

What Leadership Styles and Characteristics Do Industry Partners Need to Exhibit to Produce Positive Outcomes from Collaborative Projects that Include Government and University Partners?

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Collaborative projects that include multiple organizations are organized to efficiently solve complex problems that are beyond the scope of a single organization. This Research Question Review presents information on how industry partners on team science projects can support collaboration. While there is considerable research on collaboration, there is a gap related to the leadership contributions that industry partners bring to team science projects. This review paper systematically examines leadership styles and characteristics that could be practiced by industry partners that contribute to collaborative research.

Sponsors from many government organizations recognize that collaboration among government, academic, and private sector researchers has contributed to the solution of complex problems. The diversity provided through collaboration is one factor attributed to achieving project success. The ensuing partnerships and networks provide the foundation to share information and resources that foster discovery. However, the conduct of

collaborative research can be complicated by differing organizational cultures.

Research from various disciplines indicates possible approaches to collaborative leadership. This study uses servant leadership as a framework to better understand leadership styles, characteristics, and skills that industry partners can apply to promote collaborative success. Results from this research suggest the importance of keeping the team on target while ensuring that partners accomplish goals in accordance with the vision. Selected servant leadership characteristics and skills that industry partners can exhibit while working with partners from govern-

ment and academia are explained.

Findings indicate that the facilitation skills common among industry leaders are essential to support a university-industry-government partnership project. Industry partners are well suited to support collaboration while avoiding competitive practices that might otherwise complicate the achievement of project objectives. Industry partners can be more nimble owing to fewer bureaucratic layers.

Collaboration projects involving industry, university, and government partners are complex. Project success is challenged by hierarchical leadership. Roles become confused if viable collaboration techniques are not practiced. Issues such as competition and hoarding knowledge hinder collaboration. A servant leadership style promotes effective collaboration.

Keywords: collaboration, empowerment, hierarchical leadership, innovation, servant leadership, systematic review

Large-scale research projects that are usually funded by national governments benefit from the expertise provided by government, academic, and private sector partners (National Research Council, 2003, p. 45). Despite the differing cultures of each organization, a collaborative team might be formed once a group of scientists determine that they cannot solve a challenge alone and once each potential participant shares a common desire to advance understanding and applications regarding the challenge. Collaborative research requires cooperation not only among the partnered organizations, but also among multiple disciplines and functional areas (Iversen et al., 2020; Klein, 2017; Lee & Jabloner, 2017). The real collaborators are the individuals that form the team, and together they have more potential to generate and apply knowledge than the individual researcher. Collaborators from the different organizations share resources, responsibilities, and risks.

This systematic review explores the science of collaboration to better understand leadership characteristics and industry roles in a collaborative. Specifically, this research examined extant scholarly literature to identify leadership styles and characteristics that industry partners might demonstrate to support collaborative research projects. This study collected high-quality data from articles using systematic review procedures that are documented by the Center for Evidence-Based Management (CEBMA). The resulting 26 articles were analyzed, and findings were categorized into themes related to accountability and trust, learning, emotional intelligence, communications, empowerment, shared vision, and stakeholder engagement. Qualitative analysis of the literature provided consistent evidence that industry leaders can improve collaboration success by supporting the team building process, looking out for the well-being of others through coaching, bridging boundaries, and encouraging partners to develop and explain their own work. Leadership characteristics associated with servant leadership help generate social capital and cohesion by effectively building teams across varying cultures. The reduced hierarchy offered by servant leadership provided the highest chance to solve complex scientific and social challenges.

Collaborative projects may be established for a variety of reasons but tend to be focused on solving complex scientific issues or social problems (Maienschein, 1993; Sirman, 2008). These projects benefit from the integration of different organizations and disciplines (Yu et al., 2019). They are best used to organize committed partners to resolve grand chal-

lenges since progress on these fundamental problems is not efficiently accomplished by the independent researcher or those working on the assembly line. When the project is complex and demanding, researchers benefit from a team where knowledge, tools, and new modes of thinking are combined to achieve mutually agreed upon goals. Collaboration leaders, who may emerge during the project, provide a process and the means for researchers from differing organizations and disciplines to contribute their resources and expertise to meet goals and objectives.

In a team science project, one finds differing organizational cultures among the cooperating organizations (National Research Council, 2015, p. 10). Government cultures may be characterized by service, stewardship, and lawmaking while university cultures are characterized by knowledge creation, autonomy, and open dissemination. In general, university departments are more focused on individual achievement and recognition (Smith, 1992; Sporn, 1996). Research project grants are often awarded to one university principal investigator who works with subordinates. Industry cultures focus on meeting customer requirements through product sales

and services. Industry partners may seek to gain competitive advantage through partnerships and provide a direct complement to academia by engaging faculty and students with applied research opportunities.

Interactions among the groups in a collaborative create new challenges for government program managers, university principal investigators, industry managers, and even the users of the knowledge and capabilities that are being developed. Differing motivations by team members from these varying cultures may lead to misunderstanding and conflict during a partnership project. Collaboration leaders who have the skills to mitigate such conflicts are essential to project success. The importance of collaboration leadership or the management of teamwork and the avoidance of pitfalls is put into context by Cross et al. (2016).

