company in The Netherlands**

Researcher

Abdulaziz Nur

First supervisor: Marcella Hoozeboom

Second supervisor: Sietse Brands

Educational Science and Technology,

Faculty of Behavioural, Management and Social Sciences,

University of Twente

Words: 11502

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Abstract

Background: Daily interactions between leaders and followers are vital as they shape team dynamics and drive collective performance. Previous research on leader-follower dynamics has primarily focused on cross-sectional studies, overlooking the dynamic nature of how individuals interact during team meetings. This study aimed to address these gaps by utilizing a novel analysis tool to uncover patterns that may have gone relatively unnoticed in leader-follower dynamics, but which helps us to uncover effective leader-follower dynamics. This study aims to answer the following research question: “*What are the differences in the patterns of leader-follower dynamics in effective vs. less effective teams, and are there differences in how leader interact with effective vs. less effective followers in the effective and less effective teams in a public company in The Netherlands?*”.

Methods: In this study, video observations were utilized to capture the micro-behaviors exhibited by leaders and followers during team meetings. These observations were then combined with ratings of team effectiveness and follower effectiveness. The participants included 65 teams with 791 followers and 65 leaders. The median split was performed to create two groups: Effective teams and less effective teams. An analysis of pattern mining was then carried out to explore the connections between leaders and followers in the groups that were less effective compared to the groups that were effective. The aim was to understand how leaders interact with both effective and less effective followers.

Results: The study initially examined the behaviors of leaders, effective followers, and less effective followers from both effective and less effective teams. A comparison was made between these behaviors and those observed in the respective counterparts from other teams (e.g., behaviors of leaders in effective teams versus less effective teams). The findings revealed a predominant occurrence of task-oriented behaviors across leaders and less effective followers. However, it was observed that effective followers from effective teams demonstrated nearly twice as many occurrences of these behaviors compared to their less effective counterparts. The fuzzy mining models presented patterns of behaviors from the effective teams and less effective teams. It presented how effective teams often interacted with each other with patterns of leaders

and followers interacting back and forth, whereas the less effective teams exhibited more individualistic leaders and followers that do not exhibit significant patterns towards each other.

Conclusion: The study yielded valuable insights into effective leader-follower dynamics. The results indicated distinct changes in leader interactions between effective and less effective teams, with the latter relying on leaders for information sharing and providing minimal input from followers. Moreover, effective followers in successful teams contributed twice as much as their counterparts in less effective teams, underscoring the significance of behavioral patterns in comprehending leader-follower dynamics. In essence, this study sets a foundation for future inquiries, spotlighting the potential of thorough analysis of workplace behaviors to illuminate the complexities inherent in leader-follower dynamics.

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Introduction

The way followers and leaders interact with each other on a daily basis has a powerful effect on the performance of a team (Baird & Benson, 2022; Fairhurst & Uhl-Bien, 2012). The motivation, engagement, and general well-being of leaders and followers can all be significantly impacted by how they interact at work (Gutermann et al., 2017; Lehmann-Willenbrock & Allen, 2014). Uncovering how leader-follower dynamics influence team performance, and what specific dynamics contribute to higher team performance, can add to our understanding of effective coordination in the workplace and effective leader-follower behaviors (Hoogeboom, 2019; Lehmann-Willenbrock et al., 2015; Schlamp et al., 2021). For example, a leader who fosters a supportive and positive dynamic with their followers may improve team performance by creating a productive team atmosphere. In general, these interactions are marked by open communication, mutual respect, and support (Lehmann-Willenbrock & Allen, 2014). Contrariwise, leader-follower dynamics that possess a dysfunctional sense and malicious intent can create an unproductive and uninspired team environment that hinders performance (Van der Velde & Gerpott, 2023; Weberg & Fuller, 2019). Investigating the spectrum of interactions that can occur in a workplace is of paramount importance for a comprehensive understanding of team dynamics. However, specific fine-grained analysis on how leaders and followers interact in their day-to-day work is largely missing (Hoogeboom, 2019). This gap can be attributed to the historical prevalence of cross-sectional studies in the field (Güntner et al., 2020). These studies tend to emphasize the relationships between variables as demonstrated by leaders and followers, rather than delving into the dynamic evolution of these variables and their interactions over time. Consequently, this approach has resulted in a limited and incomplete comprehension of leader-follower dynamics (Güntner et al., 2020; Vantilborgh et al., 2018). Hence, there currently is a lack the knowledge on how these fine-grained interaction dynamics between leaders and followers look like, and how they may affect team performance in the workplace.

To gain a more comprehensive understanding of leader-follower dynamics, especially the in-situ behaviors should be considered when studying the interaction between leaders and followers. However, this is currently largely lacking in the literature (Gerpott et al., 2019; Hoogeboom, 2019; van der Velde & Gerpott, 2023). Research on in-situ leader-follower dynamics offer a detailed view of how leaders and followers interact over time, providing insights into the behavioral connections between them (Lehmann-Willenbrock et al., 2015). This

stream of research has expanded significantly since the 1990s, driven by advancements in research tools and a growing interest in exploring collaborative dynamics, including in-situ leader-follower dynamics studied through video observations and coding (Gerpott et al., 2019; Hoogeboom, 2019; Mathieu et al., 2017). This approach involves the use of behavioral taxonomies to code observable behaviors of leaders and followers, with a focus on the tasks of the teams and the relationships amongst team members (Gerpott et al., 2019; Schlamp et al., 2021). In contrast to earlier research, which often concentrated on isolated leader or follower behaviors and their linkages to other team aspects (Hemshorn de Sanchez et al., 2022; Vantilborgh et al., 2018), this direction takes a step forward by identifying patterns and interactions within these video observations (Van Dun & Wilderom, 2021; Rego et al., 2019; Sobocinski et al., 2017). Still, prior research often missed opportunities to examine leader-follower dynamics by not fully utilizing collected data, such as video observations or behavioral transcriptions (Hemshorn de Sanchez et al., 2022; Gerpott et al., 2019). Newer and more advanced analytical tools can help uncover patterns that may have gone unnoticed, thus expanding the knowledge of leader-follower dynamics (Hemshorn de Sanchez et al., 2022; Hoogeboom, 2019; Lehmann-Willenbrock et al., 2017).

This study will first provide a fine-grained analysis of leader-follower dynamics during team meetings and in doing so aiming to provide a more detailed and nuanced understanding of what kind of leader-follower dynamics are shown in practice in the workplace (Derue & Humphrey, 2011; Yukl, 2012). The study will also differentiate between effective and less effective followers, which is a novel and important aspect in this study, as it enables a deeper exploration of factors contributing to follower effectiveness and enhances theory development in the field of leader-follower dynamics (Baird & Benson, 2022). This study will investigate patterns in leader-follower dynamics through the utilization of a novel analysis method, specifically a process mining tool. The study will apply the process mining method to uncover sequential relationships in the micro-behaviors displayed by leaders and followers (Günther & Van Der Aalst, 2007; Hofmans et al., 2019). The study will also reveal potential patterns among effective and less effective teams and compare the differences between them contributing to a more complete understanding of leader-follower dynamics (Lehmann-Willenbrock et al., 2015).

Theoretical framework

Leader-follower dynamics

At the core of effective teamwork are leaders and followers, distinct roles that collaboratively shape the dynamics of a group. Leaders are defined as individuals who possess authority or influence within a group or organization, taking on the responsibility of directing and guiding others towards collective goals or objectives. (Chemers, 2008; Hofmans et al., 2019; Lehmann-Willenbrock et al., 2017). Research on leadership has suggested that the ability to influence others is at the core of leadership, and that this influence can be reflected in the response of others (Gesang & Süß, 2021; Yukl, 1998, 2012). Chemers (2001) has argued that effective leadership depends heavily on the leader's ability to motivate followers towards a shared objective, whether it is the organization's collective goal, mission, or vision. In order to provide a fine-grained analysis of leadership and its impact on follower behavior, it is essential to recognize the crucial role of leader-follower dynamics (Baird & Benson, 2022; Gooty et al., 2012). Moreover, specific behaviors in an interaction process between two or more people can invite specific type of responses (Hoogeboom & Wilderom, 2018; Meinecke & Kauffeld, 2019). Examining leader-follower dynamics assumes pivotal significance in comprehending the intricacies of team performance, as demonstrated by Lehmann-Willenbrock et al. (2013), who found that higher member satisfaction was associated with an increased number of team members assuming leadership roles and facilitating structured group discussion. Therefore, studying leader-follower dynamics is crucial for understanding the fundamental role they play in shaping effective leadership, fostering positive team dynamics, and ultimately achieving organizational goals.

Leader-follower dynamics, which encompass the sequence of micro-behavioral events between leaders and followers, have been the subject of investigation in the literature for decades (Bass, 1999; Hemshorn de Sanchez et al., 2022). Leader-follower dynamics can be defined as the sequence of micro-behavioral events that occur between leaders and followers (Hemshorn de Sanchez et al., 2022; Lehmann-Willenbrock et al., 2017). These interactions are not simply a matter of one person acting and the other reacting, but rather a back-and-forth process in which the behaviors of specific members tend to form a pattern (Hoogeboom, 2019; Lehmann-Willenbrock et al., 2015; Meinecke et al., 2017). These patterns often capture the true process

that also happens when leaders and followers interact (Gooty & Yammarino, 2011; Hoogeboom & Wilderom, 2012; Lehmann-Willenbrock & Allen, 2018).

The field of research on leader-follower dynamics often aims to uncover the elements that contribute to effective dynamics between leaders and followers (Gerpott et al., 2019; Gutermann et al., 2017). The research of Gutermann et al. (2017) investigated the spread of leaders' work engagement to their followers by examining leader-follower dynamics. The study demonstrated a significant impact of leaders' work engagement on the work engagement of their followers. The findings suggest that effective leader-follower dynamics, characterized by leaders' deep engagement in their work, can be transmitted from supervisors to subordinates, ultimately resulting in improved team performance. Furthermore, studies by Kauffeld and Lehmann-Willenbrock (2012) and Lehmann-Willenbrock et al. (2013) indicate that task and solution-focused leader-follower dynamics significantly reduce dysfunctional behaviors during team interactions. Increased counterproductive behaviors such as losing focus, criticizing others, and complaining should be given serious consideration, as they have been linked to considerable declines in team performance. Leader-follower dynamics research offers a comprehensive and in-depth analysis, shedding light on the intricate interactions and mechanisms that underlie effective collaboration between leaders and their followers.

Previous research has left a critical gap in understanding whether leaders adapt their interactions differently based on the effectiveness of their followers. While existing studies might establish connections like open communication leading to enhanced team performance (Burke et al., 2006), they often overlook the intricacies of leader-follower dynamics in scenarios where less effective followers do not experience performance improvement. Van der Velde & Gerpott (2023) highlighted this aspect of leader-follower dynamics by revealing that followers who lack faith in their leader's goals tend to resist change. Despite the importance of this topic, comprehensive research in this area remains limited. To gain a more profound comprehension of leader interactions, it is essential to investigate how leaders' behaviors may evolve in response to the effectiveness of their followers.

Behavioral taxonomies to capture leader-follower dynamics

For a taxonomy to effectively capture in-situ leader-follower dynamics, it should be widely applicable and cover a range of behaviors between leaders and followers in work contexts

(Gerpott et al., 2019; Henkel et al., 2019). Researchers have emphasized the importance of examining and comparing previous taxonomies to enhance existing knowledge and arrive at a taxonomy which captures a full-range of important workplace behaviors (Behrendt et al., 2017; Hemshorn de Sanchez et al., 2022). One such example is the leader-follower coding scheme presented by Meinecke et al. (2017), which incorporates two key categories: Task-oriented behaviors that focus on goal achievement and completion of tasks, and relations-oriented behaviors that contribute to team cohesion and collaboration. Similarly, Lehmann-Willenbrock et al. (2015) employed a comparable taxonomy that included solution-focused statements and relation-oriented statements. However, their research was different for it delved deeper into the relational aspect of behavioral taxonomies, encompassing not just positive but also negative behaviors that are considered counterproductive such as complaining (see Table 1). A common denominator in most taxonomies is that they distinguish between relations- and task-oriented behaviors, highlighting their significance in understanding leader-follower dynamics. Therefore, the task-oriented and relations-oriented behaviors model is widely regarded as one of the most comprehensive models of leader-follower dynamics (Behrendt et al., 2017; Borgmann et al., 2016; Gerpott et al., 2019; Hoogeboom, 2019; Meinecke et al., 2017).

