ARTICLES

REQUIREMENTS OF COLLABORATIVE AND TRANSFORMATIONAL LEADERSHIP IN DIGITAL ECOSYSTEMS: TECHNO-ORCHESTRATING LEADERS IN A VUCA WORLD

Requisitos de liderança colaborativa e transformacional em ecossistemas digitais: Líderes tecno-orquestradores em um mundo VUCA

Requisitos del liderazgo colaborativo y transformador en ecosistemas digitales: Líderes orquestadores tecnológicos en un entorno VUCA

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ABSTRACT

In today's increasingly web-enabled digital world, business environment is being transformed into ecosystems of partners in which digital connectivity, real-time data, information sharing, and visibility are enabled. Partners are becoming increasingly dependent, network collaboration is turning into a key success factor, and managerial, organizational and leadership paradigms are radically changing. This study investigates the requirements of leadership under these collaborative, transformational and technology-intensive conditions. Through a comprehensive and systematic literature review, the study offers main leadership requirements, desired leadership practices, and leader profiles to become successful in this context. Therefore, a conceptual framework is developed. The findings reveal that leadership requirements for digital ecosystems (DES's) are entirely different from traditional leadership understanding, and orchestration stands out as a key concept. This study is valuable for providing a comprehensive literature review and developing a conceptual framework.

Keywords: collaboration, digitalization, leadership, requirements, VUCA.

RESUMO

No atual mundo digital e cada vez mais conectado em rede, o ambiente de negócios está sendo transformado em ecossistemas de parceiros onde há conectividade digital, dados em tempo real, compartilhamento de informações e visibilidade. Nesse contexto, os parceiros estão cada vez mais dependentes, a colaboração em rede vêm tornando-se um fator de sucesso fundamental, e os paradigmas de gestão, organização e liderança estão mudando radicalmente. Este estudo investiga os requisitos da liderança nessas condições colaborativas, transformacionais e de grande intensidade tecnológica. Por meio de uma revisão sistemática, o estudo apresenta os principais requisitos de liderança, as práticas de liderança desejadas e os perfis de líderes que se tornam bem-sucedidos nesse contexto, desenvolvendo um modelo conceitual. Os resultados revelam que os requisitos de liderança para o ecossistema digital atual são totalmente diferentes do entendimento tradicional de liderança, e a orquestração destaca-se como um conceito-chave. Este estudo é relevante por oferecer uma revisão abrangente da literatura e por desenvolver um modelo conceitual.

Palavras-chave: colaboração, digitalização, liderança, requisitos, VUCA.

RESUMEN

En el mundo digital actual, cada vez más conectado en red, el entorno empresarial se está transformando en ecosistemas de socios en los que se activan la conectividad digital, los datos en tiempo real, el intercambio de información y la visibilidad. En este contexto, los socios son cada vez más dependientes, la colaboración en red se está convirtiendo en un factor clave de éxito, y los paradigmas de gestión, organización y liderazgo están cambiando radicalmente. Este estudio investiga los requisitos del liderazgo en estas condiciones colaborativas, transformacionales y de intensidad tecnológica. A través de una revisión exhaustiva y sistemática de la literatura, el estudio presenta los principales requisitos de liderazgo, las prácticas de liderazgo deseadas y los perfiles de líderes que tienen éxito en este contexto, desarrollando un marco conceptual. Los hallazgos revelan que los requisitos de liderazgo para el ecosistema digital actual son totalmente diferentes de la concepción tradicional del liderazgo, y la orquestación se destaca como un concepto clave. Este estudio es relevante por proporcionar una revisión bibliográfica completa y desarrollar un marco conceptual.

Palabras-clave: colaboración, digitalización, liderazgo, requisitos, VUCA.

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INTRODUCTION

Today's business is described by ever-increasing technology-intensive, digitalized and web-enabled character working under VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) conditions. VUCA is repeatedly used and well-supported in the literature, where: volatility refers to the nature, speed, character and magnitude of change associated with turbulence; uncertainty highlights the lack of predictability of events and risks; complexity refers to overall systems complications and chaos resulting from interrelationship, interdependency and interaction of elements both within the system and with its environment in technical, economic, organizational, managerial and global dimensions; ambiguity refers to the blurring reality and complexed meanings, resulting in confusion (Horney et al., 2010; Nobre et al., 2010; Rodriguez & Rodriguez, 2015; Singh, 2013; Sinha, 2015). VUCA represents a business environment under constant and radical change in conflicting ways, where agility, innovation, and risk embracement become imperative (EY, 2014; Horney et al., 2010). Organizations must handle VUCA conditions to remain competitive, utilizing ever-changing disruptive information technologies as the key enabler to survive.

Thus, digital transformation (DT) is inevitable for enterprises (Cortellazzo et al., 2019). Enterprises undergo a multi-dimensional transformation in technological, organizational, and managerial dimensions. These drastic changes result in increasingly collaborative, dependent, web-enabled business ecosystems which are well-supported by the new business understanding within IoT, I4.0, and blockchain paradigms (Akyuz & Gursoy, 2018, 2019, 2020; Cloutier et al., 2020; Durugbo, 2016; Fenton et al., 2020; Hahn, 2020; Kotarba, 2018; Rosin et al., 2020; Satalkina & Steiner, 2020; Stanczyk, 2019; Wang et al., 2020; Winkelhaus & Grosse, 2020). It is generally accepted that the modern business environment is viewed as interdependent networks of connected entities to create and capture value (Subramaniam et al., 2019; Williamson & DeMeyer, 2012). Hence, in recent literature, "supply network" has become the dominant terminology, increasingly replacing the term "supply chain" and referring to collaborative, digital ecosystems of partners (suppliers, manufacturers, distributors, retailers, customers, and service providers) jointly creating value (Akyuz & Gursoy, 2019; Fawcett et al., 2011). Digital ecosystems (DES) focus on complex interdependencies, networked relationships, and partnerships enabled by digital technologies (Subramaniam et al., 2019). The DES concept involves extensive use of digital technologies, flexibility, and an ad-hoc character (Valdez-De-Leon, 2019). It is supported by evidence that six of the world's top seven companies are ecosystem companies (Chung et al., 2020). Therefore, we witness the frequent use of the terms "DES" or "web-based ecosystems" in the literature to represent the network's digitally connected character (Fenton et al., 2020; Lavikka et al, 2017; Ahsan et al. 2021; Urcioli et al. 2021).