Maintaining a collaborative environment requires effective leadership to overcome many potential conflicts. Sinha et al. (2018, pp. 281 – 282) identified challenges such as the perception that time was being wasted, the failure to utilize expertise properly, and the unequal distribution of work. Other examples found in the literature addressed factors such as commercialization and patents, which were categorized as information privacy (Barbic et al., 2016; Martinez-Noya & Narula, 2018). One might mitigate these threats by maintaining accountability, a factor

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which has been shown to increase team-oriented behavior (Giessner et al., 2013). Huffman and Benson (2021) discussed the importance of business leaders in research. The role of industry to resolve complex problems is evidenced by Kalirai (2018), who described business roles that included international collaboration to develop the James Webb Space Telescope. While collaboration leaders recognize benefits from other organizations, disciplines, and functional groups, they can inspire accountability among the partners. Industry leaders work toward maintaining competitive advantage by optimizing team performance, which often involves facilitating cooperation among functional managers and project managers. Team members gain important insights from cross-functional coworkers.

Numerous researchers (Koçak, 2019; Rosenman et al., 2016; Stincelli, 2016; Xie et al., 2018) find factors such as trust between leaders and team members to be essential in activities that foster innovation. For collaboratives, trust has been shown to develop from empowerment that includes the provision of necessary support and resources (DeHart, 2017; Oliver et al., 2018). Collaboration leadership involves building trust, creating common understandings, effective communication, and reducing competition. The collaboration leader impacts outcomes by directly influencing team inputs (e.g., implementing training, leveraging expertise, team building) and processes (e.g., ensuring co-production and sharing vision, resources, knowledge, and rewards). Collaborative leadership engages partners in ways that result in better relationships among project participants and stakeholders.

Collaboration leadership should involve processes that include establishing and maintaining a viable government, academic, and industry partnership by avoiding culture clashes (Crane, 1998; Gilbertson et al., 2019; Yu et al., 2019). Communications mitigate conflicts by clearly identifying benefits to each organization. Guiding principles might cover shared leadership, co-production of deliverables, co-authorship of publications, mentoring, and shared recognition. This knowledge supports team building and fosters collaborative behaviors among the partners despite their organizations' differing approaches. By simply sharing recognition and rewards, an approach that is demonstrated by many successful corporations, the collaborative can build commitment (Luthans, 2000; Kuczmariski & Kuczmariski, 2019; Owen et al., 2008; Thibault-Landry et al., 2017). Interestingly, Moser and Wodzicki (2007) reported that cooperation is increased when rewards depend on the work of other partners. These types of egalitarian factors combine to develop and sustain the partnership.

Successful partnering brings multiple perspectives to bear on difficult problems. Towards this knowledge sharing, information technologies, and networking

Protocol

A systematic review was conducted to answer the research question. A Rapid Evidence Assessment (REA) was accomplished using guidelines published by Barends et al. (2017). The final collection of 26 articles was selected based on the articles' transparency and rigor. Codes were extracted from the articles and thematically analyzed. Results were synthesized to yield findings. This qualitative approach integrated multiple research findings from numerous studies, a method which mitigates erroneous inferences from the analysis of a single investigation (Harden & Thomas, 2005). A search string and respective inclusion/exclusion criteria was developed using keywords based on the research question. The following simple search string was initially used to find peer-reviewed articles published from 2016 to 2021:

“team science” AND collabor*

The asterisk (*) was used as a wild card to capture various forms of the word *collaboration*. The searches resulted in 94 articles which were screened for accessibility and relevancy. During the screening process seven of the articles relating to team science and collaborative research provided citations for work related to collaboration leadership styles and traits. Using the reference lists from these articles helped in the selection of relevant work despite being a time-consuming process. The use of snowballing is considered a complementary approach for the systematic review of scientific literature and generated a total of 19 articles (Greenhalgh & Peacock, 2005). This REA employed a total of 26 articles as indicated in Figure 2. The articles were critically appraised for quality and relevance through application of the TAPUPUS method (Pawson et al., 2003). TAPUPAS provides a checklist for assessing and scoring the quality of the articles according to seven components (Transparency, Accuracy, Purposivity, Utility, Propriety, Accessibility, and Specificity). Of the 26 articles, only five were rated as having lower quality but were retained for the study since they provided information relative to answering the research question. Evidence was extracted from (6) quantitative, (4) qualitative, (1) mixed-methods, (4) case studies, and (11) review articles. Primary findings from each of the articles are consolidated in Table 1. The articles were then coded using a thematic approach from the perspective of managers, principal investigators, and senior leaders. The summary of the included literature on leadership styles and traits that enable industry partners to produce positive outcomes from collaborative projects is explained in Table 2.

capabilities provide an essential resource to mitigate collaboration challenges while benefitting from the collaborative (Cui et al., 2015; Whitfield, 2008). To emphasize the value of communications, collaboration leaders need to ensure that information is generated, received, and understood. This can only be accomplished by understanding the channels of communication that exist within and between partnered organizations.