This dichotomy is also underlined by the work of Yukl (2012), who developed a behavioral taxonomy that specifically identifies distinct behaviors that leaders may exhibit towards their followers (see Table 1). Yukl (2012) identified eight behaviors that are classified into task-oriented behaviors, which are behaviors that focus on achieving goals, completing tasks and relation-oriented which consist of the social behaviors that contribute to the team goals. Yukl (2012) also added two other meta-categories: change-oriented (e.g. advocating), and external (e.g. networking). Although Yukl's detailed taxonomy covers a wide range of behaviors in the workplace, it has received criticism for the lack of differentiation between some of the behaviors (Behrendt et al., 2017). Research by Behrendt et al. (2017) sheds light on the taxonomy of Yukl (2016), revealing its subjective nature and the potential overlap over behaviors that depend on the observers' perceptions. Nonetheless, it provided a foundation that other researchers used to further build upon and create behavioral taxonomies that are applicable for different work contexts (Behrendt et al., 2017; Hemshorn de Sanchez et al., 2022; Hoogeboom, 2019).

Subsequent research in the field of leader-follower dynamics has been dedicated to the ongoing development of taxonomies, although challenges and limitations have emerged in their effectiveness. Gerpott et al. (2019) expanded on the existing behavioral descriptions of Yukl (2012), specifically the taxonomy of task-oriented, change-oriented, and relation-oriented behaviors. The research of Gerpott et al. (2019) used task-oriented behaviors to measure leaders and followers who displayed strong task-focused abilities, relations- and change-oriented behaviors to capture behaviors that go beyond mere task completion and aim to change the system (see behaviors at Table 1). It is important to note that change-oriented behaviors were originally constructed out of relations-oriented behaviors to create more nuanced behaviors that can capture leadership behaviors (Yukl, 2012). In a more recent study on leadership by Schlamp et al. (2021), the taxonomy used in the previous research was simplified to only include task and relations-oriented behavior, as shown in Table 1. However, it was found that the taxonomy of Schlamp et al. (2021) is not suitable for capturing dynamic interaction behavior such as sequences of behaviors. While it can provide specific instances of verbal correlations between followers and leaders, it cannot provide the broader patterns that are unrelated to it (Schlamp et al., 2021). The limitations of the streamlined taxonomy used in the study by Schlamp et al. (2021) emphasize the need for more comprehensive behavioral taxonomies that can capture a wide range of leader-follower dynamics. Despite limited variations in the taxonomies employed to capture different work settings, research consistently reveals that the micro-behaviors underlying leader-follower dynamics primarily revolve around task-oriented and relations-oriented behaviors (Kauffeld & Lehmann-Willenbrock, 2012; Yukl, 2012).

The research of Hoogeboom (2019) utilized the same concept of these different behavioral taxonomies to develop micro-behaviors that could be adapted for use in different settings, resulting in a set of micro-behaviors that were employed in studies of leader-follower dynamics (see Table 1). To account for the behavioral interactions among followers, a broad range of codes were employed in this study. The codebook was based on the task-oriented and relations-oriented behavior model proposed by Yukl (2012) and was supplemented with additional micro-behaviors from the team communication and leadership (e.g., Hoogeboom, 2019; Yukl, 2012; Burke et al., 2006; van der Weide, 2007). This comprehensive approach allowed for the capture of a wide range of leader and follower behaviors (Hoogeboom, 2019). This suggests that these fundamental micro-behaviors continue to be crucial factors in shaping

leader-follower dynamics across diverse work settings. Therefore, to comprehensively understand the complexities of leader-follower dynamics, it is imperative to study and analyze these micro-behaviors in detail.

Table 1

Previous behavioral taxonomies matched with the behavioral taxonomy of Hooigeboom (2019).

| Category | Yukl (2012) | Lehmann-Willenbrock et al. (2015) | Schlamp et al. (2021) | Hooigeboom (2019) | Gerpott (2019) |
|------------------------------|--|---|--|--|---|
| Task-oriented behaviors | Clarifying | Solutions-oriented behaviors | Request | Agree | Performing tasks: Solving problems, sharing, clarifying, task-related knowledge. |
| | Planning | Defining the objective | Command | Correcting | Monitoring the team task: Overseeing work progress according to plan. |
| | Monitoring operations Problem solving | Solution Describing a solution | Promote idea Directive plan | Disagreeing Directing | Change-oriented behaviors Envisioning goals: Communicating visions or goals to foster commitment towards actions. |
| | Change-oriented behaviors Envisioning change Encouraging innovation | Arguing for a solution Problem with a solution | Promoting idea (Politely) Promoting idea (Dominating) | Giving own opinion Informing Providing negative feedback | Facilitating change: helping and supporting change |
| | Facilitating collective learning | | | Structuring Task monitoring | |
| Relations-oriented behaviors | Supporting | Counterproductive behaviors | Express humility | Positive relations-oriented behaviors | Recognizing team members: using praise on people’s work to show appreciation |
| | Developing Recognizing Empowering Advocating change | Criticizing Running off-topic Complaining | Self-promotion Praising others Encourage participation | Giving personal information Humor Idealized influence behavior | |
| | | Negative relations | Support and empower | Individualized considered | Integrating team members: Engaging others to actively participate in the team |
| | Networking External monitoring Representing | | Criticize someone | Intellectual stimulation Providing positive feedback Negative relations-oriented behaviors Defending one's position Interrupting Showing disinterest | |

Note: If a category had a different name in the study, it is highlighted in bold.

Task and relations-oriented behaviors as a behavioral taxonomy

Dichotomies between task-related and relations-oriented behaviors distinguish key aspects of leader-follower dynamics, representing fundamental dimensions of leadership behavior. Task-related behaviors focus on goal achievement, task completion, and efficient work execution through clear instructions, expectations, monitoring, and feedback (Gerpott et al., 2019; Hoogeboom, 2019; Hoogeboom et al., 2021; Lehmann-Willenbrock et al., 2015). While relations-oriented behaviors prioritize building social connections, offering support, empathy, and fostering a positive team climate (Gerpott et al., 2020; Lehmann-Willenbrock et al., 2015, 2017), it can also show the opposite of behaviors that disrupt meetings such as complaining or interrupting (Baird & Benson, 2022; Meinecke et al., 2017). Both dimensions are crucial for it addresses distinct team needs: Task-related behaviors ensure effective work and performance, while positive relationship behaviors promote team cohesion, and motivation (Hemshorn de Sanchez et al., 2022; Hoogeboom, 2019). A comprehensive understanding of leader-follower dynamics considers all dimensions, offering a balanced approach to understand team performance.

Task-oriented behaviors

In a work setting, leader-follower dynamics may demonstrate a range of behaviors that can be essential for a team's successful functioning. One of the main purposes of the micro-behaviors displayed by leaders and followers is to achieve a set of goals set by the team (Lanaj & Hollenbeck, 2015). Task-oriented behaviors are focused on achieving specific goals and collaborative aims, such as directing team members on how to reach a project deadline (Behrendt et al., 2017; Henkel et al., 2019). Leaders play a crucial role in developing the strategy and achieving it, often in interaction with followers, while also fulfilling the needs of their followers and ensuring that their duties are completed accordingly (Burke et al., 2006; Yukl, 2012). Followers, on the other hand, are responsible for completing their goals and following the instructions of their leader and which can also reflect a leadership role, thus showing similar traits and behaviors (Hemshorn de Sanchez et al., 2022; Hoogeboom, 2019). This behavioral category translates to the following specific observable behaviors: It consists for example of clarifying or task monitoring.

Effective task-oriented coordination between leaders and followers is essential for achieving team goals. Such coordination between leaders and followers is a behavioral pattern that often predicted team performance (Burke et al., 2006; Michelle et al., 2001; Spreitzer,

2013). Leader-follower task-oriented coordination involves synchronizing actions among all team members and collaborating towards a shared goal while remaining focused on the current task (Burke et al., 2006; Knapp, 2010; Lanaj & Hollenbeck, 2015). Behaviors underlying such coordination were for example clarity on objectives and goal setting (Lehmann-Willenbrock et al., 2015). Previous research however showed that no matter what the work setting was, teams tend to participate in task-coordinated behavioral patterns (Barsade, 2002; Hoogeboom & Wilderom, 2020; Kauffeld, 2015; Lehmann-Willenbrock et al., 2011; Lehmann-Willenbrock et al., 2015). In the context of leader-follower dynamics, these previous findings suggest there are behavioral dependencies between the leader and the followers, such that the leader's task-oriented behaviors focused on finding solutions can encourage subsequent task-oriented behaviors by the followers, such as a leader asking for a clarification can invite a subsequent task related response (Hemshorn de Sanchez et al., 2022). Therefore, effective task-oriented coordination between leaders and followers fosters a collective focus on accomplishing tasks, highlighting the significant role of behavioral dependencies within leader-follower dynamics.

Positive relations-oriented behaviors

Task-oriented behavior is often contrasted with relations-oriented behavior, which is a behavioral category that reflect the idea that teams do not focus solely on accomplishing goals in each meeting; they tend to also have social interactions (Gerpott et al., 2019). Positive relations-oriented behaviors concern with people and the work facilitation of leader and followers (Hoogeboom, 2019). It is the category of behaviors that is meant to support and encourage the development of follower skills and confidence including recognizing achievements and empowering followers to take initiative in problem-solving in pursuit of a particular vision (Gutermann et al., 2017). Research has revealed that these behaviors have a direct impact on fostering a positive work environment that inspires and motivates followers, leading to effective performance in achieving team goals (Baird & Benson, 2022; Lehmann-Willenbrock et al., 2015). For example, Lehmann-Willenbrock et al. (2014) conducted research that demonstrated the positive impact of humor on fostering a productive work environment, ultimately leading to an improved team performance. In other research, it was demonstrated that leaders exhibiting relations-oriented behaviors were positively associated with functional problem-solving communication among team members. This positive relationship was found to be mediated by the leaders' solution-focused communication (Lehmann-Willenbrock et al., 2015). Therefore, the cultivation of positive relations-oriented

behaviors by leaders plays a pivotal role in fostering a collaborative and productive work environment, ultimately driving effective team performance and goal attainment.

Negative relations-oriented behavior

Negative relations-oriented behavior is an important type of behavior that can have an observable and influential impact on interactions with followers, as it reflects anti-social behaviors that are not conducive to high performance (Meinecke et al., 2017). In addition to task-oriented and positive relations-oriented behavior, this is thus also an important behavioral category to take into account (Hooigeboom et al., 2021; Lehmann-Willenbrock et al., 2017; Meinecke et al., 2017). This behavior is defined as counterproductive behavior that do not enhance team performance (Hooigeboom et al., 2021). It often entails leader-follower behaviors that are considered less desirable, often involving extreme actions, such as belittling, loud outbursts, or malice (Baird & Benson, 2022; Hooigeboom & Celeste Wilderom, 2018; Kauffeld & Lehmann-Willenbrock, 2012; Van der Velde & Gerpott, 2023). Therefore, the presence of negative relations-oriented behaviors in a work context is presumed to decrease the effectiveness of leader-follower dynamics.