In a global, web-enabled, and multi-partner ecosystem, IT-enabled collaboration among partners (Akyuz & Gursoy, 2019; Fawcett et al., 2011) is key to better innovation, value creation, performance, and risk management (Akyuz & Erkan, 2010; Akyuz & Gursoy, 2014; Chen et al., 2013; Graça & Camarinha-Matos, 2017; Tawaststjerna & Olander, 2021).

Undoubtedly, this is a radical transformation. Technological, managerial, and organizational dimensions must be managed, creating unique challenges for leadership (Deaton, 2018). Compared to past experiences, multi-layered, intermingled, and complex challenges stand out (Mack & Khare, 2016), along with inertia and resistance to transformation. The main management functions of planning, organizing, commanding, coordinating, and controlling are becoming more complicated in unstable conditions (Rimita et al., 2020). Therefore, the new business conditions in the VUCA world require a flexible and transformation-oriented leadership approach.

In the evolution of leadership ontologies, roots are at the Full Range Leadership Theory (FRLT), which was originally introduced in 1978 by Burns, further expanded in 1995 and 1997 by Bass and Avolio (Puni et al., 2018), and encompassing transformational, transactional, and laissez-faire (passive avoidant) leadership (Bass & Avolio, 1997). FRLT has achieved wide application and acceptance in management and leadership literature (Antonakis & House, 2014), and various meta-analyses support its success (Judge & Piccolo, 2004; Lyons & Schneider, 2009). FRLT presents transformational leadership (TFL) as the most effective form of organizational leadership, developing into a cornerstone of modern leadership research (Crede et al., 2019).

TFL has received extensive attention as a dominant approach (Atan & Mahmood, 2019; Dinh et al., 2014; Majeed et al., 2017). TFL is characterized by 4I: idealized influence, inspirational motivation, intellectual stimulation, and individual consideration (Dong et al., 2017; Kroon et al., 2017; Thompson et al., 2021), inspiring pride, respect, and trust among their followers (Puni et al., 2018).

Still, recent critiques (Knippenberg & Sitkin, 2013) highlight FRLT restrictions, failing to cover important leadership behaviors such as strategy formulation (Yukl, 2006). Consequently, FLRT is further extended by adding instrumental leadership (IL) (Allgood et al., 2022; Antonakis & House, 2014; Bass & Avolio, 1997; Chammas & Hernandez, 2019) to fill the gaps of the original model. IL emphasizes the leaders' ability to monitor and adapt to the external environment, set strategic objectives, achieve goals via analyzing the internal and external environment, use resources efficiently, and provide performance feedback (Chammas & Hernandez, 2019). Relatively few studies exist regarding IL, basically analyzing its effects on performance and comparing it with TFL (Antonakis & House, 2014; Rowold et al., 2017). Hence, the literature does not offer a unified leadership framework (Krauter, 2020).

Consequently, digitally intensive business models demand an overall DT, increasing the importance of transformational perspective while disrupting the existing leadership and organizational models, frameworks, and paradigms. It is widely accepted that leadership ontologies are less useful in increasingly collaborative contexts (Drath et al., 2008). Therefore, new approaches are essential in leadership, management, and organization (Elkington et al., 2017; Gibney et al., 2009; Kannan & Garad, 2020), requiring new skill sets and leadership styles (Nastase & Roja, 2013; Wilson, 2004). Leaders must orchestrate collaborative DES and handle the overall DT under VUCA conditions.

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Thus, we focus on the requirements of collaborative and transformational leadership (CTFL) in DES. The study answers the following research questions:

- What are the main collaborative and transformational requirements of leadership in DES?

- How can the requirements be clustered to achieve a multi-dimensional framework?

We contribute by providing a comprehensive literature review, revealing the leadership requirements in this context, and providing a conceptual framework. The study is valuable to both researchers and practitioners working in leadership and supply chain management (SCM) in relation to technology, collaboration, organizational transformation, and DES.

The article is structured as follows: first, the methodology is presented, followed by the requirements gathering section. Subsequent sections provide the developed framework, followed by a discussion. Finally, the conclusion and directions for further research are presented together.

METHODOLOGY

This study performs a systematic and comprehensive literature review for gathering and clustering collaborative and transformational leadership (CTFL) requirements in digital ecosystems (DES) to answer the research questions described.

Literature review systematic

The literature review encompassed studies conducted between 2004 and 2020 to ensure recency and reflect the technology-intensive nature of the topic. The primary search was performed on the Web of Science (WoS) database using the keywords "Transformational Leadership" and "Collaborative Leadership." By applying the date filter of "2004-2020" and refining the search for relevant WoS categories, we obtained a base set of 838 results for transformational leadership and 587 for collaborative leadership. The choice to include the years from 2004 was motivated by significant technological developments during that period, including the rise of web services and service orientation concepts, which underpin the current platform-independent connectivity of enterprise application systems. It also coincided with the global expansion of the internet through Web.2.0 and the emergence of dynamic web-based applications. Additionally, 2004 marked the birth of prominent social media platforms like Facebook. Therefore, we considered these dramatic technological changes crucial and used the time interval 2004-2020.

The studies identified were filtered to find the most relevant ones to IT and supply network topics. During the process, extra valuable resources related to VUCA and IT aspects were included to reflect the research's multi-dimensional character, such as research reports from various institutions, books/book chapters, and dissertations. In addition, a seminal work published

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before 2000 was included in the reference set to discuss the theoretical roots, as well as five recent references (from 2021 and 2022).

Resultant distribution according to resource type is provided in summary Table 1:

Table 1. Distribution according to resource type

Journal articles	Book/Book Chapter	Report/ Whitepaper	Conference/ Congress Paper	Dissertation/ Thesis	TOTAL
98	12	11	1	1	123

Source: Elaborated by the authors.Table 1 shows that articles from indexed international journals dominate the resource set.