Management research helps to better understand best practices related to leadership styles, characteristics, and skills in the collaborative environment (Boyer et al., 2019; Koçak, 2019; Mousavi et al., 2019; Shani & Coghlan, 2018; Zhang et al., 2018). Beyond appreciation for each partner's contributions, culture, and communications, certain leadership styles and characteristics have been shown to be better than others in helping the team to achieve its goals. Roles such as facilitation might be particularly useful for industry partners who are more adept at transferring basic research results to operations. This facilitation would support the exchange of ideas, the integration of knowledge among all partners, and the co-creation of products.

The Project Management Institute (2021) highlighted numerous leadership styles (e.g., assertive, autocratic, autocratic to consensus, democratic, directive, laissez-faire, participative, and supportive). In practice, one needs to know when to employ which type of style. Further, leadership characteristics for industry partners in the collaborative are not well defined in the literature (Boyer et al., 2018; Hall et al., 2018; Huxham & Vangen, 2000, p. 1160; Love et al., 2021; Shani & Coghlan, p. 40; Tang et al., 2018). For this reason, the associated research question is:

What leadership styles and characteristics do industry partners need to exhibit to produce positive outcomes from collaborative projects that include government and university partners?

Servant leadership provided the lens through which our research was conducted. The Project Management Institute (2021) defined servant leadership as the practice of leading the team by focusing on understanding and addressing the needs and development of team members in order to enable the highest possible team performance (pp. 17 – 18, 50, 250). Skills of importance include facilitation or encouraging project team members to participate, collaborate, and share work outputs. Collaboration leaders who apply servant leadership characteristics create consensus around solutions and resolve conflicts.

If an organization wants to form a collaborative, it can follow Greenleaf's (1977) theory of servant leadership, viz., the servant leader puts the well-being of collaborators and the organizations or disciplines that comprise the collaborative before his or her own needs. Figure 1 lists the ten characteristics of the servant leader as described by Spears (2010). Coetzer et al. (2017, p. 6) reported eight similar characteristics of the servant leader: authenticity, humility, compassion, accountability, courage, altruism, integrity, and listening. Langhof and Guldenberg (2020) highlighted positive individual and organizational outcomes from servant leadership and advised the hiring of managers who exhibit these attributes. Many industry leaders promote servant leadership out of concern for workers and customers and interest in achieving and maintaining customer loyalty. Figure 1 presents a servant leadership diagram that provides context for collaborative leadership.

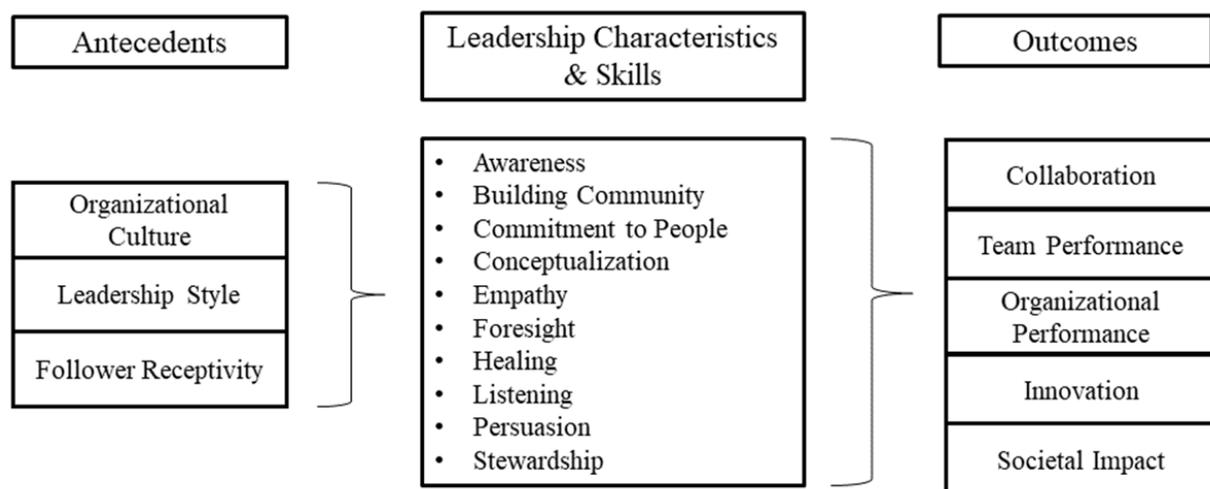


Figure 1. Generic servant leadership conceptual diagram. Servant leadership research defines selected antecedents, characteristics (moderators and mediators), and outcomes which could be applied by collaboration leaders. Adapted from Eva et al. (2019, p. 122).

