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BIOMIMICKING AS A METHOD FOR SELF-MANAGED TEAMS

***Mohammad Nozari, Ph.D and Richard Schuttler, Ph.D**

71 Joshua Court, Thornhill, ON, Canada

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****Corresponding author: Mohammad Nozari***

ABSTRACT

The potential high performance of self-managed teams materializes with implementing such teams properly and differently from traditional manager-led teams. This article contains a descriptive multiple case study that presents biomimicking as a unique and untapped resource to achieve that potential by applying a biomimicking lens to help understand successful decision-making patterns for self-managed teams. The study population included team members of self-managed teams working in information technology companies in Toronto, Ontario, as the technology hub of Canada, with a tendency to apply the latest approaches for teamwork performance and output. The findings of the study demonstrated more success in achieving organizational goals with biomimicking behaviors. The information in this article can lead to the adoption of self-managed teams by more organizations. Improved chances of success of self-managed teams using biomimicking behaviors may result in higher organizational outputs and higher employee satisfaction and lead to positive social change by optimizing limited resources and promoting better work/life balance.

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INTRODUCTION

A self-managed team is one with members who receive minimum guidance and influence from higher levels of management in activities such as planning, organizing, and controlling (Vancea, 2015). Many organizational leaders establish self-managed teams to improve innovation, speed, and employee satisfaction (MacDonald, 2019). Leaders must focus on organizational transformation to improve the success of self-managed teams; however, many leaders lack the strategies needed for the implementation of self-managed teams, specifically, decision making as the essential difference between leader-managed and self-managed teams. The similarity between how intelligent swarms in nature handle complicated problems led to designing a multiple case study to see if we can use biomimicking (applying behavior of social beings in nature) to explain common decision-making strategies in self-managed teams. In the process, we discovered with certain behaviors exhibited in intelligent swarms and tried to match them with higher-performing teams in the study and establish an interdisciplinary view of self-management through the lens of biomimicking. This approach can provide a framework to address the gap in the overall method of implementing self-managed teams using swarm intelligence that includes suitable decision-making approaches and behaviors learned from other social beings. Solving self-managed team challenges will lead more employers to adopt these teams.

BACKGROUND

There are different factors to consider in any team design, such as tasks, team dynamics, hierarchy, leadership, accountability, and authority. In a traditional team, a single leader or manager makes the decisions, assign tasks, and performs planning activities. Self-managed team members have full authority over team activities, including planning, organizing, and decision making (Vancea, 2015). This is a much different way to employ teams as compared to a more tradition top-down directive to chartering and managing team performance. Since the earliest references to self-organization in the 1960s (see Myers, 1968), corporate leaders have implemented different forms of self-managed teams with mostly positive but inconsistent results. Organizations with effective self-managed teams have higher performance levels, cost savings, innovation, customer satisfaction, commitment, and motivation (Magnusson, Brunetta, & Annosi, 2017). However, members of self-managed teams encounter different or similar but augmented challenges than members of traditional teams, such as dealing with authority, hierarchy, decision-making, and groupthink. Leaders who understand the drawbacks of self-managed teams allow for the recognition of potential challenges and set the right expectations for self-managed team members (Lee & Edmondson, 2017). Highly skilled leaders try to provide team members with opportunities and tailored solutions rather than traditional approaches.

With an awareness of the benefits of self-managed teams, researchers have expanded their focus to include more complicated situations such as large and distributed teams (Davena et al., 2013). Despite the popularity and multiple applications of self-managed teams, many leaders still struggle to find the proper implementation approaches for such teams. Corporate leaders must recognize the requirements and specific implementation needed for successful self-managed teams. The way leaders organize and implement self-managed teams impacts the success or failure of team members working in that setting (Renkema, Bondarouk, & Bos-Nehles, 2018). Leaders must organize and set up team design, employee interactions, conflict management, and communications differently for self-managed teams than traditional teams. However, due to the gap between theory and practice, lack of standards in the industry, and improper planning/implementation on how to resolve these differences with an implementation approach, many organizational leaders frustratingly achieve inconsistent or nonexistent results with self-managed teams. In the decision-making process, team members who are closer to the underlying elements of a situation make the decisions in self-managed teams (Moe et al., 2008). However, members of self-managed teams may struggle to make high-quality decisions due to issues such as groupthink and concerted control.

Organizational leaders could streamline the implementation of self-managed teams if they provided self-managed team members training on tailored decision-making approaches. Given the gaps above, we considered using biomimicking. Humans learn from nature and its inhabitants. Many inventors have been inspired by or mimicked these learnings, such as flying of the birds used in designing airplanes and using the shape of dragonflies in building helicopters. Social beings (i.e., species that achieve goals through collaboration and cooperation) accomplish tasks without assigned leaders, the same core idea as self-managed teams. These beings, such as ants, bees, wolves, and fish, have evolved over millions of years to work together to achieve their goals. The observed behavior of social beings was a component of the study to present more successful collaboration and decision-making patterns. Social beings have similar challenges as humans in self-managed teams. For example, social beings must find ways to improve the quality of their decisions (Taha, Mustapha, & Chen, 2013), and they must optimize how they choose and schedule their tasks (Parvan, Nejad, & Alavi, 2014). Social beings use certain behaviors to overcome challenges in nature, such as how bees work together to decide the location of their new nest without anyone playing the role of a leader, or when birds follow simple rules to fly together without an assigned dominant bird. These behaviors can better establish self-managed teams and implement successful decision-making processes among team members.

Serrador & Pinto (2015) indicated the success of self-managed teams using Agile models in software development. Agile models provide an iterative, evolutionary approach by integrating customers and information technology (I.T.) team members functioning close to a self-managed team (Anwer, Aftab, Shah, & Waheed, 2017). Although not all Agile teams succeed or represent a full implementation of self-managed teams, they are helpful as a starting point for the study of effective implementation of self-managed teams (Dingsøyr, Fægri, Dybå, Haugset, & Lindsjørn, 2016). Due to recent successful results from Agile teams in I.T. representing self-managed teams and potential learning opportunities from biomimicking, research is necessary to understand whether biomimicking the intelligence of social beings can help self-managed team members develop better decision-making approaches as practiced in I.T. To successfully implement self-managed teams, organizational leaders should lead their employees through a transformation (Gupta et al., 2017) that can enable team members to use their autonomy in a self-managed approach and work effectively (Renkema et al., 2018). In this research, we considered a recommendation from Kennedy et al. (2015) on applying biomimicking as a source of innovation. We investigated the potential benefits of understanding group behavior between humans and social beings, as recommended by Tindale and Kameda (2017), in the context of self-managed teams. Based on a conceptual framework of teamwork, decision making, and sociobiology constructs, we considered elements of self-management using self-determination theory (Deci, 1971) and social learning theory (Bandura, 1979). Another component of the framework included social choice theory (Arrow, 2012) on decision process. Implementation of self-managed teams must guide leadership, communications, and decision making to avoid challenges that have lowered the performance of self-managed teams.