The results of the review regarding key requirements are synthesized and clustered. The findings show that contemporary leadership characteristics, in addition to essential ones, are required. Thus, the review results are classified into seven main clusters: essential, technology-focused, collaborative, transformational, participative, agility-focused, and innovation-focused. The "requirements gathering" section is structured according to these clusters, and each cluster is discussed under these headers.

Afterward, a generic and conceptual framework for CTFL requirements was developed in compatibility with the clustering mentioned above.

Clustering rationale

The clustering was developed based on the following:

- inherent logical relevance and relationship of a variety of terminologies and traits identified from the literature,

- requently recurring common themes,

- related analogous uses, and

- harmony of collaboration, transformation, leadership, DES and VUCA concepts.

In this clustering:

- Collaboration was proven to be the most essential characteristic of changing business dynamics. Recent supply chain management (SCM) literature highly supports collaboration as the key idea for value creation across the network (Akyuz & Gursoy, 2019; Fawcett et al., 2011; Graça & Camarinha-Matos, 2017; Tawaststjerna & Olander, 2021). Therefore, collaborative characteristics stand out as a separate cluster.

- Despite the presence and relevance of a multitude of contemporary theoretical views and perspectives regarding leadership (Antonakis & House, 2014; Oberer & Erkollar, 2018; Robbins & Coulter, 2012; University of Cambridge Institute for Sustainability Leadership [UCISL], 2017), our study revealed that transformational leadership (TFL) was the most

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cited, prominent and appealing theory (Anderson & Sun, 2017; Antonakis & House, 2014; Bambale et al., 2011; Gomes, 2014; Hansbrough & Schyns, 2018; Jones, 2019; Khan, 2016; KPMG, 2017; UCISL, 2017; Vought, 2017). Dinh et al. (2014) also support that TFL is the most frequently utilized leadership approach, based on a recent review of 752 articles published in 10 top academic journals (Majeed et al., 2017). TFL is widely believed to be the most effective leadership style which can perform best (Atan & Mahmood, 2019) under VUCA conditions.

When we compared the basic characteristics of TFL with the other two main FRLT components and its extension, we observed that transactional leadership (TAL) characteristics, representing conventional leadership style, were insufficient to meet the challenges of current IT-based ecosystems under VUCA conditions. In academic literature, the main TAL characteristics – focusing on supervision, maintaining the status quo, being reactive, and focusing too much on structure (Afsar et al., 2017; Ojha et al., 2018) – are incompatible with managing dynamic ecosystems. These TAL characteristics do not fit to participative, agility-focused, and innovation-focused concepts. In fact, they are in contrast with these concepts. Laissez-faire leadership represents a non-directive and passive characteristic, which is far from handling an overall organization-wide transformation. In our IT-based context, we have also observed that the main characteristics of TFL provide better alignment with DES and transformation, better moderating VUCA (Ardi et al., 2020; Matsunaga, 2021) when compared with instrumental leadership (IL), which mainly highlights being practice-oriented and having environment-surveillance capability. We observed that in IT-based context, transformational characteristics were more vital than conventional traits. Therefore, TFL is treated as a separate cluster in line with all the dramatic demands of digital transformation (DT) under VUCA conditions.

"Participative," "agility-focused," and "innovation-focused" characteristics appeared as important recurring themes as the key leadership characteristics required to manage the challenging VUCA conditions; hence they are treated under separate headers. Important SCM concepts of flexibility, being customer-centric, and responsiveness, which are referred to in Table 2, are already interdependent with agility. Therefore, the agility cluster covers all these key SCM characteristics.

REQUIREMENTS GATHERING

Based on the comprehensive literature review following the methodology described above, this section gathers and discusses requirements for collaborative and transformational leadership (CTFL) in digital ecosystems (DES). Table 2 provides the requirements grouped into seven clusters, along with corresponding leadership traits and supporting references for each header. The requirements for each group are discussed in detail as separate subsections.

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Table 2. Collaborative and transformational leadership requirements in digital ecosystems

Requirements	Leadership Characteristics	Supporting references
Essential	• Strategic perspective • Visioneering/Foresight • Systemic thinking/holistic perspective • Global/universal perspective • Being analytical and methodical (analysis, synthesis, interpretation and evaluation) • Problem-solving skills • Ambidextrous behavior • Results orientation and path-goal facilitation towards implementation • Interdisciplinary and multi-disciplinary orientation • Focus on hybrid skills in strategy, business management and IT alignment • Openness to discussion, negotiation and consensus • Environmental alertness and monitoring on environment • Charisma and power of influencing	(Antonakis & House, 2014; Cortellazzo et al., 2019; Gomes, 2014; Horney et al., 2010; KPMG, 2017; Lad, 2017; Luo et al., 2018; Oberer & Erkollar, 2018; UCISL, 2017; Vought, 2017; Yücebalkan, 2018)
Technology-centered (Technology knowledge and awareness, digital skills, digital literacy, digital competencies)	• Awareness and knowledge of current technologies and related opportunities and constraints [cloud, big data analytics, predictive web-based consumer analytics, cybersecurity, IoT, I-4.0, smartness, mobile application development, computation and coding, enterprise application integration, 3D printing, robotics, automation, autonomous vehicles, blockchain, web collaboration tools, AI, augmented reality] • Web and mobile literacy • Social media competence • Fintech competence • Big data analytics, especially for CRM • Effectiveness in selecting and investing in disruptive technologies and infrastructures • Awareness for security, sharing of sensitive data and cybersecurity • Lifelong-learning of technical skills	(Akyuz & Gursoy, 2018, 2020; Cortellazzo et al., 2019; EY, 2014; Kotarba, 2018; KPMG, 2017; Rosin et al., 2020; Roubini ThoughtLab, 2017; Satalkina & Steiner, 2020; UCISL, 2017; Wilson, 2004; Winkelhaus & Grosse, 2020; Yücebalkan, 2018)
Collaborative	• Beyond-enterprise, networked perspective (awareness of extended organizational and leadership boundaries) • Long-term partnership orientation • Creating a transparent communication and information network based on trust • Involving multiple partners/stakeholders in decision-making • Facilitating collaborative ecosystems based on projects, networks, and transient organizations • Forming an ecosystem of capabilities and deploying resources according to competence • Decision-making for business ecosystems rather than for individual companies • Strategic use of digitalization • Fostering a collaborative culture within the ecosystem • Awareness for network leadership with networking-skills • Facilitating leadership for virtual and global teams collaborating across barriers of diversity and heterogeneity • Recognizing and seizing opportunities • Actively engaging in joint problem resolution and conflict handling by consensus in a cross-cultural, multi-partner environment • Managing risks, uncertainty, and dilemmas collaboratively • Building partnerships based on valuing mutual trust, respect, and obligations • Orchestrating the ecosystem	(Akyuz & Erkan, 2010; Akyuz & Gursoy, 2014, 2019; Chen et al., 2013; Cortellazzo et al., 2019; Dubey et al., 2020; Faccin et al., 2020; Fawcett et al., 2011; Fenton et al., 2020; Graça & Camarinha-Matos, 2017; Horney et al., 2010; KPMG, 2017; Kramer & Crespy, 2011; Lad 2017; Lazan, 2016; Luo et al., 2018; Oberer & Erkollar, 2018; Roubini ThoughtLab, 2017; Samimi et al., 2020; Stanczyk, 2019; Subramaniam et al., 2019; Tawaststjerna & Olander, 2021; UCISL, 2017; Valdez-De-Leon, 2019; Vought, 2017; Williamson & DeMeyer, 2012; Yücebalkan, 2018)