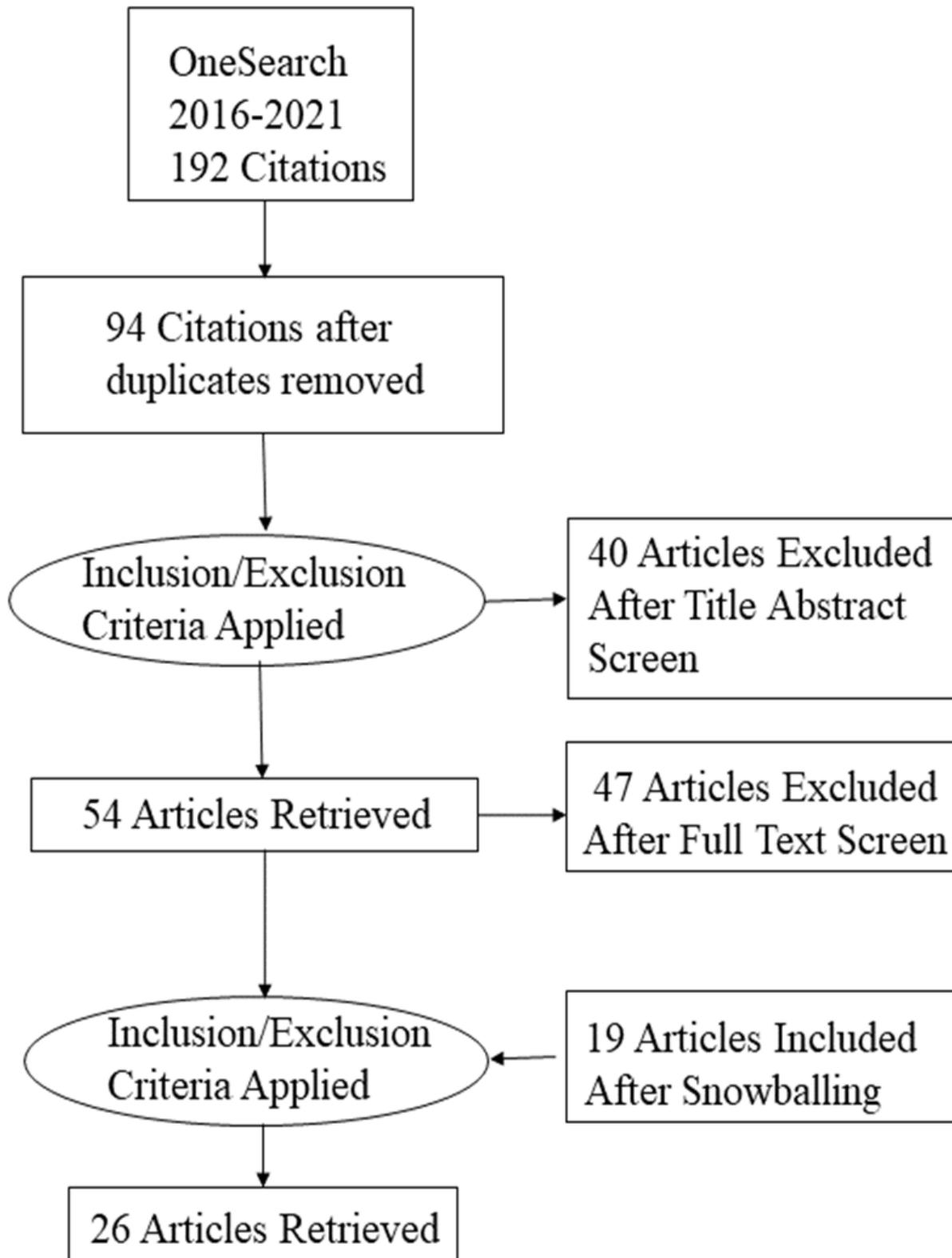


Figure 2. The PRISMA chart. This graphic depicts the flow of information through the different phases of this systematic review. Adapted from Page et al. (2021).