The fundamental difference between self-managed and traditional team design is the autonomy of making decisions (Muthusamy, Wheeler, & Simmons, 2005). To efficiently enable a self-managed team, team members need to address challenges like polarization and groupthink (Kelman et al., 2017), low synergy, and team cohesion weaknesses. This study's results extended the application of intelligent swarms into self-managed teams using the same simple rules that social beings exhibit by showing how team members in an I.T. company described decision-making strategies. Wilson's (1978) sociobiology served as the base for the study's biomimicking perspective. Sociobiology theory explains social behavior through evolution. The focus of this study concerning sociobiology is on social beings that have evolved to work together in groups and can perform functions not possible otherwise. This level of intelligence is known as swarm intelligence, meaning that individuals within the group work together and act as one higher entity exhibiting intelligence that they would not be able to achieve.

How to Build a Successful Self-Managed Team

The transition from a traditional team to a self-managed team requires planning in all aspects, including leadership, authority, and decision making. For example, the transition of authority may occur in five stages:

- understanding one-on-one interactions between the manager and the team members,
- leading interaction to happen between team members by the manager,
- taking a coaching role by the manager,
- team members step up and provide leadership on key team processes and engage others, and
- leadership enters its peak level, freeing the manager to attend to higher initiatives than managing the team (Liff & Gustavson, 2016).

As traditional team members join self-managed teams, they start taking active ownership roles. Developing and managing knowledge within the team become key contributing success factors (Wageman, 2001). Watson, Michaelsen, and Sharp (1991) examined team members' familiarity with each other and the effect of familiarity on group-versus-member problem-solving processes. Findings showed that, as team members gain experience, the influence of more experienced members becomes less essential that is directly related to decision making, groupthink, and inclusion of experience in team decision-making learning exercises. The improvement in decision-making may not immediately appear after setting new processes, enablement, and empowerment as it may take time and effort until team members can provide their true team-added value.

Understanding Decisions in Teams: Self-managed team members engage in different decision-making processes than members of traditional teams. In traditional teams, the assigned leader or manager evaluates a situation and makes a decision; because self-managed team members operate without an assigned leader or manager, they must make decisions differently. In the following sections, we review decisions and decision-making processes and explore gaps in the existing approaches.

Decision-making in teams: In the traditional decision-making process, a manager uses prior experience and situational context to decide upon the best approach. Given the spatial differences between the design of the classical decision theory and today's complex and dynamic world, there is a need for new decision-making approaches

(Beach & Lipshitz, 2017). The technological scene changes faster than in other industries, so decision-making processes that provide the best outcomes can significantly differ. The alternative to traditional decision-making is the process of allowing team members to participate. This concept is indeterminate and overlaps with the roles of each team member (Halvorsen & Sarangi, 2015). Team members have different roles and should clearly understand their own role as well as that of their fellow team members (Engleberg, Wynn, & Schuttler (2001). Activity roles are team members' core activities. Discourse roles are how team members communicate about their activity roles and how they may influence other activities. The indeterminacy and overlap of these roles within the team's context provide team members with opportunities to contribute to that decision-making process.

The roles mentioned above indicate that elements of decision distribution to team members already exist, which self-managed teams can utilize. Team members should be able to contribute to decision-making while acting in their organizational roles. With some rule-setting at the beginning of the teamwork arrangement, it is possible to identify the influence of team members in their organizational roles with subsequent direction toward the desired direction (Halvorsen & Sarangi, 2015). Team members must also consider information availability and ambiguity when making decisions as a group (Beersma et al., 2016). Sometimes information is not available due to spatial factors and data extraction, cognitive levels, and ambiguity elements. Beersma et al. (2016) stated that although the need for structure is an asset when information ambiguity is low, the structure becomes a liability when ambiguity is high. In other words, when the level of unknown elements for decision-making increases, team members can do better if they feel comfortable with less structure in the decision-making process. The need for comfort is applicable in self-managed teams, as the traditional structure of the organization may not be available for decision-making. Self-managed team members need to know how to reach a general agreement or consensus. One proposed model relies upon the expert-level in a general agreement model to achieve the desired level of consensus (Pérez, Cabrerizo, Alonso, & Herrera-Viedma, 2014). In the traditional model, the decision-maker uses a weighting system, which presents each expert's relevance and importance and, through a feedback mechanism, allows team members to optimize decisions. Members of heterogeneous teams can use the traditional model when experts with different importance and relevance must work together. This model is a unique approach because, in real-life situations, more experienced experts should have higher stakes in each decision, leading to an inclusive and more efficient decision-making model.

Team members must make decisions for different types of tasks, and some decisions may be easier than others. Self-managed team members can use decision-making based on task variety in a model to provide a configurational approach for various team tasks. Decentralized design and centralized technical work indicate improved team coordination (Kudaravalli, Faraj, & Johnson, 2017). Self-managed team members benefit from guidelines and structure while maintaining authority in a subset of activities where team members are better equipped for coordinated tasks such as decision-making. As for actually making decisions, models such as recognition-primed decision-making provide more naturalistic options than traditional decision-making models (Klein, 2008). Today's complex and fast-paced world presents the opportunity for such models to serve as alternatives or replacements of traditional models. Members of any team, including a self-managed one, should consider the challenges of traditional models and adopt models they can use to better handle time, change, shifting goals, and uncertainty. The social choice theory presents decision-making options for self-managed team members. Self-managed team members can use social choice theory to resolve situations where preferences among population members cause loops leading to paradoxical states. There are many aspects to consider regarding social choice theory. For example, does resiliency contribute to decision-making and other social functions? Olsson, Jerneck, Thoren, Persson, and O'Byrne (2015) discovered that resilient team members negated constructive collaboration. The natural inclination to replace a manager's decision-making responsibility is to achieve consensus. Team members may struggle to reach absolute consensus (Cabrerizo et al., 2015) or even partial consensus, referred to as soft consensus (Herrera-Viedma, Cabrerizo, Kacprzyk, & Pedrycz, 2014).