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Table 2. Collaborative and transformational leadership requirements in digital ecosystems

Requirements	Leadership Characteristics	Supporting references
Transformational	• Willingness/openness and ability to learn and change • Being people-oriented and technically-minded • Using technology for organizational growth and competitiveness • Rethinking business strategy and models, structure, products, IT, enterprise platforms, mindsets, skill sets, and workplaces • Reengineering in people, process, technology, and structure dimensions • Transforming existing structures via creative processes, multidisciplinary, flexible, and cross-partner teams • Creating an enterprise-wide transformative digital vision, strategy, and transformation plan • Evaluating the readiness of the company to change • Managing DT by providing leadership to guide and implement digital processes • Managing disruptive change • Acting as role models • Coaching and mentoring • Undertaking a digital change agent role • Inspiring, motivating, and stimulating people considering individuals • Managing the cultural change to create and foster a digital culture • Performing simulations and creating what-if scenarios under VUCA conditions • Managing multi-dimensional challenges of implementation toward re-engineered systems • Monitoring and evaluating performance	(Afsar et al., 2017; Alharbi et al., 2020; Amin et al., 2019; Anderson & Sun, 2017; Antonakis & House, 2014; Atan & Mahmood, 2019; Bambale et al., 2011; Chen et al., 2019; Chou, 2019; Cleavenger & Munyon, 2013; Cortellazzo et al., 2019; EY, 2014; Hansbrough & Schyns, 2018; Jones, 2019; Kane et al., 2015; Khan et al., 2018; Khan, 2016; Klaic et al., 2020; KPMG, 2017; Lawrence, 2013; Le, 2020; Lei et al., 2020; Li et al., 2015; Majeed et al., 2017; Mangundjaya & Adiansyah, 2018; Matt et al., 2015; Oberer & Erkollar, 2018; Ojha et al., 2018; Pillai & Williams, 2004; Ravesteijn & Ongena, 2019; Robbins & Coulter, 2012; Roubini ThoughtLab, 2017; Sainger, 2018; Seijts & Gandz, 2018; Subiyanto & Djastut, 2018; Tyssen et al., 2014; UCISL, 2017; Vought, 2017; Yücebalkan, 2018; Zupancic et al., 2016)
Participative	• Being human-oriented • Valuing teamwork • Valuing shared leadership • Valuing within-enterprise and cross-border, empowerment and participation • Managing multi-partner and multi-cultural teams • Designing competence networks and cross-partner intelligence • Managing team competence and task allocation according to skills and capabilities • Ensuring relational transparency and trust • Valuing expertise, culture, and talent development • Providing autonomy to employees, supporting individual work • Counting on employees and teams with self-responsibility for proactive behavior and innovation • Providing freedom to experiment and to learn from faults • Life-long learning	(Cortellazzo et al., 2019; Horney et al., 2010; Kane et al., 2015; Khan, 2016; Lilian, 2014; Mitchell, 2012; Morrison-Smith & Ruiz, 2020; Oberer & Erkollar, 2018; Rao, 2016; Liebert & Trzeciak, 2019; UCISL, 2017; Vought, 2017; Webber & Webber, 2015; Yücebalkan, 2018)
Agility-focused	• Speed, fitness, flexibility, and responsiveness in VUCA-world • Managing uncertainty and risk collaboratively • Anticipating change and initiating action in VUCA world • Being customer-centric, valuing customer relations and customer engagement for a seamless, omnichannel customer experience • Being service driven • Modularity, speed, scalability and reliability with tight integration of IT architectures	(EY, 2014; Horney et al., 2010; KPMG, 2017; Lawrence, 2013; Roubini ThoughtLab, 2017; Slagmulder & Devoldere, 2018; Tanniru, 2018; Yücebalkan, 2018)

Table 2. Collaborative and transformational leadership requirements in digital ecosystems   Concludes

Requirements	Leadership Characteristics	Supporting references
Innovation-focused	• Being innovation-centered • Balancing growth and risk related to innovation • Fostering a sustained culture of innovation by inspiring creativity • Having a mindset allowing and rewarding in-house entrepreneurship and intrapreneurship • Divergent thinking by applying new methods and instruments • Valuing the development of digital talent • Innovation for the ecosystem, open co-innovation	(Agger et al., 2015; Arun et al., 2021; Beğeç & Arun, 2020; Cook, 2016; Cortellazzo et al., 2019; Deprez et al., 2018; EY, 2014; Fenton et al., 2020; Guinan et al., 2019; Horney et al., 2010; KPMG, 2017; Le et al., 2020; Mainemelis et al., 2015; Oberer & Erkollar, 2018; Okun et al., 2020; Raza, 2016; Roubini ThoughtLab, 2017; Super, 2020; Tanniru, 2018; UCISL, 2017; Utoyo et al., 2020; Yücebalkan, 2018)

Source: Elaborated by the authors.