Table 1: Main findings from the literature

Finding	Sources
Effective collaboration involves team building (partner selection) and negotiation skills (cooperative agreements) to promote technology and knowledge sharing. Collaboration leaders must be able to build trust and manage factors such as cultural differences and competing goals. Leaders gain partnering competencies through collaboration (learning).	Beamish & Lupton (2016); Lascaux (2020)
Collaboration requires leadership and management skills such as (1) decisiveness to operate in a bottom-up and mission-driven collaborative and (2) negotiating to execute collaborative agreements.	Beamish & Lupton (2016); Boyer et al. (2019)
Collaboration leadership involves (1) building cohesion through development of trust (e.g., meeting partners in advance), (2) effective communication (e.g., allowing scientists to discuss their work, encouraging the use of technology to co-locate, leveraging insights from experienced team scientists, planning regular meetings and some should be face-to-face, and publicizing specific team member contributions), and (3) training (reflection or lessons learned).	Chapman et al. (2018); DeHart, D. (2017); Hall et al. (2018)
Empowering leadership is essential to effect collaboration across geographically dispersed teams. Elements of empowering leadership include coaching, mentoring, and training.	Hill & Bartol (2016); Koçak (2019)
Collaborations can address well-articulated challenges. The practice of collaborative management research is not well defined or practiced. New methods to manage the collaborative should be identified starting with the evaluation of past university and industry partnership projects. Business leaders bring program management capabilities, inventiveness, and knowledge integration to the collaborative. Participants from industry need to be co-creators of knowledge.	Cheah et al. (2018); Huffman & Benson (2021).
Since structures, processes, and participants are outside of the control of the individual partners, key collaboration leadership skills include building trust, mentoring, mutual understanding, negotiating joint goals, and training.	Huxham, C., & Vangen, S. (2000); Lascaux (2020); Love et al. (2021)
Collaborators need to transition from hierarchical to lateral leadership processes. Creativity, coordination, and a strategic mindset will lead to innovation in the absence of hierarchical authority. Lateral leaders inspire, coach, and develop trust.	Koçak (2019)
Management is key to the collaborative and includes aligning goals and building trust while maximizing value creation for partners. Maximizing coordination and communication builds value while protecting knowledge.	Barbic et al. (2016); Martínez-Noya & Narula (2018)
Collaboration leaders must develop trust and commitment among partners by promoting the bilateral exchange of knowledge. Valuing diverse expertise shows mutual respect and fosters trust.	Gilbertson et al. (2019); Pinto et al. (2021)
The perception of shared leadership improves the efficiency of the collaborative. Collaboration leaders who encourage self-direction and autonomy among partners improve team process (e.g., team building) and performance (e.g., creativity).	Tang et al. (2020)

Leadership promotes a collaborative development culture by engaging stakeholders and providing an optimistic message.	Tuurnas et al. (2019)
University and industry partnerships provide an opportunity to develop ethical leaders for future collaboration.	Tymon & MacKay (2016)
Collaborations need a formal structure and network. The structure supports sharing leadership, knowledge, technology, recognition, and rewards.	DeHart (2017); Hall et al. (2018); Martínez-Noya & Narula (2018).

Table 2: Selected collaboration leadership characteristics or behaviors

Theme	Findings from the Literature	Selected References
Accountability & Trust	Collaboration leaders build trust within the team while promoting harmony and resource sharing.	Barbic et al. (2016); DeHart (2017); Hall et al. (2018); Oliver et al. (2018); Pinto & Fernandes (2021); Rajalo & Vadi (2017); Lascaux (2020); Xie et al. (2018)
Coaching, Learning, & Mentoring	Collaboration is a skill which can be enhanced through coaching and mentoring. Tools such as sprints offer the opportunity for a team to benefit from experts on broader aspects of the problem.	DeHart (2017); Hall et al. (2018); Love et al. (2021); Sinha et al. (2018); Tang et al. (2018); Tuurnas et al. (2018); Tymon & Mackay (2016);
Emotional Intelligence	Collaboration leadership involves perceiving, managing, and regulating emotions. Relationship-based leadership supports collaboration.	Boyer et al. (2018); Love et al. (2021); Rajalo & Vadi (2017); Tymon & Mackay (2016); Zhang et al. (2018)
Effective Communication	Information Technology and networking tools are essential to support collaboration across organizations and disciplines	DeHart (2017); Hall et al. (2018); Hill & Bartol (2016); Yu et al. (2019); Oliver et al. (2018); Shani & Coghlan, 2018
Empowering Leadership	Building confidence in team capacity to execute the collective mission and goals, establishes essential trust for the collaborative.	Hill & Bartol (2016); Tang et al. (2018)
Shared Vision and Values	Collaboration leaders share vision and values along with previous experience and knowledge to build a level of trust that is essential for teambuilding.	Chapman et al. (2018); Gilbertson et al. (2019); Mousavi et al. (2019); Rajalo & Vadi (2017)
Stakeholder Engagement	Stakeholder support is vital to the success of the collaborative.	Gilbertson et al. (2019)

Literature Summary

Numerous management discoveries were made through the study of articles identified in the REA. The main findings are summarized in Table 1. Extraction of the findings from the scientific literature helped the reviewer to analyze the studies, regardless of the type of study. Analyses focused on the capture of salient codes from the literature. In addition to the listed findings, the articles were read for potential application for industry partners who are supporting government-university-industry partnership projects.

Overall, there were multiple leadership styles and characteristics that could be gleaned from the literature. Example leadership styles that were investigated included empowering, laissez-faire, lateral, servant, transactional, and transformational leadership (Tang et al., 2018; Xie et al., 2018; Zhang et al., 2018). Key leadership characteristics included accountability, coaching or mentoring, coalition or team building, self-awareness, subject matter expertise, and integrity (Boyer et al., 2018; DeHart, 2017; Oliver et al., 2018; Pinto & Fernandes, 2021; Xie et al., 2018). Many of these characteristics could be

mapped to the servant leadership style. They support servant leadership skills such as demonstrating commitment to the team, listening, mindfulness, persuasion, sharing vision, and stewardship. Servant leaders apply these skills to develop trust, build relationships, and guide the team to goal achievement.