Methodological approaches of leader follower dynamics

The analysis of leader-follower dynamics is a crucial step for understanding the complexities of interpersonal relationships and how this contributes to higher performance in teams. Research has often built on the principle of methodological fit, which is understood as the alignment between theory, measurement, and analytical methods (Edmondson & Mcmanus, 2007). The research of Hofmans et al. (2019) revealed that up to 86% of the studies on leader-follower dynamics failed to measure and analyze their relations in a correct manner. Research shows this was often due to two facts. First, Hofmans et al. (2019) and Harmen & Ashkanasy (2015) argued that research in leader-follower dynamics reached a methodological stalemate, where ongoing methodological constraints limit theoretical progress. Second, other research has shown that it was not from the point of lacking a tool but a mismatch between the theory and the analysis tool, as in viewing the relationship of leader and followers from the eyes of the leaders alone and not taking into account the perspective and experiences of the followers (Kim et al., 2020). This severely limits our understanding of effective leader-follower dynamics as research may have failed to view and study the dynamics between leaders and followers as a process. However, current developments in terms of new methods

and tools that are available, enable and stimulate the appropriate analysis that can gain deeper insight into leader-follower dynamics.

Previous research

While often leader-follower research is based on similar theoretical approaches, the methods of measurement and analysis differ. Not every tool is viable for every research, but often every analysis method can have positive and negative effects on the results it produces (Hofmans et al., 2019). For the measurement of leader-follower dynamics, research recently has used a lot of video observation, captured those micro-behaviors, and created behavioral taxonomies that elaborate on what kinds of actual behaviors are displayed between leaders and followers (Behrendt et al., 2017; Henkel et al., 2019; Yukl, 2012). Hoogeboom (2019) showed that by utilizing video observations to capture micro-behaviors including collecting and relating this to perceptions of effectiveness, a more comprehensive picture of the team can be obtained. Understanding what kind of patterns exist in displayed leader-follower micro-behaviors is essential for further understanding of how effective teams operate (Gerpott et al., 2019; Lehmann-Willenbrock et al., 2017). A number of different analytical techniques has been used so far to understand the dynamics between leaders and followers.

Research has often employed lag sequential analyses to investigate specific sequences of leader-follower or follower-leader behavior (Gioia & Sims, 1986; Goltz et al., 1990; Güntner et al., 2020; Lehmann-Willenbrock et al., 2015; Meinecke et al., 2017). In their research, Lehmann-Willenbrock et al. (2013) introduced and explained the concept of lag sequential analysis, stating “This method analyzes temporal patterns in sequentially recorded events of groups or individuals, to determine how often one behavior was followed by another, interaction sequence matrices were generated. Transition frequencies were determined for each pair of statements” (p. 374). Moreover, while lag sequential analyses have offered valuable insights into the temporal patterns of leader-follower or follower-leader behavior, there is ample opportunity for innovation and the utilization of new tools and methodologies to enhance our understanding of leader-follower dynamics (Gooty et al., 2012; Van Der Aalst, 2012). By exploring alternative analysis methods, researchers can uncover novel insights into the intricate patterns and dynamics exhibited by leaders and followers, paving the way for a more comprehensive comprehension of their interactions.

Pattern analysis

For the identification of complex relationships between behaviors and outcomes a pattern analysis tool must be used (Gerpott et al., 2019; Hemshorn de Sanchez et al., 2022; Lehmann-Willenbrock et al., 2015). Process mining is an analysis method that can be used in studies that have a large quantity of time sequenced data, such as log data (Günther & Van Der Aalst, 2007; Van Der Aalst, 2012; Verbeek et al., 2010). While this technique has instrumental value in examining processes that involve a temporal sequence of events, such as data logs, it can also be used for coded video observations (Brands, 2019; Sobocinski et al., 2017). Process mining is a new tool that has not been used in a lot of research yet. Research that has used process mining did not focus specifically on leader-follower patterns. It has been used for identifying patterns and strategies in students' self-regulated learning. However, it can be used to uncover leader-follower patterns that are not immediately apparent using conventional methods of analysis (Beheshitha et al., 2015; Ramadan et al., 2019; Schoor & Bannert, 2012). To analyze patterns of interaction between leaders and followers in both effective and less effective teams, such as an analysis matches theory (i.e., leader-follower dynamics) and the measurement. Process mining has been shown to be capable of presenting a clear picture of the patterns of behaviors that occur in different settings (Bannert et al., 2014; Beheshitha et al., 2015). Beheshitha et al. (2015) conducted research demonstrating the capabilities of process mining algorithms to provide valuable insights into the temporal and sequential connections observed in self-regulated studies. The study presented models showcasing the distinctions between successful and less successful patterns of students. This research shed light on the potential of process mining algorithms to uncover meaningful information regarding the relationships and patterns that emerge within self-regulated learning contexts.

Research questions

The aim of this study is to explore the patterns of leader-follower dynamics that are displayed in teams using process mining. This method will be employed to compare the patterns of leader-follower dynamics for both the effective and less effective teams. Therefore, in this study, the following questions will be addressed: “*What are the differences in the patterns of leader-follower dynamics in effective vs. less effective teams, and are there differences in how leader interact with effective vs. less effective followers in the effective and less effective teams in a public company in The Netherlands?*”. To answer this question, the following sub-questions will be answered: “What are the leader-follower dynamics in less

effective teams vs. the effective teams?”, “What behaviors do the leaders display in the recurring patterns in the effective vs. the less effective teams?”, and “What behaviors do the followers display in the recurring patterns in the effective vs. the less effective teams?”.

Methods

Participants

The participants were chosen randomly through stratified random sampling. The participants were 65 teams, consisting of 65 leaders and 791 followers in a public company in the Netherlands. The leaders in the teams were 73.4% male and 26.6% female. Their average age was 49.94 ($SD = 8.05$), and job tenure was 22.47 years ($SD = 13.27$). The followers were 65.8% male and 34.2% female. Their average age was 49.63 ($SD = 9.74$), and their job tenure was 24.81 years ($SD = 13.15$). The largest team consisted of 24 followers, and the smallest team was comprised of 4 followers; the average number of followers in the teams was 8.40 ($SD = 5.59$).

Instruments

Video observation

In order to observe the behaviors of leaders and followers, a camera was strategically positioned inside the meeting rooms to effectively capture their interactions without being obtrusive. This was done before the participants arrived, and no video technicians were present during the meetings to minimize intrusiveness (Schweingruber & McPhail, 1999). This choice of data collection method was deliberate to find leader-follower dynamics and is often most visible in everyday regular meetings (Fairhurst & Uhl-Bien, 2012; Lehmann-Willenbrock & Allen, 2018).

Team effectiveness survey

To measure the teams that possess an effective performance, followers took a scale in which they gave ratings to items that measured how effective a team was in conducting tasks ($\alpha = .93$). The survey used a four-item scale from Gibson et al. (2009). A Likert scale from 1 (very inaccurate) to 7 (very accurate) is used, where a high score indicates that the team is effectively able to accomplish their goals. An example from the survey is: “This team does high quality work”.

Follower effectiveness survey

To measure the effectiveness of the followers, number tags were assigned to all followers in meetings. Their respective leaders were then asked to rate the effectiveness of their followers using a survey with items tailored to the job descriptions of the followers ($\alpha = .94$). The survey included 4 items revised from the scale by Gibson et al. (2009), with wording adapted to evaluate each individual follower (e.g. "This follower produces high-quality work"). The survey used a 7-point Likert scale ranging from 1 (very inaccurate) to 7 (very accurate). The focal leader of each team was responsible for rating each of their own individual followers.

Table 2*Leader-follower behavioral taxonomy*

| Category | Behavior | Definition |
|---------------------------------------|----------------------------------|---|
| Task-oriented behaviors | 1. Agree | The act of agreeing to a statement or an act |
| | 2. Correcting | Instituting punitive measure |
| | 3. Disagreeing | The act of contradiction of teammates |
| | 4. Directing | Sharing the tasks amongst the team |
| | 5. Giving own opinion | Expressing one's viewpoint about the best course of action |
| | 6. Informing | Providing factual information |
| | 7. Providing negative feedback | Condemning team members' behaviors or acts |
| | 8. Structuring | Changing topics in the meetings or moving from one topic to another |
| | 9. Task monitoring | Requesting team members clarification or confirmation about their tasks |
| Positive relations-oriented behaviors | 10. Giving personal information | Divulging personal information |
| | 11. Humor | Making jokes or humorous statements |
| | 12. Idealized influence behavior | Discussing the teams' collective vision and beliefs |
| | 13. Individualized considered | recognizing each person's need for growth and accomplishment |
| | 14. Intellectual stimulation | Encouraging team members to come up with new ideas and approach tasks and opportunities with a critical mindset |
| Negative relations-oriented behaviors | 15. Providing positive feedback | Positive feedback on the actions or behaviors of team members |
| | 16. Defending one's position | Highlighting one's role as a leader or a follower and emphasizing one's own importance |
| | 17. Interrupting | Interrupting or disrupting when other team members are speaking |
| | 18. Showing disinterest | Failing to act when it is expected |

Methodology

Behavioral taxonomy and coded behaviors

Scholars have emphasized the need to use a comprehensive range of codes to accurately capture the behavioral interactions among followers (Allen et al., 2016). Table 2 presents a codebook that was employed in the research conducted by Hooigeboom (2019) and has been verified in other studies (Hooigeboom & Wilderom, 2020). The classification of 18 micro-behaviors in this study into three meta-categories of behavior was built upon by prior research (Avolio & Bass, 1995; Derue et al., 2011; Lehmann-Willenbrock et al., 2015; Yukl, 2012). The three categories include task-oriented behavior, positive relations-oriented behavior, and negative relations-oriented behavior. By employing this comprehensive codebook, the research can capture a broader range of behaviors and interactions among followers, resulting in a more nuanced and accurate analysis of the data.

The recorded meetings that will be used for this research were chosen randomly and the behaviors of both leaders and followers were coded by two coders using a 15-page codebook that was previously refined and validated to be able to systematically code leader-follower behaviors (Hooigeboom & Wilderom, 2015). The unit of analysis was a speech segment, which could be a finished statement, a sentence, or even a single word. A micro-behavior, such as "agreement" could be assigned to each speech segment using the preset codebook. All behaviors were mutually exclusive, which meant that only one behavior could be coded at a time. The use of a pre-developed codebook and using specialized video-observation software from Noldus Information Technologies "The Observer XT" software allowed for a systematic and meticulous analysis of each video as seen in Table 3 (Noldus et al., 2000). The coders discussed the coding and used a confusion error matrix and inter-rater reliability output generated by the program. The inter-reliability of 94.35 ($\kappa = .94$) was established.

Table 3

Sample of the behavioral transcription of the effective team

| Absolute time | Subject | Behavior |
|-------------------------|-------------------------|---------------------|
| 24-04-2014 11:56:40.287 | Less effective follower | Humor |
| 24-04-2014 11:56:40.287 | Less effective follower | Humor |
| 24-04-2014 11:56:41.787 | Leader | Showing disinterest |
| 24-04-2014 11:56:41.787 | Effective follower | Structuring |
| 24-04-2014 11:56:44.137 | Less effective follower | Humor |
| 24-04-2014 11:56:44.137 | Less effective follower | Humor |
| 24-04-2014 11:56:46.698 | Effective follower | Structuring |

Effective teams

To create two distinct groups of effective teams and less effective teams from the initial sample of 65 teams, a median split was conducted using the team effectiveness survey. That resulted in 32 teams classified as effective and the other 33 classified as less effective. The resulting split yielded effective teams scoring above 5.41, and less effective teams scoring below 5.41. Each team in both groups consist of three subjects, namely a leader, effective followers, and less effective followers.

Effective followers

During staff meetings, a total of 791 followers were recorded on video, and effective and less effective followers were identified based on their average scores on the follower effectiveness survey items. Those scoring 8 or higher were considered effective. It is important to note that only a small number of leaders assign the highest possible scores of >8 to effective followers. Typically, leaders assigned a score of 8 to their most effective followers. This is

confirmed by the fact that out of the 791 followers, 109 were scored exactly with a score of 8 (18.9%), which indicates that an effectiveness score of 8 is considered adequate.