Essential requirements

The main leadership requirements were classified under the "essential" header. Findings in this group include characteristics such as having a strategic perspective, foresight/vision, charisma, and power to influence others (Gomes, 2014; Oberer & Erkollar, 2018; UCISL, 2017). Further essential skills such as having a global perspective, being systemic thinkers, seeing the holistic view (UCISL, 2017), thinking beyond enterprise borders, and seeing the top-level interactions, relations and dependencies within a collaborative-ecosystem (Lad, 2017; Vought, 2017; Yücebalkan, 2018), are vital. Environmental alertness and monitoring to obtain practical results are definitely among leadership essentials (Antonakis & House, 2014).

Key issues identified were possessing hybrid skills in strategy, business management, and IT, as well as focusing on business-IT alignment (KPMG, 2017). They should view IT as the greatest enabler of strategic success and work with the business duality to obtain the best IT-business alignment. This requires having an interdisciplinary and multi-disciplinary orientation (UCISL, 2017). Among the vital traits were the characteristics of being analytical and methodical; having the ability to analyze, synthesize, interpret, and evaluate complex issues; applying problem-solving skills in complex settings; having a results-oriented mindset (Cortellazzo et al., 2019; Horney et al., 2010; Vought, 2017); exhibiting ambidextrous behavior; and pursuing exploration and exploitation simultaneously (Luo et al., 2018). Providing path-goal facilitation toward practical results and implementations is undoubtedly among the key characteristics. Openness to discussion, negotiation, and consensus are also essential.

This group of requirements revealed that along with core leadership values such as vision and charisma, leaders in collaborative DES should be systemic, methodical analytical thinkers equipped with hybrid skills, having both IT and business perspectives.

Technology-centered requirements

Under this heading, technology-related requirements stemming from the pressure to adopt dramatic technological changes are presented. In the literature, various phrases are employed to describe this characteristic, such as "technology-knowledge and awareness," "digital-skills," "digital-literacy," and "digital-competences" (EY, 2014; KPMG, 2017; Roubini ThoughtLab, 2017; Wilson, 2004; Yücebalkan, 2018). Therefore, the authors have chosen to use the term "technology-centered" and have provided the other terms in parentheses in Table 2.

This cluster emphasizes that leaders of DES need to have awareness and knowledge of current technologies as well as the associated opportunities and constraints they bring. The speed in technological developments involves a variety of technologies frequently referred to as "disruptive". Cloud technology, big data analytics, predictive analytics, web-based analytics, cybersecurity, IoT, Industry 4.0 (I-4.0), smartness, mobile application development, computation and coding, enterprise application integration, 3D printing, robotics, automation, autonomous vehicles, blockchain, web collaboration tools, Artificial Intelligence (AI), and augmented reality are recent disruptive topics that significantly impact the businesses (Cortellazzo et al., 2019; Dubey et al., 2020; EY, 2014; KPMG, 2017; Roubini ThoughtLab, 2017; Yücebalkan, 2018).

These technologies are essential in various configurations and combinations to create a visible and transparent ecosystem where partner processes are managed through online and real-time information exchange. Implementing these concepts improves efficiency, information sharing, and integration, enabling unprecedented levels of connectivity, visibility, jointness, and collaboration within DES's (Akyuz & Gursoy, 2018, 2019). Therefore, leaders in a technology-intensive ecosystem must possess knowledge and awareness of the opportunities, barriers, and risks associated with these technologies (EY, 2014; KPMG, 2017).

Web and mobile literacy, social media competence (Cortellazzo et al., 2019; UCISL, 2017), awareness of Fintech concept and its applications and big data analytics emerge as key leadership skills (Roubini ThoughtLab, 2017). Ensuring effective use of social media, guaranteeing web-based connectivity of financial transactions, and keeping the pulse of the customer by using customer relationship management (CRM) data are indispensable skills (EY, 2014; Roubini ThoughtLab, 2017).

Our review shows that leaders in DES should select the most appropriate disruptive technologies and infrastructures and invest in them aggressively (KPMG, 2017). With awareness and knowledge of a broad spectrum of available technologies, they should select and combine them in an effective configuration aligned with strategy and business components, resulting in a unique management information system design. A significant level of awareness is also needed for the ethical issues of security, sharing of sensitive data, and cybersecurity (Roubini ThoughtLab, 2017). The ability to actively use and engage in lifelong learning of these technologies appears as the key aspect characterizing a technologically competent leader using technology for the ecosystem benefit.

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Thus, this cluster of requirements highlights the need for leaders of DES to have a broad awareness and knowledge of recent disruptive technologies. They should demonstrate a desire and willingness to learn and update their skills in this context.

Collaborative requirements

Collaboration-related traits are of significant importance in DES leadership (Akyuz & Gursoy, 2019; Cortellazzo et al., 2019; Fawcett et al., 2011; Graça & Camarinha-Matos, 2017; KPMG, 2017; Kramer & Crespy, 2011; Tawaststjerna & Olander, 2021; UCISL, 2017; Lad, 2017). Within this cluster, leaders are expected to adopt a beyond-enterprise, networked perspective and be aware of extended organizational and leadership boundaries (Cortellazzo et al., 2019; Oberer & Erkollar, 2018; Raza, 2016; Yücebalkan, 2018). They should prioritize long-term, network-level values and partnerships over short-term benefits and the well-being of individual enterprises (Akyuz & Gursoy, 2014, 2018, 2019). This collaborative understanding, which entails a different mindset, requires that partners value the long-term benefits and well-being of the network above their individual interests and short-term benefits (Akyuz & Gursoy, 2014; Horney et al., 2010; UCISL, 2017). Leaders should establish a transparent communication and information network based on trust, utilizing IT-based collaboration tools (Raza, 2016; Roubini ThoughtLab, 2017; Vought, 2017). It is crucial to involve multiple partners in decision-making, leading to joint planning, execution, and control across the partners.

Therefore, leaders with a collaborative mindset should actively facilitate the creation of new collaborative ecosystems centered around projects, networks, and transient organizations (UCISL, 2017; Vought, 2017). Within this collaborative paradigm, leaders should facilitate the development of an ecosystem of capabilities, deploying resources according to competence. This requires guidance and leadership beyond the boundaries of individual enterprises, as well as the capability of managing teams across enterprises (Horney et al., 2010; Raza, 2016; UCISL, 2017). Strategic digitalization requires decision-making that prioritizes the well-being of DES over enterprise-centric considerations. Leaders should emphasize collaborative decision-making based on consensus (Akyuz & Gursoy, 2018; Chen et al., 2013). As a result, leaders operating beyond enterprise borders should adopt a mindset that avoids individualistic and opportunistic behavior and makes decisions for the overall well-being of the network.