Systems of decision-making: Team members can use established systems such as consensus decision-making, voting-based methods, Delphi method, and dotmocracy (allowing members to use a set number of dots to choose and vote for more essential items) to improve group decision-making processes. Team members require a process known as a decision support system (DSS) to execute any of these systems. In a DSS, alternatives can be incorporated into the process. Examples of DSS include gatherings (involving everyone), subcommittees, or participatory contribution (having a say proportional to stake). In this section, we explore these systems and approaches. In consensus decision-making, group members help and participate in finding a decision that best supports group members' overall interest. Challenges arise quickly: What if some members do not agree with the resulting outcome? The group can reach a unanimous agreement, near-unanimous agreement, or full consent instead of complete consensus. Specific complex models (Liao, Xu, Zeng, & Xu, 2016; Pérez et al., 2014) have fuzzy logic to keep members active in the decision-making pool, but using these processes is not easy or in formats that team members can apply to general decision-making situations. The more straightforward options include unanimous agreement minus one or two votes, Condorset consensus or voting (voting on a preference/priority basis), a supermajority (with set thresholds such as 90%, 75%, or 60%), a simple majority, or escalation of the decision to a committee or leadership.

Team members who use the general consensus-based approach share information through active listening and allotted speaking times for each member to allow everyone to be heard. Team members resolve differences through discussion and do not record names for solutions or ideas. If unresolved objections occur, objecting members are allowed to stand aside or block the whole process. Consensus-oriented decision-making, popularized by Harnett (2011), provides a step-by-step approach that members can use to make decisions. Decision-making steps include framing the topic, open discussion, identification of concerns, collaborative proposal building, selection of direction, final proposal synthesis, and closure. Self-managed team members must account for their emotions if they use biomimicking in the decision-making process. Implementing recommendations from Lerner, Li, Valdesolo, and Kassam (2015) will help organizational leaders who are implementing self-managed teams to form a model that includes important methods of directly and indirectly dealing with emotions in the decision-making model. Beshears and Gino (2015) proposed that leaders act as "decision architects" to help handle emotions and biases. As decision architects, leaders change the work environment to trigger the right emotions and biases by simplifying processes or increasing accountability.

Group Decision-Making Aspects and Challenges

Groupthink: Groupthink is a situation that occurs when subgroups of team members drive team decisions that may not include all courses of action (Janis, 1971). Team members may struggle with groupthink and weaken the chance of establishing cohesion, as groupthink can be a significant drawback of self-managed teams. In self-managed teams, the lack of a designated central leader often causes smaller groups of members within the team to use their experience, influence, or personal agendas to overestimate, underestimate, and maintain closed-mindedness. Generally, structural issues within the team, situational context, and high cohesiveness within sub-teams cause groupthink. Lack of team structures and potency can also lead to groupthink. Team members who engage in groupthink negatively affect team cohesion and members' well-being (Markova & Perry, 2014). Paxton (2015) suggested considerations for appropriate design that team members can implement to reduce and address groupthink,

such as the environment, decision-making processes, facilitation, education, and full team involvement. Because self-managed team members may be prone to groupthink, members of self-managed teams should be equipped with strategies to avoid groupthink in the team setup.

Overanalysis: Responsibility for decision-making or lack of a structure to lead to faster decisions may lead to overanalysis - a concept often referred to as analysis paralysis. Kelman, Sanders, and Pandit (2017) researched decision-making processes in the U.S. government and found significant delays in decisions due to overanalysis. In accordance with rigorous existing system processes, decisions follow vigilant decision-making; in comparison, subcabinet executives dealt with latencies caused by overanalysis.

Synergy: Self-managed team members need to find successful decision-making approaches. A factor of team decision-making is members' abilities to use team synergy to make more effective decisions than decisions made by each team member. In organizational terms, synergy occurs when members work together as a group and outperform individual members. Positive team synergy indicates success in the absence of dedicated leaders. Sassenberg, Landkammer, and Jacoby (2014) confirmed that team members who allow personal biases work against group decision-making processes. When team members focus on the specific problem together, they work toward higher synergy levels. Team members can measure synergy levels by establishing an effective process in which team members share information about their backgrounds and their desired outcomes from the decision or group activity. Lack of proper processes to enforce synergy will be augmented in a self-managed team setting.

Cohesion: Team cohesion is a critical factor for successful synergy. As team cohesion increases, interactions and communication levels go up. Team members with cohesion collaborate and coordinate at a higher degree (Gächter, Starmer, & Tufano, 2017). A team model should provide tools to increase cohesion. Used as a measure of team success, cohesion may be apparent in both personal psychology and team psychology. To successfully create team cohesion, team members should consider all relevant factors, including common goals, interests, and member satisfaction. Self-managed team members should integrate these factors into the setup of their teams. Polarization and groupthink can negatively affect cohesion in the team. Self-managed team members can mitigate decision-making polarization risk by using deliberative norms (Strandberg, Himmelroos, & Grönlund, 2017). Deliberative norms are simple rules that members communicate and facilitate within the team. Self-managed team members can use deliberative norms to provide opportunities for discussions instead of arguments to reduce group polarization. When team members exchange ideas, they can express thoughts and opinions, have the proper discussions, and foster true alignment without polarization to make decisions.

Decision-making in self-managed teams

The transfer of authority from leaders to team members differentiates self-managed teams from traditional teams. This difference is noticeable in decision-making events. In an organizational hierarchy accepted by team members, the quality of decisions, the support of decisions, and as such, the performance is high (De Hoogh, Greer, & Den Hartog, 2015). The psychological safety of team members' buy-in provides opportunities for teams to overcome autocratic behaviors like groupthink. In self-managed teams, however, this process does not work. In self-managed teams, team members should replace managers' roles with processes as part of the team setting. One of the team members in each case may assume the role of facilitator to execute the process (Pierce & Horkings, 2016). With the right setting and execution of the decision-making processes, self-managed team members make more effective decisions because they know the job better than anyone else. How can self-managed team members make better decisions? Lim and Lee (2015) discovered that if the team members shared a mental state, the effectiveness of the team and decision-making outputs increased. Team members can share a mental state when they receive appropriate, adequate information and facilitate discussions before decision-making. Cordes (2016) reported that team members equipped with action processes made successful decisions. Action processes include formulation review, coordination, and decision-revisiting. Team members who follow action processes improve performance when they review, discuss, and revisit team decisions. Self-managed team members should refine the decision-making process in their team setting to make better, more inclusive decisions to reach a consensus. Because they share both decisions and consequences, team members can implement shared decision-making by studying the consequences of different levels of the organization (Elwyn, Frosch, & Kobrin, 2015). This model provides opportunities for team members to participate in the decision-making process, as they are directly accountable for the consequences. Organizational leaders may use self-managed teams to foster participation among all members because whole-team participation leads to better performance for processes such as decision-making. The traditional models of team management and decision-making include managers who perform those tasks. The literature review showed a need for implementation approaches that include consequences at personal, organizational, and higher system levels and can provide feedback for better decision-making processes.