Data analysis

Process mining

To analyze the patterns of interaction between leaders and followers in both effective and less effective teams, the behaviors of leader and follower were analyzed using specific process mining software, ProM 6.11 (Verbeek et al., 2010). The specific process mining method used is the Fuzzy miner (Beheshitha et al., 2015; Günther & Van Der Aalst, 2007). Several steps were taken based on the research of Schoor & Bannert (2012). The behaviors of each team (i.e., the behavioral transcription of teams) were imported from the Observer XT in 65 Excel files (see example at Table 2). After performing the median split, the resulting 65 teams were analyzed separately, with 32 teams classified as effective and the other 33 classified as less effective. All teams within each group will be analyzed together, and based on this aggregated result a process mining model will be produced.

The next step was to create a fuzzy model. The program had two units of analysis, first the *exact time* of the occurred event and the second unit of analysis is the *event class*, which is subject combined with a behavior, for instance a “leader informing” is a single unit of analysis. As there are three subjects and 18 behaviors, there will be a total of 54 *event classes*. The program then created a model on the basis of three metrics. 1) Unary significance, which determined the significance of an event class in the model by the frequency of how often it occurred in the input log. 2) Binary significance, which determines the relative importance of an edge (i.e., how often two event classes occurred) to the model, and it affects whether an edge stays in the model or not. Which means in this research, the model will not display two behaviors that do not have relationship. 3) Binary correlation, which determines if two events are sequentially occurring more often than is expected by chance. Which means if two event classes rarely occur in proximity to each other, the program will not display an edge connecting them. Essentially, the presence or absence of an edge between two event classes depends on the frequency of their co-occurrence, as determined by the binary significance and binary correlation metrics.

Interpretation of the fuzzy model. An example output of the fuzzy miner is used to demonstrate how the program uses these three metrics to create a model can be seen in Figure 1. The output highlights the interactions between the three subjects and their respective sets of behaviors, including humor, disinterest, and structuring (i.e., the event classes). The fuzzy model comprises various elements that shed light on the leader-follower dynamics.

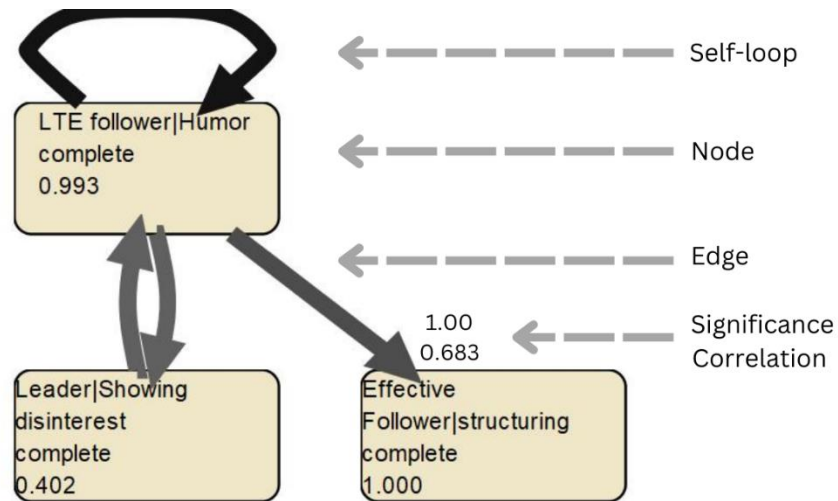
The first element is a node which represents an event class. The significance of those event classes was determined based on their frequency of occurrence in the behavioral log. Typically, the most frequently occurring node is assigned the highest value up to 1 that is created by the unary metric. In this example, the less effective follower displaying humor and the effective follower structuring the meeting are more significant, and thus occur more often in the dataset as compared to other behaviors for this subset of teams.

The second element in this example is the edge, which, using binary significance and binary correlation, signifies the relationship between event classes based on the direction of the arrow. The most correlated relationships between event classes get a significance value of 1. The correlation between two event classes is determined not only by their frequency of occurrence but also by the temporal proximity between them. The closer two event classes are ordered by time, the higher the correlation score they receive. In this example, a higher value edge indicates a strong correlation between the less effective follower demonstrating humor and the effective follower organizing the meeting.

Finally, the model includes self-loops, which are edges that depict repetitive behavior, such as the less effective follower making multiple jokes. Figure 1 illustrates the less effective follower repeating the same behavior, like making a joke, followed up with another joke. The accuracy and details of these metrics is shown by the research of Günther and Van Der Aalst (2007), and in the study conducted by Bannert et al. (2014).

Figure 1

Example model of three individuals displaying behaviors.



Note: The significance and correlation were added on top of the figure because the program only shows it inside the program.

The final step involves post-analysis, where two fuzzy models are created using the behavioral data logs. The first model pertains to effective teams, while the second model pertains to less effective teams. These models depict a reduced visualization that excludes events deemed insignificant by the program, resulting in a more understandable and interpretable model. However, analyzing a large volume of behavioral data can be challenging. The software provides flexibility in selecting specific metrics and adjusting their weight according to the study's requirements. Prior research has often employed the program's standard settings, highlighting significant patterns (Bannert et al., 2014; Brands, 2019; Ramadan et al., 2019; Swinnen et al., 2012). This study will follow similar analysis methods, using simplification techniques offered

by the program, such as edge filtering, aggregation, and abstraction, as previously used by other researchers (Bannert et al., 2014; Schoor & Bannert, 2012).

To simplify the model, the fuzzy miner applies edge filtering to reduce the number of edges (i.e., without this simplification also the non-significant results are included, leading to an uninterpretable model). This procedure aims to highlight the data and to produce the relevant information of the respective models (Verbeek et al., 2010). To apply edge filtering in the software, the function “best edge” will be used. It is a filtering tool that preserves the most important outgoing edges per node based on their significance and correlation, filtering out lower significance edges.

The next step in simplifying the model is node aggregation and abstraction. A node significance cutoff is established to determine whether a node should be included in the model. A node cutoff of 0.8, which is considered to be a very high cutoff and not commonly used in previous research, would lead to the loss of valuable information as event classes above the cutoff would be either abstracted or grouped into a cluster (Bannert et al., 2014; Verbeek et al., 2010). Therefore, researchers often choose a lower significance cutoff to enable more in-depth analysis of the data.

It is worth noting that when event classes fall below the significance cutoff, clusters may be formed. Any isolated clusters that are not connected to other nodes or clusters are eliminated. If a cluster with only one element cannot be merged, it is abstracted, and its relationships are passed on to neighboring clusters.

Process mining parameters

To analyze the behavioral files, a main significance cutoff point was chosen of 0.25¹. In previous studies a similar threshold was chosen to effectively filter out low significance events (Bannert et al., 2014). Default settings were used for edge filtering by setting an edge cutoff of 0.2 and a utility ratio of 0.75. By using these cutoffs, patterns that contain multiple significant behaviors are considered more noteworthy and meaningful (Schoor & Bannert, 2012).

Results

To be able to separate the effective and the less effective teams, a median split was performed on the team effectiveness scores. The median split of the 65 teams was a 5.41 ($M = 5.31$, $SD = 0.54$). There were 32 effective teams that consisted of 78 effective followers and 242 less effective followers. The effective teams displayed 37,487 behaviors, of which the leaders displayed 14,900 behaviors and the followers displayed 22,586 behaviors. While the less effective teams comprised a total of 33 teams; that consisted of 60 effective followers and 411 less than effective followers. These teams displayed 41,797 behaviors. The leaders displayed 17,786 behaviors, and the followers displayed 24,797 behaviors.

Occurrences of behaviors

Leader behaviors in effective and less effective teams

Table 4 presents the results of the behaviors of 65 leaders in both effective and less effective teams. It also presents the relative occurrences of those said behavior to the behaviors leaders make in the meetings. It shows that the occurrence of three prominent task-oriented behaviors among leaders in both effective and less effective teams, namely, informing (10.99%), giving own opinion (7.99%) and task monitoring (5.70%). The less effective leaders showed the

¹ Multiple models were created using different significance cutoff. significance cutoff of 0.25 was deemed to be sufficient to showcase leader-follower patterns.

same three behaviors: Informing (11.25%), giving own opinion (8.35%), and task monitoring (5.28%). The frequency of those task-oriented behaviors of the effective and less effective teams show almost no large differences.

For positive relations-oriented behaviors, the biggest behavior for both groups of leaders was individualized consideration. There was a slight bigger involvement from the less effective teams, but the biggest difference in behaviors for both sets of leaders was the fact that effective teams showed less "informing" (-0.54%) than less effective teams. Leaders in effective teams also showed the behavior of "defending oneself" less by (-0.46%) from leaders in less effective teams, which was an interesting finding, as leaders in effective teams showed that behavior a 100 times compared to the less effective leader who showed it 304 times.

Table 4*Frequencies of Occurred leader behaviors.*

| Subject | Event class | Occurrences (absolute) | | Occurrences (relative) | | Percentile difference |
|--------------|------------------------------|------------------------|----------------------|------------------------|----------------------|-----------------------|
| | | Effective teams | Less effective teams | Effective teams | Less effective teams | |
| Leader | Task monitoring | 2136 | 2200 | 14.33% | 12.37% | 1.97% |
| | Informing | 4120 | 4700 | 27.65% | 26.43% | 1.23% |
| | Structuring | 1842 | 2012 | 12.36% | 11.31% | 1.05% |
| | Humor | 478 | 550 | 3.27% | 3.09% | 0.12% |
| | Directing | 314 | 356 | 2.10% | 2.00% | 0.11% |
| | Giving own opinion | 2994 | 3566 | 20.09% | 20.05% | 0.04% |
| | Showing disinterest | 10 | 20 | 0.06% | 0.11% | -0.05% |
| | Agreeing | 788 | 954 | 5.28% | 5.32% | -0.08% |
| | Providing positive feedback | 294 | 366 | 1.97% | 2.06% | -0.08% |
| | Providing negative feedback | 44 | 88 | 0.29% | 0.49% | -0.20% |
| | Giving personal information | 76 | 128 | 0.51% | 0.72% | -0.21% |
| | Correcting | 156 | 240 | 1.05% | 1.35% | -0.30% |
| | Idealized influence behavior | 160 | 258 | 1.07% | 1.45% | -0.38% |
| | Interrupting | 214 | 342 | 1.43% | 1.92% | -0.49% |
| | Individualized consideration | 628 | 840 | 4.21% | 4.72% | -0.51% |
| | Intellectual stimulation | 464 | 648 | 3.11% | 3.64% | -0.53% |
| | Disagreeing | 82 | 214 | 0.55% | 1.20% | -0.65% |
| | Defending one's own position | 100 | 304 | 0.67% | 1.71% | -1.04% |
| Total | | 14900 | 17786 | 100% | 100% | |

Effective followers in effective teams and effective followers in less effective teams

In line with the analysis done for leader results, Table 5 presents the behaviors of effective followers from effective and less effective teams. For the effective followers in the effective teams, the biggest task-oriented behaviors were informing (29.10%), giving own opinion (28.42%), and task monitoring (11.49%). For the effective followers in the less effective teams, the order slightly changed but it was the similar behaviors, giving own opinion (27.32%), informing (18.90%), and task monitoring (11.04%). For the positive relations-oriented behavior, humor was shown more for the effective teams (7.67%) compared to their counterparts who had individualized consideration as their most shown behavior (5.56%). Both sets of followers also had “interrupting” as their first negative behavior. The data suggests that both groups had similar number of participants, but the effective followers in the effective teams exhibited twice as many behaviors as the effective followers in the less effective teams. While there was not a significant difference in the percentile differences, there was a noticeable gap in the total occurrences of these behaviors, with followers from the less effective teams exhibiting fewer of them. Another interesting finding came regarding the behavior of informing, in which the effective followers from less effective teams informed less by 10.24% than their counterparts.