Leaders who have assimilated this mindset should foster a collaborative culture within their company and cultivate collaboration across partners (Oberer & Erkollar, 2018). They should demonstrate leadership by facilitating the performance of virtual and global teams working in different time zones, facing language barriers, and adapting to organizational and cultural boundaries. They must adopt a flexible and inclusive leadership style that embraces the diversity of views and belief systems while respecting different cultures across cultural, political, and geographical heterogeneities (UCISL, 2017).

Furthermore, they should facilitate building partnerships based on mutual trust, respect, and obligations. This entails creating open communication channels, ensuring

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symmetrical information sharing, and making consensus-based decisions to form the foundation for trust development. Building mutual trust and respect requires far beyond sharing operational information and processes. These elements evolve with time to the point that collaboration reaches strategic-level decisions and processes (such as collaborative performance and risk management, design, and development) (Akyuz & Gursoy, 2018).

It is evident that awareness of network leadership opportunities and networking skills are essential. Leaders must recognize and seize opportunities while actively engaging in joint solutions and handling conflicts by consensus (Samimi et al., 2020) in a cross-cultural, multi-partner environment. The collaborative management of performance, risks, and uncertainty also becomes crucial. Therefore, the ability of a leader to "orchestrate the ecosystem of partners" emerges as a key concept (Faccin et al., 2020; Fenton et al., 2020).

Consequently, collaborative ecosystem leaders should have a mindset that is eager and willing to engage in collaboration and consensus-based decision-making at operational, tactical and strategic levels for better organizational results (Lazan, 2016; Subramaniam et al., 2019; Valdez-De-Leon, 2019). They should work for the network's benefit by truly valuing openness, negotiation, consensus, joint decisions, mutual trust, and respect.

Transformational requirements

The ability to manage a comprehensive organizational transformation encompassing various dimensions such as technology, management, and organization is a fundamental requirement in DES (Bambale et al., 2011; Cortellazzo et al., 2019; Jones, 2019; Kane et al., 2015; Ravesteijn & Ongena, 2019; Roubini ThoughtLab, 2017; Zupancic et al., 2016). Therefore, transformational requirements emerge as a distinct group.

In a transformative environment, a high level of willingness/openness and the ability to learn and change are the key traits. Leaders should be open to change to guide people toward the transformation with a digital vision (EY, 2014; Khan, 2016; Yücebalkan, 2018). Being both people-oriented and technical-minded, they should use technology for organizational growth and competitiveness (Kane et al., 2015; KPMG, 2017; Roubini ThoughtLab, 2017). They should rethink business strategy, structure, models, products, IT, enterprise platforms, mindsets, skill sets, and workplaces (EY, 2014; Ravesteijn & Ongena, 2019). Making constant shifts in people, processes, technology, and structure is critical to transforming existing structures via creative processes and multidisciplinary, flexible cross-border teams (Seijts & Gandz, 2018; Yücebalkan, 2018).

Having a broad awareness and knowledge of technology, transformational leaders should adopt a mindset of managing a technology-intensive transformation for the enterprise and the collaborative network. They should create an enterprise-wide transformative digital vision and strategy, extending the transformation to other partners in the ecosystem. The literature strongly supports the importance of alignment between IT and business strategies during digital transformation (DT) (Matt et al., 2015). Critical aspects of a technology-based transformation include evaluating the company's readiness for change, creating a sound and

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feasible digital transformation plan, and managing the the implementation process through effective leadership (Yücebalkan, 2018; Sainger 2018). Leaders should be aware that they are driving a disruptive change to create and foster a digital culture (Sainger, 2018). The combination of digital strategy, culture, and leadership is central to the transformation (Kane et al., 2015). The ability of transformational leadership (TFL) to influence employee attitudes and enhance inter-team collaboration is crucial (Chou, 2019; Cleavenger & Munyon, 2013; Mangundjaya & Adiansyah, 2018; Cha et al., 2015). Leaders should act as digital change agents for both their own enterprises and partners in the collaborative ecosystem (Khan, 2016), inspiring, motivating, and stimulating people. Additionally, they should possess the skills for continuous environmental surveillance, managing multidimensional implementation challenges toward successful practical results, and monitoring and evaluating performance for the entire system towards successful practical results (Antonakis & House, 2014).

The ability to simulate and create what-if scenarios under VUCA conditions appears as a key capability. TFL plays a facilitating role in fostering creativity, change, innovation, and entrepreneurship at individual, team, and organizational levels, as supported by the literature (Afsar et al., 2017; Alharbi et al., 2020; Chen et al., 2019; Klaic et al., 2020; Le, 2020; Lei et al., 2020). TFL also enables organizational ambidexterity (Li et al., 2015; Ojha et al., 2018; Subiyanto & Djastut, 2018), and it proves effective in times of uncertainty and crisis for temporary organizations (Pillai & Williams, 2004; Tyssen et al., 2014). TFL is necessary for network sustainability and corporate responsibility, which are crucial for managing the VUCA conditions of the ecosystem (Amin et al., 2019; Khan et al., 2018; Anderson & Sun, 2017; Lawrence, 2013).

Consequently, TFL is still at the heart of leadership in web-based ecosystems (Atan & Mahmood, 2019; Dinh et al., 2014; Majeed et al., 2017). The literature supports that managing disruptive technological change within organizational and managerial contexts is more challenging nowadays. The leader has to select relevant technological components, assess organizational readiness and maturity, manage IT-based implementations, and align technological components with business strategies and processes. Hence, the classical understandings of leadership are insufficient. The meaning of TFL appears to be extended beyond the enterprise, assuming an increasingly technological character in collaborative DES. Undoubtedly, lessons learned from successful/unsuccessful company-wide enterprise resources planning (ERP) implementation projects are also to be extended to cross-partner IT-based projects to meet the implementation challenges involving multiple technological components.