Self-organization background: Self-organization occurs when simple rules produce complex patterns (Fisher, 2009). Researchers can observe self-organization at atomic levels up to human societies. In a crystal, atoms align in specific ways. Those crystals then form patterns in seashells. The complex structure of the seashell began with atom formation in crystal patterns that led to a much larger structure. In this case, the primary forces are simple rules of force between atoms. The premise in self-organization is the same, as there is no central director other than simple rules. For a team to become a self-organizing entity, team members should respond collectively to internal and external changes, thus becoming a complex adaptive system. Members of this adaptive system show intelligence when they collectively react to changes in smart and appropriate ways. Swarm intelligence is an emergent property of teams that enables members to resolve challenges and problems in ways that would not otherwise be possible at team-member levels. For collective adaptability to occur, Miller and Page (2009) proposed eight criteria loosely based on Buddhism's path. The eightfold path includes right view (ability to receive and understand others), right intention (a common goal that they all want to achieve), right speech (ability to send and receive information), right action (ability to influence others by doing something), right livelihood (rewarding system; reason for participation), right effort (strategies to work and function with others), right mindfulness (same or similar rationality), and right concentration (ability to focus on the event or the task with the highest priority). Each of the paths can apply to different levels of life forms; for example, humans use languages and body gestures to communicate, and cells in the human body use chemical substances to send messages. Wrong chemicals or wrong words do not work.

Social beings (including many species of animals and insects) generally follow simple swarm intelligence rules as if they are working together or led by a leader or an entity with a different level of intelligence. For example, each fish in a school moves in the same direction as other nearby fish, maintains distance from neighbors, changes direction and follows neighbors when other fish alter their path. Fish use these rules to escape from danger and move toward food or a better location. Team members who make decisions in business settings need more complex processes than just moving together, but the underlying idea is the same. If team members can follow simple rules to lean toward one of the options in a decision-making process, the movement of schools of fish is not far from a decision-making model. Complex mathematics indicates that in responding to questions with definitive answers, the group members as a collective always outperform individuals. Page (2007) presented the diversity prediction theory, which indicates that collective error is equal to average participating person error minus prediction diversity. Therefore, decisions made or actions taken by collective group

members always provide better results with higher diversity. Members of complex societies use simple rules in decision-making approaches for productivity. For example, baboons follow different directions from dominant herd members when the degree of disagreement is high (Strandburg-Peshkin, Farine, Couzin, & Crofoot, 2015). Baboons choose movement paths by using simple voting systems in which they stand closer to the path they prefer to generate a democratic collective action. Group decisions have received centuries of study. Marquis De Condorcet published Application of Analysis to the Probability of Majority Decisions in 1785, in which he set forth what is known as Condorcet's jury theorem. In this theorem, Condorcet theorizes that the quality of the decision-making process does not necessarily improve with the number of voters. The probability that each voter will decide correctly indicates the quality of the decision-making process. If this probability is less than 50%, increasing the number of voters may cause a wrong decision. The theorem described above is the simplest version of the main theorem, as researchers have presented many varieties and applications of Condorcet's theorem (Nitzan & Paroush, 2017). Fisher (2009) presented rules that team members can use to improve decision-making processes and teamwork. Fisher includes approaches for dealing with groupthink, decision-making alternatives, teamwide inclusion, and choosing pragmatism over idealism. For example, members can avoid groupthink by stepping away from the situation to think individually. Also, team members can plan for emergencies so that making rapid decisions becomes simpler due to what team members have already discussed about boundaries, priorities, timing, and exit rules. To foster alignment and stronger decision-making, team members need to equally allocate resources to alternative decisions; investigate alternatives thoroughly before dismissing them; present issues for all team members; study how members of more successful teams approach tasks; and, once ready to decide or vote, choose the most practical method over the ideal method (Fisher, 2009). Once properly established as team processes, these simple rules can guide the team-member level for improved teamwork and quality decisions.

Utilizing Intelligent Swarms

Many interdisciplinary studies have used intelligent swarms to improve their results, with each study expanding on one or a few bioinspired processes or algorithms. Bats, fish, fireflies, cuckoos, bee colonies, wolves, and many other social beings collaborate to achieve complex goals. These social beings act in groups, swarms, or colonies that are a form of intelligence at large. Biologists conduct field studies of intelligent swarm behaviors in long-term research studies, expedited with new findings made possible using the latest technologies, such as video analysis. Applied researchers use these findings in various forms, sometimes in simplified models that scholars in various fields can apply. For example, Luo, Xie, Huang, and Shan (2017) used a simple model of schools of fish, known as the artificial fish swarm algorithm (AFSA), to model a dispatching method for taxis. Karaboga et al. (2014) applied the behavior of bee colonies to a variety of applications for finding the optimum solution and performance increase. Such behaviors can be used in the implementation of self-managed teams. For example, leaders setting up self-managed teams can apply bats' approaches to moving toward their goals in their decision-making processes. Bats live in large groups and use the same simple rules to move around and toward their prey. In a self-managed team, each person should evaluate the choice between options (and, if possible, a binary selection between only two options). As all team members evaluate choices, they find the preferred option and approach a decision. Bats continuously use their method, but team members can discuss at intervals as they collect more information and move toward ideas presented by others; individuals can then consider final results to make the final decision. Certain species of fish move together for food and protection. As in other swarms, fish do not have leaders, yet they act and work together as a unit. Scholars used the AFSA to simplify the complex behavior exhibited by fish in schools. AFSA is "a population-based evolutionary computing technique" that uses social behaviors of fish in schools (Hassanien & Emary, 2016, p. 17). The concept behind AFSA presents an essential aspect of swarm intelligence applied to the study of self-managed team members: different behavior based on the scope of vision. Self-managed team members benefit from different field visions that include the perspectives of others in activities, including the decision-making process. Fireflies exhibit swarm intelligence behaviors when they attract mates and prey or use their flashes as warning mechanisms (Hassanien & Emary, 2016). Fireflies produce short and rhythmic flashes that have various meanings depending on their intensity and frequency. Self-managed team members can use this behavior by offering their stances on a situation. Team members will observe and study other members' points of view and check the relative rational information to vote for another person. Once done, they will review the information and stances of others, eventually selecting the best stance. Different species of wolves present various group behaviors, one being when wolves in the pack divide and separately search for prey. Tang, Fong, Yang, and Deb (2012) introduced the wolf search algorithm to simplify the movement of wolves toward prey. Self-managed team members can use this approach. When team members search for a solution, they can break the problem down into smaller sub-problems, with each member then working on a particular sub-problem. As individuals work on their assigned sub-problem, they keep an eye on others, trusting that team members cover their particular space. When team members encounter issues, they can mark the challenge and find passage around it.