Following coding, the findings from the literature were synthesized to develop themes. Categorizing data into themes or patterns assisted in the integration of various types of research methods to create a set of findings that described the articles. This type of analysis is often referred to as a thematic synthesis, since it involves the coding of data in the articles to develop descriptive themes that are overarching while maintaining linkages to the original studies. The themes identified provide a higher level of abstraction for concepts that have been identified in more than one study, while also enabling the researcher to translate the findings to more common language. As indicated in Table 2, collaboration leadership activities appropriate for industry partners were grouped under themes such as empowering leadership, accountability and trust, learning, and stakeholder engagement.

The literature revealed that it was helpful to apply a servant leadership style, especially to build effective teams and in the case of industry to promote technology transfer. Chea et al. (2018) highlighted that knowledge sharing through successful collaboration provided industry partners with a competitive advantage. Servant leadership characteristics build on the pillars of empowerment (Boyer et al., 2018; Hill & Bartol, 2016; Tang et al., 2018; Tuurnas et al., 2019). Similar to transformational leadership, servant leaders encourage the team to achieve higher levels of performance. Servant leaders who understand each partner's roles and responsibilities can develop cohesive teams and put processes in place that support collaboration within the collaborative. By encouraging a team-based approach and sense of community, the collaborative can become a more productive, inclusive, and safe work environment. Numerous investigators (Barbic et al., 2016; Beamish & Lupton, 2016; Mousavi et al., 2019; Boyer et al., 2018; Chapman et al., 2016; Cheah et al., 2018; Martinez-Noya & Narula, 2018; Lascaux, 2020; Pinto & Fernandes, 2012; Rajalo & Vadi, 2017; Tymon & Mackay, 2016) discussed concepts such as knowledge sharing, coproduction, and facilitation, which are particularly important concepts for the industry partner to apply.

Discussion

Collaboratives that include government, university, and industry partners may form to accomplish complex projects (National Research Council, 2003). The partners complement each other so that together they can accomplish more than the individual

researcher. Industry partners are more application oriented and may be more rigorous in the evaluation of a new technology. For example, universities seldom establish measures of success beyond publications, while quite often industry researchers utilize measures of performance and effectiveness to quantify success (Smith, 1992; Sproles, 2000). Since collaborative projects are often purported to end in failure, it is beneficial to understand and assess factors that improve chances for collaborative success (McNamara et al., 2020). Through collaboration, researchers and practitioners can elevate the relevance and utility of their research results.

Collaborative research has been successfully employed to bring investigators together to address common objectives and solve common problems (Boardman & Gray, 2010). While there are many challenges, a strong team includes government scientists, university researchers, and practitioners from industry (Chapman et al., 2018). All of these organizations tend to apply hierarchical approaches in an authoritarian fashion, which does not foster collaboration. Government agencies and universities typically have multiple hierarchical layers where decisions are made. Industry tends to be flatter with fewer hierarchical layers from the company president to the industry participant working on a collaborative project. This is especially true in small businesses where there are fewer middle managers. Collaboration is improved by reducing the hierarchy and elevating levels of responsibility. For example, research sponsors could require application of a multiple principal investigator model to encourage team science. Lateral leadership needs to replace the top-down or hierarchical style of leadership to better meet 21st century challenges (Koçak, 2019).

Collaborative leadership is essential to forming and maintaining a collaborative charged with solving complex problems (Sirman, 2008). One of the key roles for the collaboration leader involves team building, which is described by numerous authors (Barbic et al., 2016; Boyer et al., 2018; DeHart, 2017; Gilbertson et al., 2019; Hall et al., 2018; Love et al., 2021; Yu et al. 2019). Effective team building develops trust and provides a foundation for a successful project (Gratton & Erickson, 2008). Team members are those who demonstrate an interest in working together across disciplines and sectors to achieve project objectives. Collaboration leaders believe in the capabilities and commitment of the partners. From the university researcher perspective, collaboration with industry provides opportunity to challenge long-held assumptions while enhancing the learning experience for students (Siegel 2007, 2008).

In forming a collaborative, leadership characteristics that included promoting vision, defining values, and coaching were found to optimize organizational performance (Bell & Habel, 2009; Lawler III, 1988).

Collaborative leaders develop more agile, innovative, and high-functioning teams that can make a lasting impact across industries or disciplines. They incentivize effective individual and team collaborators (Cross et al., 2016). Leaders from industry often have specific training and certifications in project management and the concomitant expertise to provide consensus building skills to benefit the collaborative (Lutas et al., 2020; Nesbit & Martin, 2012).

The servant leadership style, which focuses on empowerment, is especially effective to create a sense of unity among program managers, principal investigators, and senior leaders (Konczak, et al., 2000; Moll & Kretzschmar, 2017; Thakore, 2013; Washington et al., 2006). Through respect and acknowledging the value of each participant, the collaboration leader is helping to engage and retain members, even those coming from government, university, and industry organizations. Shared leadership, knowledge, recognition, and co-production encourages collective progress toward achieving project goals (Allen et al., 2018; DeHart, 2017; Oliver et al., 2018). Scientific communications such as publications and workshops provide opportunities to expand the sense of unity among partners and extend the collaborative's network.