Participative requirements

Participative requirements are founded on the essential principles of being human-oriented, having teamwork orientation, and valuing empowerment and participation, which are well-established in the total quality management philosophy (UCISL, 2017). In a collaborative multi-enterprise context, these ideas appear to be extended and redefined for the entire ecosystem. In this context, valuing within-enterprise and across-enterprise participation is required in this context,

and teamwork orientation and shared leadership are extended to the ecosystem. Collaborative leaders should mentor and coach multi-partner, multi-cultural teams (Gomes, 2014; Vought, 2017; Webber & Webber, 2015) and lead cross-border virtual teams in extended context, bringing in additional challenges (Cortellazzo et al., 2019; Lilian, 2014; Mitchell, 2012; Morrison-Smith & Ruiz, 2020; Liebert & Trzeciak, 2019; Yücebalkan, 2018). It is important to design competence networks and cross-partner intelligence by creating tight couplings and linkages among participants, managing team competencies, and allocating tasks according to skills and capabilities (Oberer & Erkollar, 2018; Rao, 2016). For Khan (2016), ensuring relational transparency and trust are the core values in this context. Valuing expertise, culture, and talent development requires a comprehensive understanding of member skills and traits to provide personal development and effective talent management (Kane et al., 2015). The participative requirements entail autonomy to employees, support for individual work, and reliance on self-responsible teams. These measures lead to proactive behavior and innovation as the key leader characteristics (Khan, 2016; UCISL, 2017). Providing freedom for experimenting, testing, making mistakes, learning from faults, and providing inspirational motivation (Khan, 2016; Oberer & Erkollar, 2018) are essential.

Consequently, a participative leader should be the one truly believing in coaching and life-long learning while respecting personal talent development.

Agility-focused requirements

Agility refers to speed, flexibility, responsiveness, and customer centricity, which are the key issues determining the competitiveness and survival of complex supply network ecosystems. Hence, requirements inherently related to these key concepts are classified under "agility-related" requirements. Leadership's most important and imperative traits are speed, flexibility, and responsiveness in decision-making to obtain results under VUCA conditions (Horney et al., 2010; KPMG, 2017; Roubini ThoughtLab, 2017; UCISL, 2017). Also, leaders should be able to collaboratively manage uncertainty and risk by anticipating change and taking proactive action in a VUCA world (Horney et al., 2010; Slagmulder & Devoldere, 2018). Being customer-centric and service-driven while valuing customer relations and engagement are again mentioned as a "top priority" (Lawrence, 2013; Tanniru, 2018) for seamless, omni-channel customer experience. The leaders should have an agile perspective related to IT architectures and IT-business alignment, considering modularity, speed, scalability, and reliability with tightly-coupled integration of IT architectures (EY, 2014; KPMG, 2017).

Hence, the leaders of IT-based collaborative ecosystems should have an agile perspective, valuing the key principles of speed, flexibility, responsiveness, and customer orientation.

Innovation-focused requirements

With tremendously shortened product and design lifecycles, ever-increasing customer demands, ever-changing technology, and VUCA conditions, our study identified being innovation-

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focused as a key class of requirements. Leaders should balance growth and risks related to innovation (Deprez et al., 2018; KPMG, 2017; Yücebalkan, 2018). They should understand the vitality of innovation for the survival of the ecosystems and continuously strive to foster a sustained IT-enabled culture of open collaborative innovation by inspiring creativity (Agger et al., 2015; Cortellazzo et al., 2019; EY, 2014; Guinan et al., 2019; Horney et al., 2010; Mainemelis et al., 2015; Raza, 2016; Super, 2020; Tanniru, 2018). Thus, key theme appears as "collaborative innovation," referring to the generation and fostering of innovation across partners (Horney et al., 2010) in a collaborative context (Cook, 2016; Le et al., 2020). In this direction, an entrepreneurial and intrapreneurial mindset that allows and rewards in-house entrepreneurship and intrapreneurship, appear as essential traits. Leaders focusing on innovation should seek an ecosystem in which innovation, entrepreneurship, and intrapreneurship are really valued and rewarded (Ardi et al., 2020; Arun et al., 2021; Begeç & Arun, 2020; Oberer & Erkollar, 2018; Okun et al., 2020; Roubini ThoughtLab, 2017; UCISL, 2017; Utoyo et al., 2020). In this regard, divergent thinking ability with a mindset of applying new methods and instruments is critical. Innovative leaders should think out of the box (Lawrence, 2013), appreciating and supporting such ideas. Open-mindedness, openness to new ideas and suggestions, and valuing digital talent development and free thinking are critical (Horney et al., 2010).

Consequently, supporting the creation of an ecosystem in which collaborative creativity, innovation, entrepreneurship, and intrapreneurship are valued appears as the key requirement in the new paradigm.

FRAMEWORK DEVELOPMENT

This section develops a generic framework for the requirements of collaborative and transformational leadership (CTFL) in digital ecosystems (DES) based on the literature review developed in the previous sections. Table 2 shows the following seven clusters with the main requirements:

- Essential
- Technology-focused
- Collaborative
- Transformational
- Participative
- Agility-focused
- Innovation-focused

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The framework proposed in Figure 1 is based on these main headers:

Figure 1. Generic framework for collaborative and transformational leadership requirements in digital ecosystems
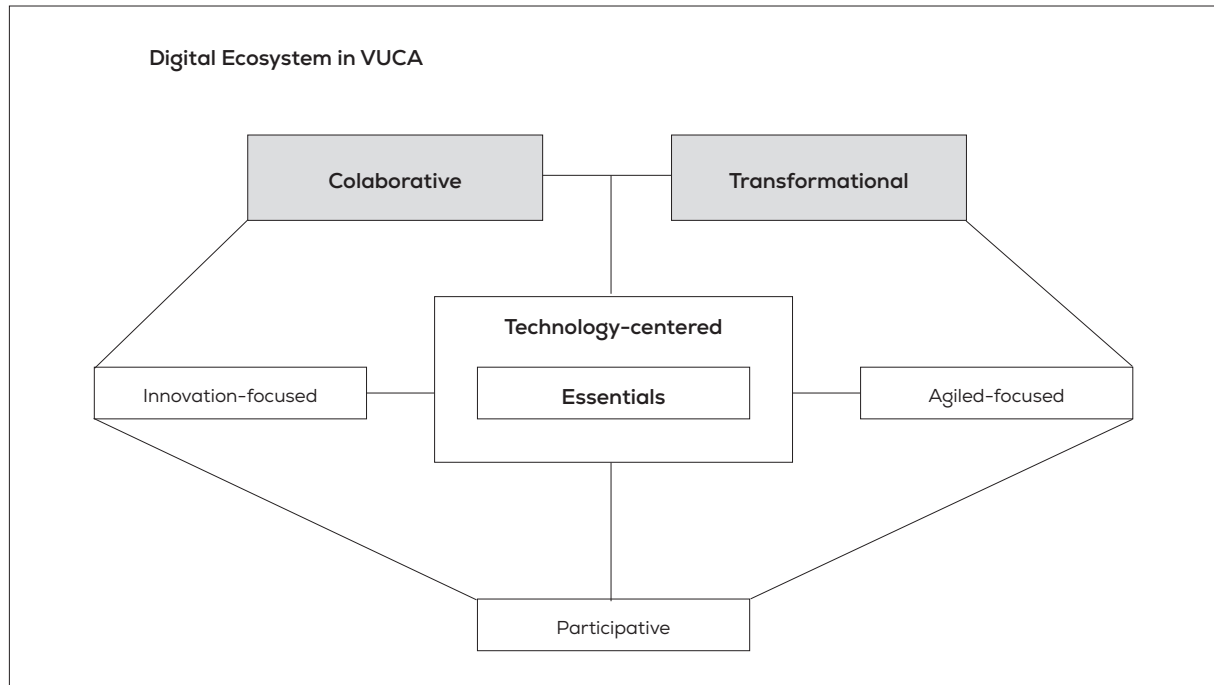
Source: Elaborated by the authors.

In this diagram, it is important to highlight the following:

- All clusters interact with and affect each other,
- Being centered around essential characteristics and technology-focused provides the foundation for a contemporary and holistic approach to the entire ecosystem. This approach enables collaborative, transformational, agile, innovative, and participative leadership within DES.

This framework is comprehensive and integrative by accounting for all the following leadership requirements from technical, managerial, organizational, and behavioral aspects:

- essential traits and new requirements arising from current disruptive technological changes,
- collaboration requirements in complex, web-based, networked ecosystems spanning enterprise boundaries,
- transformational requirements in this extended ecosystem,
- participative requirements,
- agility and innovation requirements in web-enabled ecosystems.

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The framework considers the requirements for managing technological, organizational, and managerial transformation needed to align new disruptive technologies, business strategies, models, and processes reengineering efforts toward an overall transformation. The need for aligning these components with appropriate change management is well-established in the management of information systems (MIS) and organizational change management literature. However, these issues must be handled in a more complex, extended, and multi-partner context in a collaborative web-based environment. This demands the embracement of more disruptive and dramatic technological change; development of digital strategy, vision, and a transformation plan; assessment of company readiness for digital transformation; and proper management of the transformation with all dimensions.

Thus, this framework is compatible with and accounts for the core ideas of the literature from leadership, strategic management, organizational design and change, collaborative and complex supply networks, and MIS domains. These core ideas are extended to multi-partner, multi-cultural web-based ecosystems and integrated to meet the increasing collaboration, agility, innovation, transformation, and participation needs of complex, technology-enabled ecosystems in the VUCA world. Due to these characteristics, this framework is unique and contributes to the literature in the above-mentioned domains.

DISCUSSION

This study shows that for managing technology-intensive ecosystems, contemporary leaders should possess core leadership characteristics while meeting new requirements related to being technology-focused, collaborative, transformational, participative, agility-focused, and innovation-focused.

This is a radical paradigm shift in leadership, demanding a collaborative and transformational mindset with the skills to simultaneously handle multiple dimensions of digital transformation (DT) for the entire ecosystem. Being technology-centered to manage the disruptive technologies toward organizational goals and handling the organizational change within a participative mindset is essential. Hence, a transformational approach is vital to handle the technology-intensive transformation and all the organizational and managerial aspects. Also, it is critical to create opportunities for cross-border participation and a collaborative climate for agility and innovation-related results.

Findings show that leaders for technology-intensive collaborative ecosystems should possess a holistic view that can oversee multiple players, dimensions, components, processes, dependencies, and interactions while understanding the VUCA challenges in managing the transformation.

Orchestration also appeared as a critical theme, referring to the ability of a leader to act as a maestro to orchestrate all system components and processes synchronously and collaboratively for the ecosystem. Harmoniously managing well-defined multi-partner processes and interactions for operational, tactical, and strategic dimensions with the alignment of

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technological, managerial, and organizational aspects appears to be a critical leadership characteristic. Consequently, we believe that "techno-orchestrating leaders" can be an appropriate and overarching term to define CTFL to meet the demands of the VUCA world in today's I-4.0 and IoT age.

CONCLUSIONS AND FURTHER RESEARCH

This study has shown that identified leadership requirements seem to redefine the skill sets and capabilities needed to manage contemporary, interdependent, technology-intensive, and collaborative business networks. It appears that the classical transactional approach and authoritative leadership understanding cannot result in successful leaders in today's era. Our findings support that collaborative leaders with a technology-focused mindset and transformational participative spirit with a focus on agility and innovation are required to manage DES under harsh VUCA conditions. Hence, they should be "techno-orchestrating" leaders to meet the challenges of the I-4.0 and IoT era.

Depending on the framework developed, we believe this study is valuable for guiding today's leaders toward a comprehensive and holistic understanding of all these requirements. With its broad coverage, we hope that the clustering provided in this study can be useful in any further theory development efforts in the leadership domain.

Further studies can examine how well the leadership requirements identified in this study are met in different business contexts. Enterprise-based, sector-based, and network-based studies can be useful for researchers studying this field.

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CONFLICTS OF INTERESTS

The authors have no conflicts of interests to declare.

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Suat Begeç: Project Administration; Formal Analysis; Conceptualization; Data Curation; Writing - First Writing; Writing - Review and Editing; Investigation; Methodology; Supervision; Validation; Visualization.

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