More than 12,000 ant species show behaviors that self-managed team members can use to improve problem-solving. Ants use pheromones to communicate with each other, as each leaves a trail of pheromones as it forages for food. Eventually, the shorter or more successful path to food receives more pheromones and becomes the preferred choice. Dorigo and Gambardella (1997) were among the first to demonstrate how we can use this behavior to solve optimization problems, such as the traveling salesman problem (choosing the shortest route to travel between a few destinations). The researchers presented a communication mechanism with decision-making and usage of experience. Self-managed team members can act as ant colony members by simulating the knowledge, experience, exploratory results, and lessons learned from past situations. Ants communicate their preferences after walking a passage; team members can use the same concept to propose an option or weigh in on a concept offered by others. Dorigo and Stützle (2019) used applications of the Ant Colony Optimization to solve scheduling problems, vehicle routing problems, and assignment problems (pairing items based on particular conditions and desired outcomes). Ant colony optimization approach uses two elements to determine the probability of a certain choice: accumulation of pheromones on each option and visibility of success. The comparison between the ant colony optimization-based approach in solving selection decision-making processes and traditional approaches had over a 95% success rate (Ghasab, Khamis, Mohammad, & Fariman, 2015). When self-managed team members reach a decision-making point or need to generate options, team members can use lessons learned and experience to make a selection in the same way ant colony optimization shows passage preference based on pheromone accumulation. Ants' visibility of their surroundings translates into organizational knowledge, personal knowledge, and knowledge gained during the performance of the current or recent tasks.

Honeybees display behaviors that self-managed team members can apply when dealing with challenges. They work with each other in various ways, but similarities in their foraging behavior and finding nests, with what team members in self-managed teams need to do, are in abundance. Self-managed team members can use these approaches to start exploiting solutions along with further exploration, depending on the underlying problem at hand. Self-managed team members can also learn from how bees explore options. Self-managed team members can apply bee behavior when making decisions and when choosing the team's next important task, as an example. Team members choose the right next step while seeking the next activities. Although bees work as swarm and follow the next best move, they benefit from the skills and experience that each bee brings to the

situation. The main decision-making difference between bees and humans is how bees use their experience (cognitive knowledge) but update their points of view when they learn about the latest food or nesting options (social knowledge). For leaders to establish their teams based on the learned disciplines of nonhuman social beings and intelligent swarms, members should exhibit the following behaviors that if not already inherent can easily be trained to do:

- Understand the overall team function, goals, and required tasks.
- Respond to internal and external changes collectively.
- Understand and plan for emergencies.
- Understand the equality of all members and feel comfortable opining in team activities.
- Know about end goals and periodically check for internal or external system changes. Team members strive to stay in alignment with other team members. In this way, team members can make small corrections to stay on track.
- Understand that, due to different frames of reference, certain team members may need more time to reach the same level of understanding. They should collaborate to reach the same degree of understanding or move in the same direction in thought processes. Team members with closer points of view and those with different ideas should consult with each other frequently.
- Iteratively share information and communicate changes.
- Because team members may have different perspectives, members should constantly transfer knowledge to ensure information distribution.
- Consider team members' experience, organizational knowledge, and lessons learned from past tasks and prioritize and validate options presented through experience.

In addition, team members must follow a series of steps in making a decision. These are:

- Break down the problem into smaller sub-problems with few and preferably binary options and discuss the best choice with all team members. Team members will continue to solve other problems until they find a clear solution to the main problem.
- Communicate alternatives and discuss choices iteratively to reach a stronger acceptance of the decision.
- Discover and present potential solutions and invite team members to explore solutions. Team members should advocate for the strongest solutions, regardless of who first presented them, checking other solutions with open minds.
- Divide into sub-groups to find different potential solutions if team members cannot find clear alternatives. Team members exchange sub-groups to trigger innovation.
- Opine on selected solutions and change parameters to discover a potential stronger solution variation.
- Once team members select a solution, they continue to explain the approach to others who do not understand or were not able to take part in the discussions for any reason.

Conducting the research

Each team in this study was considered a separate case. We had three teams in the study, which we simply called Case A, B, and C. The interview protocol had 14 simple open-ended questions about how participants described their work in the self-managed team they worked in. There were questions about their perception of success in a team, their experience working in a self-managed team setting, and mostly how they worked with each other, making decisions, comping up with plans of execution, and executing those plans. The triangulation, at least from the company's point of view, was through the Key Performance Indicators (KPIs) provided by the project management office, responsible for project metrics.

FINDINGS AND DISCUSSION

The learnings from social beings provided nine behaviors for teamwork and communications processes. For the decision process, six behaviors were mapped to decision patterns. In the following sections, we review the findings and provide interpretations based on participants' feedback and the company's KPIs.

Experience: The theme of experience is related to team dynamics and the teamwork element of the conceptual framework. On experience, team members in Case B are all experienced working in self-managed teams. They are also all experienced with the company and its processes. Case C and Case A follow Case B, in that order. Other indicators measured in the study, like previous experience and experience joining the self-managed team between the three cases, are too close to use for comparison purposes. Team members in Case B meet all their KPIs. Case C follows, meeting customer expectations and business goals but only partially fulfilling their delivery and claim-to-commit KPIs.