Table 5*Frequencies of Occurred effective follower behavior.*

| Subject | Event class | Occurrences (absolute) | Occurrences (absolute) | Occurrences (relative) | Occurrences (relative) | Percentile difference |
|------------------------|---------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| | | Effective teams | Less effective teams | Effective teams | Less effective teams | |
| Effective followers | Correcting | 44 | 122 | 0.83 | 4.85 | -4.01 |
| | Individualized consideration | 114 | 140 | 2.15 | 5.56 | -3.41 |
| | Providing negative feedback | 50 | 106 | 0.94 | 4.21 | -3.26 |
| | Showing disinterest | 64 | 74 | 1.21 | 2.94 | -1.73 |
| | Giving personal information | 38 | 58 | 0.72 | 2.3 | -1.59 |
| | Providing positive feedback | 14 | 40 | 0.26 | 1.59 | -1.32 |
| | Intellectual stimulation | 24 | 36 | 0.45 | 1.43 | -0.98 |
| | Disagreeing | 78 | 50 | 1.47 | 1.99 | -0.51 |
| | Structuring | 120 | 66 | 2.27 | 2.62 | -0.35 |
| | Defending one's own position | 46 | 26 | 0.87 | 1.03 | -0.16 |
| | Interrupting | 178 | 82 | 3.36 | 3.26 | 0.11 |
| | Directing | 24 | 4 | 0.45 | 0.16 | 0.29 |
| | Idealized influence behavior | 40 | 8 | 0.76 | 0.32 | 0.44 |
| | Task monitoring | 608 | 278 | 11.49 | 11.04 | 0.45 |
| | Giving own opinion | 1504 | 688 | 28.42 | 27.32 | 1.1 |
| | Agreeing | 400 | 146 | 7.56 | 5.81 | 1.76 |
| | Humor | 406 | 118 | 7.67 | 4.69 | 2.99 |
| Informing | 1540 | 476 | 29.10 | 18.9 | 10.2 | |
| Total | | 5292 | 2518 | 100% | 100% | |

Less effective followers in effective teams and less effective followers in less effective teams

The less effective followers demonstrated a similar structure of task-oriented behaviors as leaders and effective followers, where the less effective followers from effective teams showed informing (30.31%), giving own opinion (26.82%), task monitoring (28%). Their counterparts in the less effective teams had different order of the occurrences of behaviors, giving own opinion (29.73%), informing (25.34%) and task monitoring (11.28%). For positive relations-oriented behaviors humor was the most occurring behavior and the most negative behavior for both were interrupting. The higher number of behaviors exhibited by the less effective followers can be attributed to the fact that there were more followers in the less effective teams than the effective teams.

Table 6*Frequencies of Occurred less effective follower behavior.*

| Subject | Event class | Occurrences | Occurrences | Occurrences | Occurrences | Percentile difference | |
|--------------------------|------------------------------|-----------------|----------------------|-----------------|----------------------|-----------------------|--|
| | | (absolute) | (absolute) | (relative) | (relative) | | |
| | | Effective teams | Less effective teams | Effective teams | Less effective teams | | |
| Less effective followers | Giving own opinion | 4638 | 6390 | 26.82 | 29.73 | -2.91 | |
| | Individualized consideration | 300 | 736 | 1.73 | 3.42 | -1.69 | |
| | Showing disinterest | 206 | 464 | 1.19 | 2.16 | -0.97 | |
| | Giving personal information | 80 | 250 | 0.46 | 1.16 | -0.70 | |
| | Defending one's own position | 168 | 344 | 0.97 | 1.6 | -0.63 | |
| | Correcting | 226 | 380 | 1.31 | 1.77 | -0.46 | |
| | Agreeing | 1116 | 1482 | 6.45 | 6.9 | -0.44 | |
| | Providing negative feedback | 360 | 536 | 2.08 | 2.49 | -0.41 | |
| | Interrupting | 666 | 912 | 3.85 | 4.24 | -0.39 | |
| | Humor | 912 | 1110 | 5.27 | 5.16 | -0.11 | |
| | Disagreeing | 272 | 356 | 1.57 | 1.66 | -0.08 | |
| | Idealized influence behavior | 56 | 76 | 0.32 | 0.35 | -0.03 | |
| | Providing positive feedback | 120 | 134 | 0.69 | 0.62 | 0.07 | |
| | Directing | 62 | 46 | 0.36 | 0.21 | 0.14 | |
| | Intellectual stimulation | 150 | 146 | 0.87 | 0.68 | 0.19 | |
| | Structuring | 350 | 260 | 2.02 | 1.21 | 0.81 | |
| Task monitoring | 2228 | 2424 | 12.88 | 11.28 | 1.6 | | |
| Informing | 5384 | 5446 | 31.13 | 25.34 | 5.79 | | |
| Total | | 17294 | 21492 | 100% | 100% | | |

Fuzzy model

The fuzzy miner presented two models showcasing significant patterns for both effective and less effective teams, consisting of significant behaviors. To compare the leader-follower dynamics in the less and in the effective teams, first there will be established what patterns exist in each type of team. Specifically, it will highlight the patterns in which these dynamics are demonstrated by exploring the significant edges of significant event classes. As effective leader-

follower dynamics are not determined by a single behavior, it is crucial to examine the combination of behaviors that lead to successful outcomes. Therefore, this research will discuss the patterns that comprise at least three event classes or more to capture the differences between effective and less effective dynamics.

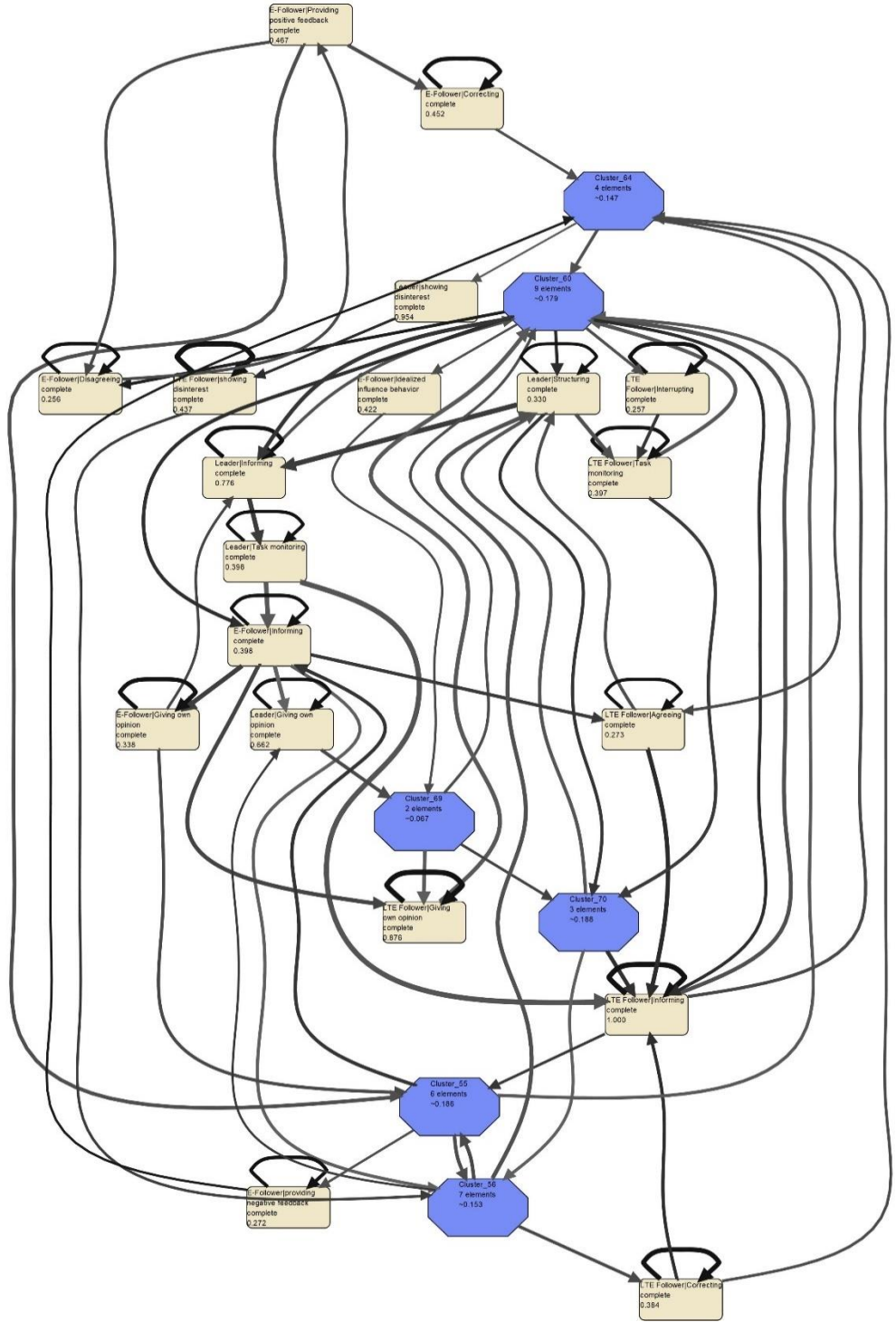
To further illustrate on why three event classes are looked at, Figure 2 illustrates the effectiveness of the fuzzy miner approach in filtering out ambiguous information and extracting the most important and frequently occurring event sequences. Furthermore, the results also suggest that certain behaviors may have a higher correlation, such as leaders showing disinterest followed by less effective followers showing disinterest. This observation implies that either these two behaviors often occur together, or that one often follows the other. This shows that dynamics are not just a back and forth between team members and it should be studied in patterns.

Effective teams

The fuzzy model presented 19 significant behaviors as shown on Figure 2. It showed effective teams focused mostly on task-oriented behaviors, out of a total of 19 behaviors, a noteworthy of 14 exhibited significant task-oriented characteristics, revealing deviations in their node significance ($M = 0.486$, $SD = 0.241$), followed by some negative relations-oriented behaviors with 3 behaviors ($M = 0.444$, $SD = 0.318$), lastly positive relations-oriented behavior with 2 behaviors ($M = 0.549$, $SD = 0.361$).

Figure 2

The fuzzy model of the effective teams



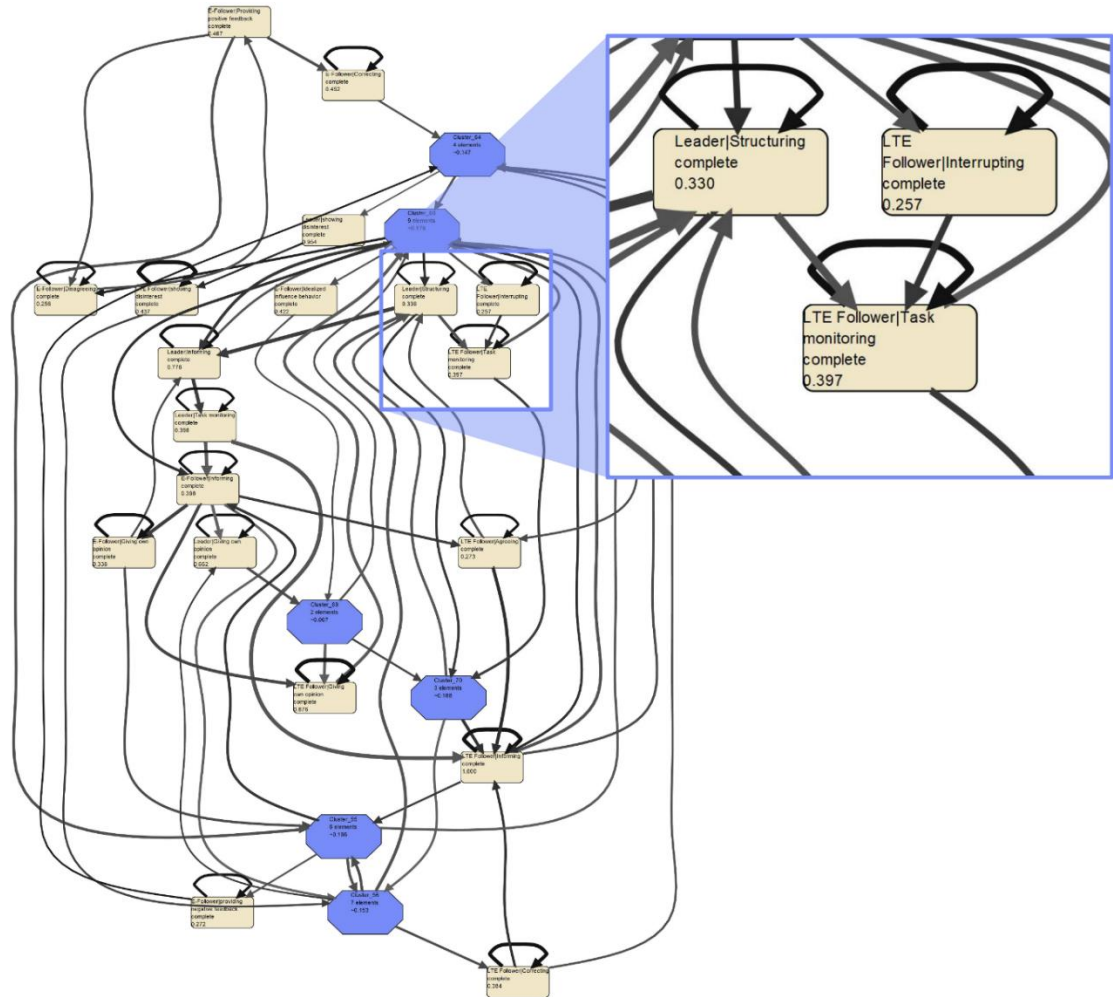
The model includes a measure of the frequency of interactions between team members, which is determined by analyzing the outgoing edges of the event class and their corresponding recipients. Outgoing edges were chosen to demonstrate how active members of a team are because the nature of outgoing edges indicates the idea that members initiate involvement. Figure 2 suggests that less effective followers tend to interact more frequently with each other. Another interesting observation was that less effective followers had no edges towards effective followers, while effective followers had the most edges towards less effective followers, with a total of four edges. This interesting observation implies that effective followers could be taking on leadership responsibilities towards less effective followers.