Servant leadership characteristics allow the leader to build trust and accountability, which are considered essential elements in today's successful collaborations (Bilge et al., 2021; Eva et al., 2019). Accountability ensures that goals and objectives are accomplished and instills a sense of trust in the partnership and its members. These factors encourage the sharing of resources and knowledge among partners. Sharing in this context drives innovation or the resolution of societal challenges.

Servant leadership has similarities and differences to other leadership styles (Anderson & Sun, 2017; Brown et al., 2020). Transformational leadership and servant leadership both emphasize the interests of subordinates and skills such as listening. However, servant leadership focuses on supporting and developing the team members, while transformational leadership focuses on inspiring others to accomplish their goals. Servant leadership emphasizes meeting needs, which is very different from top-down or authoritarian styles where managers give orders that employees must follow. For example, transactional leaders focus on monitoring and directing followers in order to achieve organizational goals. They exchange rewards for subordinate effort. The Project Management Institute (2021) points out that there is a use case for each of the leadership styles. Servant leadership is well suited to collaborative projects and has been shown to contribute high morale among team members. It may not be appropriate at a construction site where rapid decision making is required to meet tight deadlines.

Collaborative work causes people to work harder for their own inherent satisfaction (Carr & Walton, 2014). Leaders who can pass on a sense of purpose are better able to garner support from team members (Beamish et al., 2016; Boyer et al., 2019). Being an accepted and viable member of the team encourages the sharing of information. Leaders with integrity and who are in touch with their own values can apply these traits to teambuilding. Such traits support being accountable to the collaborative and have been shown to build trust.

Collaboratives have been shown to stimulate open innovation and the development of new products, processes, services, and business models (Pinto & Fernandes, 2021). Collaborative research by scholars and scholar-practitioners provides value over time and the exchange of knowledge (Shani & Coghlan, 2018). In the case of university-industry collaborations, the success is the transition of research results to operations. In this case, the university, with the help of industry collaborators, contributes to economic development, i.e., new products and services.

Conclusions

The evidence suggests that scientists and practitioners working together from different disciplines and organizations on complex problems improves the chances for discovery and innovation. While the best leadership styles and traits for a collaborative are debatable, certain styles and traits provide positive impacts for teams that have made remarkable contributions. Collaboration leaders who borrow from servant leadership and exhibit traits such as foresight, conceptualization, persuasion, listening, empathy, and stewardship are helping to affect the team's success.

Industry partners may be less bureaucratic than government or university leaders and have greater latitude to support a collaborative by forming a coordinating team, which is especially important for large projects. Activities that support collaborative work include identifying champions, commitment to the objectives, frequent communication to share results, and shared incentives when milestones are reached. Industry leaders participating in a collaborative generally have backgrounds and experiences that enable learning (e.g., mentoring) and the building of trust by empowering partners who all share common goals. Industry partners are especially useful in planning and executing demonstrations to highlight progress, especially with stakeholders. Collaboration leadership activities related to facilitating lessons learned, stakeholder engagement, and technology transition are appropriate for industry.

Collaborative projects that are organized and led appropriately can achieve results that would be unachievable by any partner alone. A collaboration leader who applies servant leadership focuses on

people and goals while a team leader who applies an authoritarian style would provide partners with little control. Collaboration leaders from industry might provide different services than those from the public sector and academia. For example, industry leaders facilitate learning by proactively collecting project information along the way to facilitate after action review. Industry support in the planning and execution of technology exchange meetings, demonstrations, and the use of project information for lessons learned are examples tasks that mitigate inevitable project setbacks while providing opportunity for improvement, adaptation, and innovation. The servant leader approach, regardless of where the leader is from, is focused on removing project impediments to reach agreed upon goals.

While the purpose of this study was to understand factors that could enable industry leaders to motivate collaboration, it is equally valuable for government managers and university principal investigators. The design and development of collaboration tools requires an appreciation of factors that sustain collaborations and enable the research results to move successfully to practice. Communication, which is a key servant leadership skill, is fundamental to the technology transfer process. It involves documenting what does and does not work while inspiring team members to make any changes necessary that will help the team to achieve innovation or solve complex problems.

Implications for Managers

The nature of collaboration requires a departure from the practice of hierarchical or top-down leadership styles. A servant leadership style should be applied to remove project obstacles, protect the team from external demands, and provide support tools which facilitate the achievement of goals.

Collaboration leaders from industry should help to catalyze leadership with their government and university partners (Senge et al., 2019). Activities supported by industry should enable learning, trust-building, and empowered action. Facilitation by industry leaders helps partners who are focused on issues within their government or university sectors to see the larger picture. Characteristics include building relationships, creating consensus around solutions, obtaining necessary support for partners, providing oversight, resolving conflicts, sharing control, and sharing vision.

Understanding leadership styles and characteristics that support collaborative research will make a positive difference in the way teams are formed and managed. The industry leader should note that:

- Top-down forms of leadership based on authority and control will not work well in a project composed of participants from government,

academia, and industry (Hill & Bartol, 2016; Koçak, 2019).