Self-Managed Team: The self-managed team theme is directly based on the self-management element of the conceptual framework. Comparison between Tables 7 and 12 shows that success in implementing the team with better results is not related to how participants described their self-managed team's success status. Comparing the benefits feedback across the three cases shows similar decision-making improvements, but team members in Cases A and B worked more effectively than Case C. Teams also differed in how team members considered personal value. All team members in Case B saw personal benefits in the self-managed team, which can be linked to their success in achieving the organizational KPIs more consistently. Full participation by all team members is a theme related to the self-management construct in the conceptual framework. On valuing participation, swarm intelligence is possible when all members participate in serving higher goals like survival. Absolute participation is a more complex problem for team members due to differences in personalities and other available options. However, implementing a self-managed team creates a level of autonomy and freehand in decision making, to the degree that they are motivated, engaged, and want to stay and contribute. Observations showed that Teams B and C show a stronger participation value (20% more than the team in Case A). As a result, they have a higher sense of belonging and a slightly higher sense of success in the context of self-managed teams. This description helped the team in Case B meet its KPIs and helped the team in Case C connect to its customer base to set the right expectations and achieve customer satisfaction. On the personal side, all team members across the three cases indicated they are satisfied by their work and motivated to do better as a result. Members from Cases B and C also mentioned they were growing at a personal level, and they have observed much higher employee retention as a result. As data analysis showed, team members in Case A have more issues and drawbacks than Cases B and C, confirming more successful outcomes for those teams. Team members in Cases B and C showed higher participation, which is a key biomimicking behavior, aligning and confirming the confluence of the emerged research pattern and biomimicking behavior.

Core Process: The core process theme includes elements required for performing the team's jobs, related to teamwork construct of the conceptual framework of the study, building on stages of teamwork (Tuckman, 1965). On awareness of goals and responding to changes, teams in all three cases follow the biomimicking behavior of understanding the goals with a slight difference in using them within their process. There is no KPI for understanding the goals. Team members in Case A focus on their current goal. When a change happens, they must redirect their efforts to handle the change. This finding aligns with performance results for Case A, as they do not fully meet the business goals and customer satisfaction. In Case B, team members have a structured approach to goals as they break it down from overall goals to user stories that they work on, and at the same time, they monitor a wide range of changes. Team members in Case B meet the business goals and customer satisfaction KPIs.

The planning theme is related to the self-management aspect of self-management in the conceptual framework. On planning, the results indicated that team members in Case B do more planning and engage

in preplanning activities. Biomimicking behavior from intelligent swarms indicates the importance of understanding the plan by everyone, especially when there is an emergency change. Although all teams engage in planning activities, a higher level of engagement indicated by participants in Case B and the preplanning activity has helped the team achieve KPIs of delivery dates and Claim-to-Commit. Alignment and collaboration themes are directly related to the teamwork theory aspect of the conceptual framework of the study as they contribute to team dynamics and how the team will be able to go through various stages of Tuckman's (1965) model. Alignment and collaboration are two of the traditional teams' constructs, but a self-managed team should have been implemented so that these functions can work without the supervision of a manager. Most of the team's input consists of goals and objectives. These get communicated to the teams in the study in the form of customer problems. The implementation of a self-managed team in the participating company makes it clear that the responsibility of solving the problem is with the team members. Once the problem is understood within the context of the team, team members commit to delivering the solution to the problem. That commitment and responsibility are understood across the three teams in the study. Besides the responsibility, participants in Case A indicated a strong sense of trust between team members. They work with each other to get to an agreement. In other cases, there are team dynamics such as a sense of ownership and cohesiveness, so team members work together to come up with solutions, plans, and delivery. Collaboration happens through various communication forms, but in essence, team members gather in a physical or virtual room to discuss the problem. A major difference between traditional teams and self-managed teams in the participating company is facilitation. At each stage of problem-solving, a lead role facilitates discussions. This feedback to other team members and playing the facilitator's role aligns with similar behaviors in intelligent swarms, with members closer to the external change initiating the call to action. The team learning theme is a key construct in the conceptual framework of the study related to social learning theory (Bandura, 1979). On learning, all the teams in the study follow the review and retrospective processes and meet after each work cycle to review how they did and evaluate their performance. This approach aligns with the biomimicking behaviors of learning lessons from experience. In reviewing KPI as all the teams follow this process consistently, no case-specific conclusion can be provided.

Communications Process: Communication is the underlying theme in the conceptual framework of the study, connecting teamwork theory, self-management, decision, social choice, self-determination, and sociobiology constructs together, enabling accomplishing tasks to go beyond each team member and towards a team. On communications, constant sharing of status and information is a repeating biomimicking behavior. Members of intelligent swarm constantly monitor their surroundings and react to changes. Others follow a change initiated, and as a result, swarm behavior appears. In the view of participants in the study, communications happen for reasons such as sharing, participating, establishing a cadence, visibility, and de-risking. Case B had the highest frequency of official communication points between the three cases in the study, and Case C has the least. On the variety of roles, important for communications to happen in between, Cases A and C have wider communication points. Combining these two findings, team members in Case B benefit from more focused and more frequent communication as it has helped them meet business goals and customer satisfaction. In Cases A and C, the wider range of roles means they must work with more people, showing that their type of work requires having more communication points leading to missing some business goals. Team members in Case C exceed customer expectations that can be interpreted as a customer-oriented mindset as they give priority to visible issues to customers but miss other goals. In the conclusion of teamwork and communication processes, a closer implementation and following of biomimicking behaviors have led to more team success. Team members in Case B match with more of these behaviors, and they succeeded in meeting all their KPIs and exceeding in few. Team members in Case C focus on customers and have been establishing processes that help them achieve business goals and customer satisfaction KPIs but only partially meet delivery and Commit-to-Claim. They can increase their planning efforts, change management and responsiveness, and internal communications to overcome their challenges. This approach applies to team members in Case A, but they also have to increase their external communications and manage expectations.