Pattern wise, the model produced three patterns that were recognized and identified through the analysis, indicating that there are three specific combinations of event classes that contribute to leader-follower dynamics.

Pattern 1. A pattern emerged regarding what leads to less effective followers initiating *task monitoring* inside meetings, it was followed by two nodes. It has a correlation of 0.804, which is higher than its counter event class with a correlation of 0.661, which indicates that less effective followers tend to monitor their tasks after a leader structures the meeting or after any interruption occurs in the meeting. Which shows the participation of the less effective followers in the meeting.

Figure 3

Pattern 1 of effective teams



Pattern 2. The second pattern showcases the complementary interactions between positive oriented behaviors and task-oriented behaviors. It showed two task-oriented behaviors resulting from a positive relations-oriented behavior. This pattern also involves only effective followers. The event class of effective followers *providing positive feedback* resulted in two actions. It was followed by the event class of effective followers *correcting* and it had a

When a leader performed *task monitoring*, it was followed by both effective and less effective followers *informing* with a similar correlation but with different outcomes. The model shows after less effective follower *informed*, it was not followed by any subsequent significant behaviors. On the other hand, when effective followers performed the same behavior, it was followed by all leaders, effective followers and less effective followers *giving their own opinion*. The last event class concerns a loop in which only when effective follower *gave their opinion*, it returned to the first behavior of *leader informing* again.

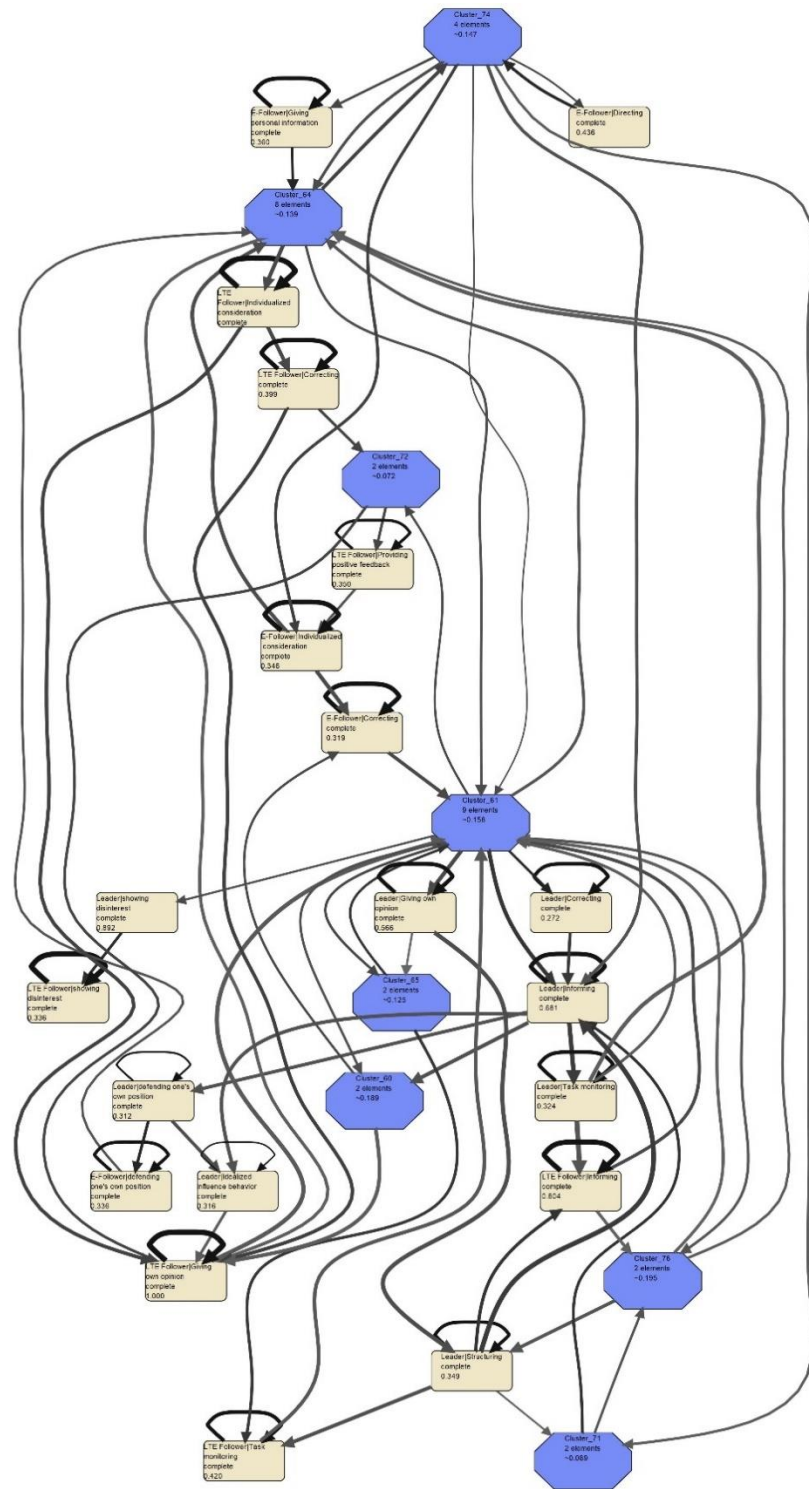
Less effective teams

The fuzzy model of the less effective team highlighted 20 behaviors (see Figure 6). It presented a different structure of what are the significant behaviors are presented with 11 task-oriented behaviors that possessed no significant deviations in node significance ($M = 0.500$, $SD = 0.227$), 5 positive relations-oriented behaviors ($M = 0.329$, $SD = 0.040$), and 4 negative relations-oriented behavior ($M = 0.451$, $SD = 0.282$).

This was also reflected in how team members interacted in the outgoing edges as shown in the model. It shows that the interactions of the less effective teams are much less than the effective teams, where most of the interactions occurred between leader to leader event classes or leader to less effective follower event classes. This indicates that interactions within less effective teams primarily take place within their own groups. Effective followers tend to communicate with fellow effective followers, while less effective followers interact with peers who share similar traits. The highest significance edge ($M = 0.191$, $SD = 0.160$) is much less to their effective counterparts. The highest correlated edges were from effective to less effective followers ($M = 0.732$, $SD = 0.033$).

Figure 6

*The fuzzy model of
the less effective teams*

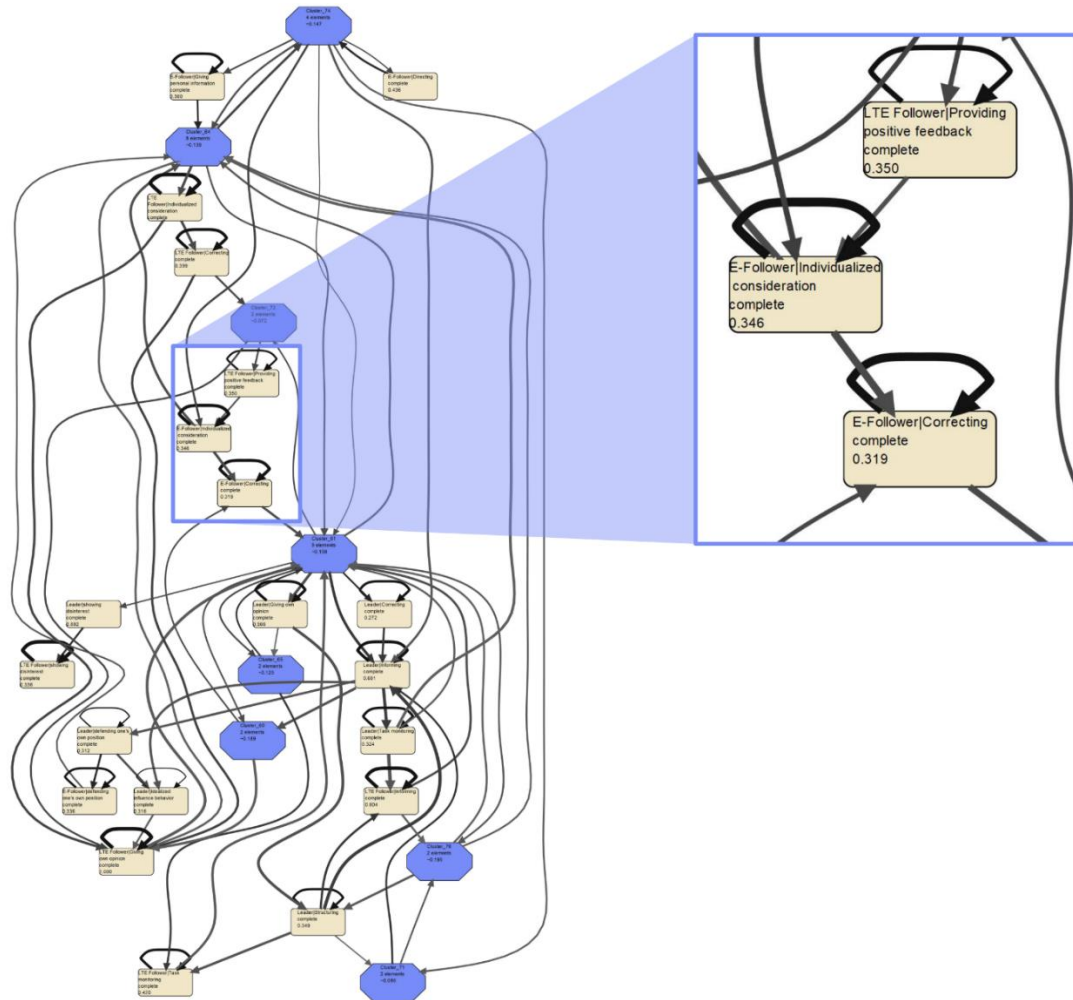


Pattern wise, the analysis identified four distinct patterns, indicating that there are four specific combinations of event classes that contribute to leader-follower dynamics of the less effective teams.

Pattern 1. A pattern emerged regarding how effective followers respond to being given positive feedback. Similar to Figure 4 from the effective teams, it showcases the complementary interaction that starts with positive relations-oriented behaviors and then leads task-oriented behaviors. The first behavior regarded effective followers *giving positive feedback*, which followed by the effective follower showing *individualized consideration* with a correlation 0.622, which was subsequently followed by the effective followers *correcting* with a correlation of 0.692. This pattern showcases how effective followers deal with feedback from less effective followers. However, it does not specify what the less effective followers are giving positive feedback to. On the other hand, effective followers often respond by expressing the need for room for growth and ensuring that any errors are corrected.