- Participants working together to accomplish goals come from differing organizations and cultures. Research among government, academia, and industry partners is not without challenges, e.g., perceptions of bias, collusion, and coercion (Chapman et al. 2018).
- Collaboration on multidisciplinary and integrated projects that include participants from government, universities, and industry benefits from expert facilitation and co-production (Tuurnas et al., 2019).

Effective collaboration that borrows from servant leadership will increase teamwork while producing greater levels of commitment to the partnership's overall goals.

Recommendations

Based on the themes found in this study's research, seven recommendations emerged that highlight actions industry leaders can apply when participating in collaborative research. The findings are as follows:

1. Applying a servant leadership style will help the collaboration leader to build trust within the team while promoting harmony and resource sharing.
2. Coaching or mentoring enhances collaboration by providing learning that helps the team reach its full potential. One might employ sprints or demonstrations where experts are able to engage the team on broader aspects of the problem.
3. Developing emotional intelligence traits such as the management and regulation of feeling supports decision making. Relationship-based leadership that appreciates different cultures is associated with thoughtful and deliberate decision making.
4. Communicating should exploit IT and networking tools to facilitate collaboration across organizations and disciplines. Collaboration leadership tasks such as planning and executing technology exchange meeting and demonstrations may be easier to implement by industry partners. Industry participation in presenting accomplishments at professional association meetings builds trust with partners from other sectors.
5. Exhibiting empowering leadership by allocating more autonomy and responsibilities to the team results in improved capacity for the team to collectively solve a specific problem or provide innovative solutions to issues affecting society. Empowering leadership establishes essential trust for the collaborative.
6. Sharing vision and values builds the level of trust among partners. Industry leaders should

support the research community by helping to mitigate collaborative research challenges.

7. Engaging stakeholders is vital to accountability and sustainability. Industry leaders should participate in the identification and assessment of stakeholders owing to their understanding of the customer.

Implementation Plan

Since collaborative research involves multiple organizations and disciplines, implementation requires clear understanding between scientists and practitioners who have different expertise and skill sets. Collaboration leaders from each organization should be selected to facilitate openness and trust, which encourages the sharing of different perspectives, resources, and ideas across sectors, disciplines, and functional areas. The process starts with open discussions and the development of a project charter. Agreements need to be made that define roles and responsibilities or a division of labor. Discussions should include funding sources that support the collaborative.

An industry facilitator should know who has access to which technologies and data. Discuss the use of technology and expectations for the data before the project start. Many government-sponsored programs require that codes, data, and resulting information are open-source. A written data management plan should discuss concepts for sharing technology and data. All partners should participate in creation of knowledge and new technologies.

Encourage university partners to assign co-principal investigators. Industry collaborators can help to identify target professional meetings and journals that support the communication of results. The publication of results is very important to individual team members and requires decisions regarding authorship and sharing recognition. Government participants may want to publish technical reports that impact the publication of peer-reviewed literature. University researchers may desire to publish for their tenure dossier. An industry partner may want to file for a patent prior to any publication of results. Collaboration leaders need to ensure co-production and co-authorship.

Facilitators from industry can help to formalize the collaboration by running technology exchange meetings and technology demonstrations. To help maximize communication, industry collaborators should facilitate in-progress reviews to assess accomplishments toward meeting project goals. Meetings should enable all participants to assess progress toward milestones and overall project status. Project communications (e.g., emails, video calls, and instant messages) need to be managed so that reporting does not impact progress. Communications

should improve relationships and the probability of producing research that informs practice.

Risks of Implementation

Successful implementation of collaborative research can be very challenging because organizations and the personnel assigned to collaboratives have difficulty departing from top-down practices. For example, university participants may introduce a principal investigator, a person who is primarily responsible for the preparation, conduct, and administration of the entire project. Hierarchical approaches have been shown to be less effective on co-creation and the transition of research results to practices. Other common threats to implementation are lack of resources and administrative support.

Future Research

This study identified key research related to the science of collaboration. The assessment of team-science literature indicated that many collaborative research projects follow a principal investigator model. For this reason, additional research related to collaboration among co-principal investigators is needed to better understand skills that are needed to conduct lateral leadership. Effective leadership practices that have contributed to successful collaborations need to be defined. A systematic review related to success factors that support the management of government, university, and industry partnership projects would be helpful to practitioners involved in collaborative research. Evidence that supports the optimal sizing of a projects and methods to allocate resources would support effective teambuilding. Best practices that provide sufficient value for each of the partners should be described to sustain future collaboration efforts. Toward this, a study of collaborative research projects might provide insights on the types of phases that a collaborative research team goes through from problem identification to knowledge production to the transition of evidence to practice.

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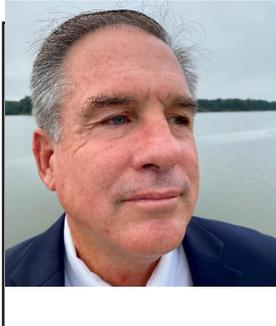
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Review

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