Decision Process: Autonomy to make teamwork-related decisions is a fundamental attribute of self-managed teams. Intelligent swarms make decisions fast and effectively by applying the processes. The decision process consists of breaking down a large decision into smaller ones, subgroup to understand all aspects, discover as many options as possible, discuss the options, participate in discussions and opine, make decisions, and strengthen it by reviews and learning. Not all these components may be done on the same decision depending on how much team members know about it, if there is missing information, or if the team has made similar decisions before. The following sections provide an interpretation of findings on these components. All aspects of the decision process tie back to decision theory and social choice theory in the conceptual framework as team members share their thoughts and experiences in the form of options to make decisions, as well as teamwork theory as the team members review available paths to solve a challenge while going through various stages of team building towards normalization stage (Tuckman, 1965). Team members in Cases A and C indicated they encounter decisions that they had to break down into smaller pieces, more than members in Case B. This difference is because team members in Case B do this by transforming goals into smaller steps, and when it is time to decide, they already have user stories to look at instead of a big unknown problem. If they have a bigger problem to solve, they bring it up in their daily meeting, and the whole team participates in the discussion. In Case A, breakdowns happen internally, whereas in Case C, they consult with external stakeholders. Regarding dividing teams into subgroups, all teams in the three cases subgroup to discover missing information, but the difference is that in Cases A and C, this is done by role, meaning that the team members with specific roles like developer or designer take a problem away and try to solve it however in Case B team members discuss it at the team level.

On discovery of options, each team in this study perform sketching sessions to help them visualize what the results should resemble. They brainstorm and engage in short round sessions that help them to come up with many ideas in a short time. In Case C, team members performed an extra step and check the competitors' designs to see how they can learn from them. On discussing and opining options, all teams have free-form conversations as they review aspects of what they need to decide. These discussions are facilitated by one of the team members, depending on where on the process the team is. For example, in the beginning, the product owner facilitates the discussion while communicating the customer's problem. After that, a system analyst or business analyst will facilitate so team members can develop an approach. Next, a designer will facilitate so they can come up with design ideas. In many cases, team members reach a consensus, and there is no need for voting. Team members in Cases A and B use a simple voting method to choose one option. If they can choose more than one item (for example, they can start working on three user stories and want to vote for the priority among the next ten items), they use a multi-vote method. Using an online tool or a whiteboard, team members get two or three votes, and they spend their votes on what they think matters most. Team members in Case C give priority to the roles in voting. For example, it is up to designers to choose a design unless they want to consult with the team. In Case A, team members encounter personal challenges like disagreements and attachment to one's ideas. They have methods to encounter for each type of these issues. On the technical side, if there is missing information, they collect it from the input source like business unit lead or customers. Team members in Case B have been able to resolve their personal challenges in the decision-making process, so they remain focused on technical aspects. They ask each other to support the claims by data, and if there is missing information, they strive to find out. In Case C, team members also look for data to

support discussions. When making hard decisions, they try to de-risk it by running it to fail or succeed as early as possible, so they have time to correct it. These slight differences in Cases A, B, and C have led to different KPI results. Many of the KPIs are missed in Case A because they do not prepare for emergencies and have to overcome personal challenges in the decision-making process. In Case B, they do not miss on external changes and are ready for them. They do preplanning, which helps them be more realistic about their commitments, and they have already figured out to work as a team. This approach can be related to their experience as the most mature self-managed team across the three cases in the study. In Case C, team members face similar problems as Case A, but their approach in finding drawbacks of their decisions sooner and closer collaboration with customers gives them an advantage on business and customer satisfaction KPIs, even though they miss delivery dates and claim-to-commit indicators.

Limitations of the Study: Case studies are generally limited to the specific case in the study. Although a multiple case study provides more context and enables comparison and deriving richer conclusions, it is still bound to the specific context of the scope of the cases in the study. Another limitation of the study is the lack of comparison between implementing the self-managed teams in the participating company and other companies that have done the same. The research is also limited in supporting previous research on the interdisciplinary view of self-managed teams and biomimicking behaviors. Access to participants was limited to those working in target self-managed teams and only team members who chose to respond. Concerns of privacy, confidentiality, and openness to discuss all topics were reviewed with participants through the interview process, but the study is limited in validating the depth and totality of feedback provided.

RECOMMENDATIONS

This study appears to be the first of its kind in the interdisciplinary field of self-management and sociobiology. This originality presented itself as a limitation of the research in lack of similar studies but provided many opportunities in future research. The findings showed an alignment between successful self-managed team practices with intelligent swarm behaviors, which open a whole new field and future research possibilities. Like any research, this study started with a passion for seeking the possibility of learning from nature. History is full of lessons humans have learned from observing nature and even the behavior of social beings. At the beginning of the research, the question was to see how we can learn from the behavior of social beings in management. We went through an exhaustive process to narrow down the scope of the research to achieve the quality of findings within an acceptable timeframe. The areas that were excluded from the research can guide future research. Implementation of self-managed teams varies across different companies as it depends on many different factors, including decisions on decentralization, level of self-management, applying required changes (Lee & Edmondson, 2017). For that reason, scholars either have provided high-level guidelines (Liff & Gustavson, 2016) or elaborated particular areas of interest in self-managed team implementation like leadership style (Stewart et al., 2011) or success (Wageman, 2001). This study set a new source of simplifying the variances that the organization's leaders will have to decide when implementing a self-managed team by following behaviors exhibited in intelligent swarms.

The findings of this research described the decision-making process in self-managed teams in one particular company. Findings are as such that the closer the behaviors of biomimicking were followed, the better results were achieved. Although the study findings contain new insights into other processes of teams, such as communications, collaboration, and alignment, future research should consider studies focusing on other processes, including elements of team dynamics like trust or cohesiveness of team members. This research was directed towards teams in an I.T. company in Toronto, Ontario. Simple replicating the research in other I.T. hub cities in North America or other continents can extend the understanding of effective self-managed teams. A comparison of those results with the findings of this study can provide new insights into the effects of geographical locations or cultural backgrounds. Similar research can be done in industries other than I.T. to see if biomimicking behaviors can improve self-managed teams.

The approach and research design for this study was a qualitative descriptive multiple case study. Other research designs may be more suitable depending on the types of self-managed teams. For example, a service company with many small self-managed repair teams can be studied using a quantitative approach with variables such as service duration and hours of experience. This study was done in a company with self-managed teams already implemented. The purpose was not to compare the states of KPIs before and after the implementation of self-managed teams. Possible future research can be to study the state of KPIs as team members transit through the implementation. Such a study will help to guide for transforming a traditionally-managed team into a self-managed one. This research described some of the drawbacks that occur due to working in self-managed teams, including disagreements, groupthink, and fear of making wrong decisions. Although the findings of this study guide to avoid these challenges and resolve them when they happen, a recommendation for future research is to focus on these drawbacks and research how biomimicking can benefit towards overcoming these particular issues.