Figure 7

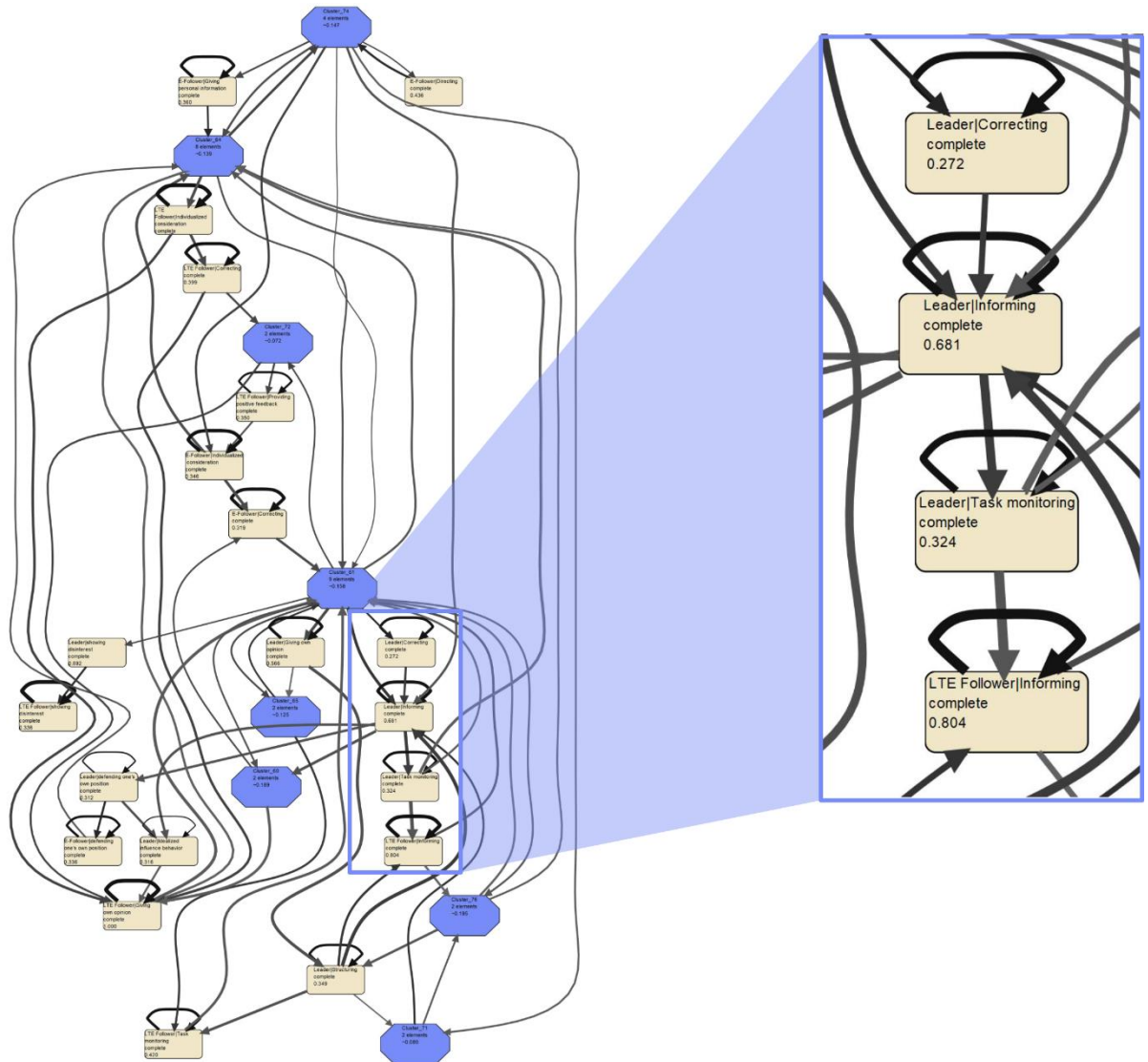
Pattern 1 of the less effective teams.



Pattern 2. The second pattern showed how leaders operated in their task-oriented behaviors. It first presents the information sharing patterns of behaviors that starts with leader *correcting*. Subsequently it is followed with a correlation of 0.794 by leader *informing*. then leader *task monitoring* with a correlation of 0.773, and lastly, it was followed by less effective follower *informing* with a significant correlation of 1.00. This further showcases how followers are not presented in the ineffective teams, and the information sharing patterns are typically center around the leader rather than leaders and followers.

Figure 8

Pattern 2 of less effective teams

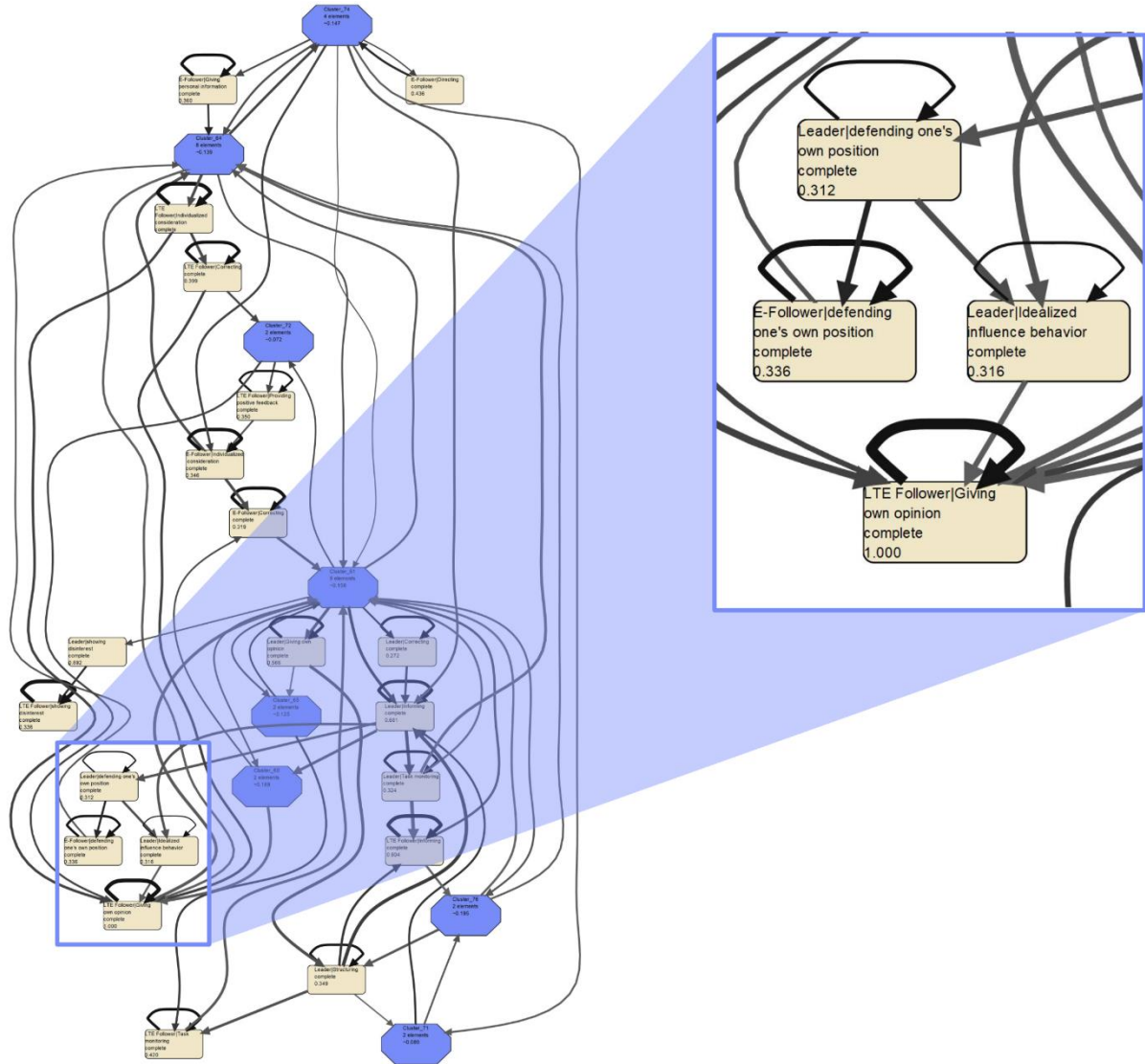


Pattern 3. The third pattern concerned a mixed pattern consisting of positive and negative relations-oriented behaviors. When leaders displayed the behavior of *defending one's position*, it was either followed by effective followers displaying the behavior of *defending one's position* with a correlation of 0.897 or leaders displaying *idealized influence behavior* with a less significant correlation of 0.686. Then it continues with less effective followers displaying the highest significant behavior in the model which is *giving own opinion* with a correlation of

0.600. This pattern shows that less effective teams tend to remain in relations-oriented behaviors and they are not followed by a leader aiming to *structure* the meeting.

Figure 9

Pattern 3 of less effective teams

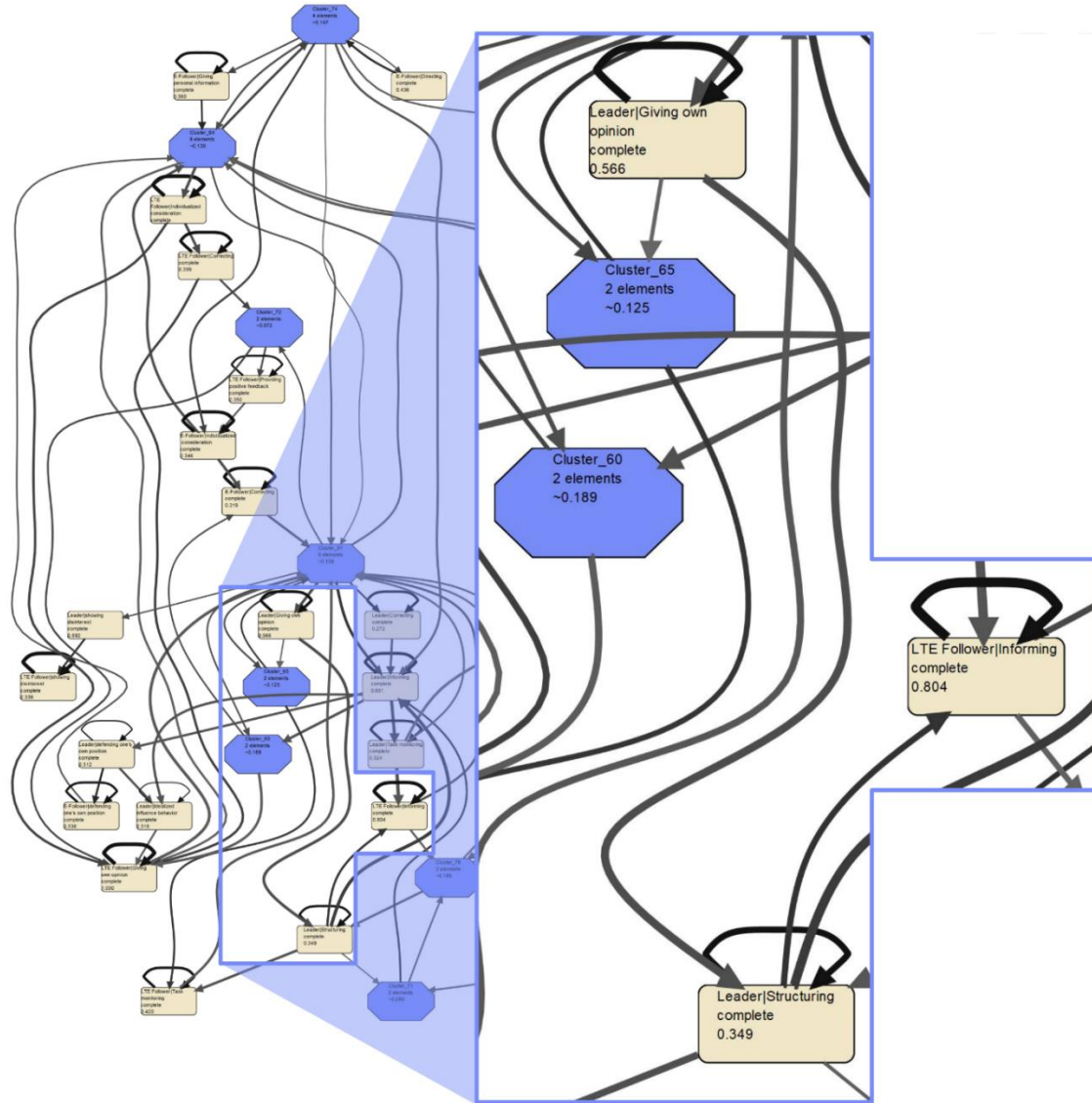


Pattern 4. The final pattern concerned another leader centered task-oriented behavior pattern. However, unlike the coherent information sharing patterns observed in the information sharing pattern of the effective teams, this pattern is shown to be incoherent. It starts with leaders giving their own opinion, followed with a correlation of 0.680 by the behavior of leader structuring, which is then followed by less effective followers *informing* with a high correlation

of 0.823. This showcases that leaders do not present all the needed information in a singular order such as the effective teams did in pattern 3 (see Figure 5).

Figure 10

Pattern 4 of less effective teams



Discussion

Understanding how leader-follower dynamics shape effective environments and contribute to performance is crucial. This study delved into the behavior frequencies of 65 teams, coupling them with effectiveness surveys of both teams and leaders. By analyzing this data using the fuzzy miner, the study identified seven highly significant interaction patterns. These patterns

reveal the differences in leader-follower dynamics between effective and less effective teams. In the following sections, we will delve into the in-depth analysis of these patterns.

The initial results from the video observation showcased the behaviors exhibited by leaders during team meetings. It became apparent that leaders from both teams displayed similar interaction patterns with minimal changes. This consisted of both task- and relations-oriented behaviors by leaders. However, the key differences seemed to lie in how these behaviors were sequenced and presented during the meetings. When it came to followers' behaviors, the initial findings indicated a clear distinction between the behaviors of less effective and effective followers. While the interactions of less effective followers were largely uniform, seemingly unaffected by their team's effectiveness, effective followers exhibited a considerable range of behaviors. Notably, effective followers in effective teams contributed twice as much as their counterparts in less effective teams, prompting the need for more nuanced research into effective follower dynamics.

In the models, distinctive patterns emerged between leaders in effective teams and those in less effective teams. Leaders in less effective teams tended to impede follower participation during meetings. This was characterized by an approach centered around the leader, where they predominantly relied on their own inputs to conduct the meeting. This approach limited opportunities for active involvement from team members, resulting in reduced engagement and responses from followers, in contrast to their more effective counterparts. Effective teams displayed a cohesive dynamic marked by frequent communication and reciprocal behaviors among leaders, effective followers, and less effective followers. These interactions covered both significant task-related and relations-oriented behaviors, contributing collectively to the heightened effectiveness of the team (Kauffeld & Lehmann-Willenbrock, 2012; Lehmann-Willenbrock et al., 2015). This further aligns with the research conducted by Kauffeld & Lehmann-Willenbrock (2012) and Meinecke & Kauffeld (2019), strongly underscoring the importance of adopting a cooperative approach to enhance overall team effectiveness. Furthermore, the analysis revealed divergent follower interactions based on their effectiveness levels, particularly in terms of their contributions during meetings and their engagement with others. In effective teams, the role of effective followers was prominently evident in information sharing, where they outperformed their less effective counterparts by 10%. In contrast, effective

followers in less effective teams were notably absent from the information sharing dynamic, showcasing the most significant difference between the two groups.

In the effective teams, informing was an essential behavior demonstrated by leaders and followers. Even though the function best edges tend to reduce the number of edges for event classes, all event classes that entail informing contain multiple edges. Effective followers' informing in the less effective teams pertained nine incoming and outgoing edges and is considered a central event on which all other events converged. While their counterparts in the effective team demonstrated the same behavior with only four incoming and outgoing edges, which suggests a more efficient flow of information within the effective teams (Kauffeld & Lehmann-Willenbrock, 2012).

The fuzzy models furthermore revealed an important difference related to the impact of leadership in effective teams on followers' behavior. Specifically, the results showed that leaders from the effective teams who provided information and structured the meeting often led to subsequent task-oriented behaviors from both effective and less-effective followers. In addition, when leaders gave their own opinions, it signaled to the followers that they were encouraged to participate in the meeting and voice their opinions. This finding was consistent with Lehmann-Willenbrock et al. (2015) research, which demonstrated that effective leader-follower dynamics create an environment where team members tend to emulate certain behaviors.

One unexpected finding was the existence of positive relations-oriented behavior, where in the patterns exclusively involved followers and were uncommon for leaders. Positive type behaviors were present for leaders as a recurring behavior, but the program detected only one significant behavior for leaders, which was then followed by a task-oriented behavior. On the other hand, negative relations-oriented behaviors were less present than positive relations-oriented behaviors. This aligns with research by Lehmann-Willenbrock et al. (2017) and Lehmann-Willenbrock & Allen (2014), which indicates that positive and productive behaviors are more prevalent than negative and counterproductive behaviors.

Theoretical implications

First, the present study's findings align with those of previous research by Baird and Benson (2022) and Lehmann-Willenbrock et al. (2015), which indicate that effective leader-

follower dynamics involve reciprocal behavior. Whether it was task-oriented or relations-oriented behavior, the leader-follower process often involved a balanced pattern of reciprocal influence among team members, forming the foundation of shared leadership. The results suggests that leaders often exhibited the same level of task-oriented behaviors. Our models further contribute to this research by demonstrating that less effective leaders did not receive the same behaviors from their followers, whereas their effective counterparts received reciprocal behavior from both effective and less effective followers.

Second, in contrast to earlier findings (Kauffeld & Lehmann-Willenbrock, 2012; Lehmann-Willenbrock et al., 2011), that found that negative type of patterns, were strongly correlated with unfavorable outcomes, surpassing the positive impact of positive type of patterns inside team meeting interactions. This study did not find evidence of negative behaviors substantially outnumbering positive and productive behaviors. This analysis showed that while both teams occasionally engaged in negative relations-oriented behaviors, these behaviors were not common. However, the model did consider some of these behaviors significant, indicating that they may still have an impact on leader-follower dynamics.

Lastly, the present study adds to the growing interest in utilizing pattern analysis tools in interaction research (Bannert et al., 2014; Sobocinski et al., 2017). By employing a process mining tool, this research delved into in-depth patterns of real-time leader-follower dynamics. While previous studies have established correlations between specific originating from leaders and followers and how they relate to team performance (Burke et al., 2006; De Jong & Elfring, 2010), the pattern analysis is able to offer insights into the underlying leader-follower patterns that give rise to such behaviors. This contribution highlights the value of process mining in uncovering nuanced and detailed dynamics within leader-follower dynamics.

Practical implications

The study's results suggest that the number of task-oriented behaviors exhibited by leaders does not necessarily impact the outcome of team meetings. Thus, it is crucial for leaders to avoid individualistic approaches and instead create an open and inclusive space for discussion. The finding that effective followers in less effective teams exhibited fewer behaviors than their counterparts reinforce the need for leaders to foster an environment that emphasizes the importance of collaborative work.

The study's model also reveals that effective followers' most significant responses are directed towards other effective followers, underscoring the importance of creating a collaborative environment. Leaders can achieve this by encouraging participation, which can be done by more task-orientated behaviors that invite participation, for example leaders *task monitoring* of all followers. thereby fostering an environment where everyone can contribute to meetings.

The usage of pattern analysis tools and video observation can provide valuable insights into how leaders and followers interact in the workplace. It aids in pinpointing and eliminating minor differences between teams, refining the depiction of overarching leader-follower dynamics. However, to fully investigate leader-follower dynamics, it is essential to combine these methods with qualitative data collection techniques such as interviews, focus groups, and surveys.

Limitation and future studies

The study's goal was to highlight leader-follower dynamics, yet it did not offer insights into what created these patterns. It is possible that a leader's personality traits (Yukl, 2012) or external circumstances (Lehmann-Willenbrock & Allen, 2014) may play a role in creating such patterns. Therefore, further investigation is necessary to better understand the identified patterns and the specific contextual conditions that contribute to these patterns in meetings.

A limitation occurred with the method of which the program presents the model. While the program shows leader-follower dynamics that for example effective followers in Figure 4 may *inform* and then continue to *give their opinion*, the program does not show if it was made by the same follower or another effective follower. It is a limitation for it cannot show a clear image of if the followers are effectively building up on their own behavior or if other effective followers are assisting in creating that effective pattern. Therefore, in future research, it is recommended to avoid grouping individuals into large groups and instead maintain smaller, identifiable members in longitudinal studies. This approach allows for a clearer understanding of individual roles, actions, and the underlying reasoning behind them.

One limitation of the study is related to the use of the process mining tool. While previous research has focused on the usage and methods of creating a fuzzy model with ProM

6.11, there is limited research on the metrics used by the tool. Specifically, there is a lack of research on the relationships between the three metrics. This can be seen in the behavior of the leader *showing interest*, which occurred only ten times in 37,487 behaviors but was one of the most significant nodes with a significance score of 0.954. It can be assumed, but not confirmed, that the unary significance metric does not only grant significance to an event class based on its frequency of occurrence but also on its relations with other behaviors, such as the less effective follower *showing disinterest*. Therefore, future research should investigate these relationships in greater depth.

Another limitation of these findings is that creating only two groups, one consisting of effective teams and another of less effective ones, may oversimplify the findings. The use of a median split that creates two groups may hinder the opportunity of presenting interesting findings of leader follower dynamics. Including a third group that represents the average interaction between leaders and followers would provide a better understanding of how each group performs their tasks and fulfill their duties. Such an approach may assist in identifying how exact leader-follower dynamics may assist in creating an effective team.

Future research can benefit from exploring the role of relations-oriented behaviors in leader-follower dynamics, alongside the typical focus on task-oriented behaviors during team meetings. While these behaviors may not be as prevalent in meetings, longitudinal studies that investigate the evolution of relations-oriented behaviors within teams can provide valuable insights into their development beyond task-oriented relationships. Such studies could help identify essential factors that contribute to establishing and sustaining positive leader-follower dynamics over time. By moving beyond the scope of a single meeting, conducting longitudinal research has the potential to greatly enhance our understanding of the temporal progression of these patterns.

Conclusion

Comprehending the profound influence of leader-follower dynamics on effective environments and overall performance is indeed pivotal. This research serves as an illustration of future avenues for investigating leader-follower dynamics through fine-grained analysis of workplace behaviors. The study's objective was to discern differences between effective and less effective followers, employing an innovative analysis tool. By delving into behavior frequencies

from video observations combined with effectiveness surveys, this research demonstrated compelling interaction patterns that underscore the distinctions in leader-follower dynamics within effective and less effective teams. Initial observations illuminated leaders' behaviors during meetings, revealing consistent task- and relations-oriented action. The models, in turn, unveiled stark disparities in leader behavior, portraying individualistic tendencies within less effective teams in contrast to cohesive interactions in effective teams. Notably, effective followers in effective teams exhibited twice the contribution of their counterparts in less effective teams, underscoring the imperative for nuanced research into follower dynamics. The models underscored that effective teams exhibited reciprocal interaction patterns, while less effective teams manifested individualistic leadership styles. In such instances, leaders primarily engaged in task-oriented behaviors without anticipating responses from team members. The approach of this study is considered to be a valuable start towards a more accurate depiction of overall leader-follower interactions, which has the potential to offer more tailored advice to real-life teams to how they can improve their interactions and subsequent effectiveness.

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