The background and experience of organizational leaders can be a major factor in the implementation of self-managed teams. One finding in the research was that groupthink was a challenge in discussion but no more than traditionally managed teams. Team members pointed out that dealing with specific problems such as groupthink requires responsible leaders for the implementation of self-managed teams to be familiar with this issue and provide avoidance process for it; however, many of these leaders may not have the background to know its effects as they normally rise in ranks from technical backgrounds. As a result, future research on leaders' backgrounds and experiences who implement self-managed teams may provide insights into this matter. New biomimicking behaviors may help extend the recommendations of the implementation of self-managed teams. Seeley (2010) started his research on the honeybee decision-making process years before new video technology enabled him to find the underlying approach bees follow to make decisions and move the colony towards the new nest. Field researchers will continue to discover new behaviors that may be useful for self-managed teams or other management aspects.

IMPLICATIONS

Methodological and Theoretical Implications

The gap established and elaborated in the literature review of this study was the lack of guidance in implementing self-managed teams in processes like decision making. The findings of this study contribute to fill the gap in the implementation of decision-making strategies in self-managed teams and help establish an interdisciplinary field that sets biomimicking as a learning source for management. The results of this study appears to contribute to research to understand group behavior between humans and social beings (Tindale & Kameda, 2017). Biomimicking behaviors were constantly present and helped to improve the successful outcomes of self-managed teams in the study. The study's findings show that following biomimicking behaviors by members of self-managed teams improves their work experience and outcome. The descriptive multiple case study provided the right approach to establish biomimicking behaviors as a source for successful team behaviors. Principles of social-determination theory (Deci & Ryan, 2012), social learning theory (Bandura, 1979), and social choice theory (Arrow, 2012) structured the framework to look for behavioral learnings in intelligent swarms. These behaviors were based on Wilson's sociobiology theory. The results contribute to the social determination

theory on how team members are motivated to participate and benefit from their autonomy in the implementation of self-managed teams. It strengthens social choice theory in reaching consensus in self-managed teams and de-risking the decisions by being open to revising if needed when the early feedback results become available.

RECOMMENDATIONS FOR PRACTICE

Organizational leaders may use the results of this study to implement self-managed teams in general, and specifically, the decision-making approach. The findings showed that members of self-managed teams handled challenges of working in such teams easier if their established team practices closer to biomimicking behaviors. These behavioral learnings can be simplified in response to team members' challenges, from technical/work perspectives to team/personal challenges. Biomimicking behaviors presented in the study for the successful self-managed team also support Ginnett's team leadership model in achieving a high-performance team (Hughes, Ginnett, & Curphy, 2009) and can provide an approach to implement such teams. Ginnett's model provides components for establishing a high-performance team, including outcomes acceptable to stakeholders, the satisfaction of team members, and improvement in the future capabilities of the team. The biomimicking behaviors presented in this study support all of these components, plus they can be used to establish guidelines to implement self-managed teams and resolve their challenges.

Social Change Implications: The findings in this study showed that the implementation of a self-managed team closer to biomimicking behaviors could lead to personal motivation, satisfaction, and loyalty. 80% (4 of 5) of team members from Case A, 100% (4 of 4) of team members from Case B, and 60% (3 of 5) of team members from Case C directly mentioned satisfaction, personal growth, higher retention (loyalty), and motivation as a direct benefit of working in a self-managed team. Team members in Case B led others in following biomimicking behaviors, achieving consistency in member KPIs, and delivering on projects consistently. More success and consistency in teams that follow biomimicking behaviors will enable team members to manage challenges, collaborate within the team and outside of the team with other business units and customers, speculate the upcoming changes, and organize more effectively. Implementation of self-managed teams using biomimicking behaviors is simple, such as the behavior of social beings that inspired them. These achievements may stimulate leaders of other teams within the organization or other organizations to implement biomimicking self-managed teams. Achieving more goals and objectives will enable organizational leaders to align resources better, amplify organizational and personal achievements, and may lead to positive social change. At a personal level, satisfaction and growth will lead to a healthier state of mind for team members, inspire more work innovations, and improve work/life balance. This state will have positive effects on the larger scale of families and society. At the organizational level, having a simpler and more successful approach in implementing a self-managed team will inspire more leaders to adopt such teams in their organizations. It will help overcome the challenges that have slowed the implementation of self-managed teams (Lee & Paunova, 2017). Organizational leaders will anticipate the challenges, facilitate the implementation of self-managed teams, and validate the decisions earlier and faster. These improvements will lead to saving limited organizational resources. From an educational view, this study may inspire business schools to consider a new perspective in management practices inspired by nature and provide organizations with new methods to manage complicated situations using simple rules of biomimicking behaviors. This awareness will allow institutionalizing the approach as an advanced yet simple method of setting teams and organizations for success. With increased public knowledge about the benefits of biomimicking self-managed teams, organizational awareness on the societal level will increase and contribute to solidifying issue preventions (Simard & Lapalme, 2019). Higher appreciation of organizational and personal outcomes may lead to larger-scale positive social change.

CONCLUSIONS

Organizations have suffered from the low performance of teams that have led to low levels of satisfaction, motivation, growth, and lower rates of employee retention. Organizational leaders apply various approaches to stimulate members of their teams and increase performance and outcomes. Self-managed teams have been implemented as one way of more participation, inspiration, and performance, but the adoption rate has been slowed down due to common challenges that team members encounter. The success of self-managed teams depends on how it is implemented within the organization, but traditional methods applied along with previous research results provide inadequate guidelines that are high level and do not address the challenges directly. This research approach was based on social choice, social learning, self-determination, and sociobiology theories to provide a new approach to supporting self-managed team members in encountering challenges of working in such teams. This new biomimicking self-managed team implementation will allow organizational leaders to have simple guidelines in the form of proven biomimicking behaviors to apply in their teams' implementations and benefit from higher personal, team, and organizational outcomes. Employee satisfaction and retention will enable the organizational leaders to plan their limited resources better and advance their contribution to positive social change. Our study's findings may help reshape how teams and companies are organized as the units of performing activities towards high-performing teams, learning, and satisfaction at personal, organizational, and societal levels. We hope that this unique and unprecedented approach in the implementation of biomimicking self-managed teams inspires further studies of potential opportunities in this interdisciplinary field.

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