Received: 21 March 2020 | Revised: 2 April 2020 | Accepted: 19 April 2020

DOI: 10.1002/bse.2514

RESEARCH ARTICLE

Business Strategy and the Environment

WILEY

Building responses to sustainable development challenges: A multistakeholder collaboration framework and application to climate change

Gianluca Elia[1] | Alessandro Margherita[2] | Claudio Petti[2]

[1]Engineering for Innovation, Campus Ecotekne Via per Monteroni sn, University of Salento, Lecce, Italy

[2]Engineering for Innovation, University of Salento, Lecce, Italy

Correspondence
Gianluca Elia, Engineering for Innovation, Campus Ecotekne Via per Monteroni sn, University of Salento, Lecce 73100, Italy.
Email: gianluca.elia@unisalento.it

Abstract

The affirmation of open innovation and collaborative systems is enabling unprecedented opportunities to create business value while facilitating multistakeholder conversation on sustainability issues. In particular, platform-based models are emerging as organization archetypes able to facilitate cooperative dynamics among industrial actors, policy makers, academicians, scientists, and citizens. In this article, we use interdisciplinary business management and collaborative innovation literature to build the conceptual framework of a multisided platform as a collaboration environment gathering actors willing to define responses to sustainable development challenges. We present five dimensions or "genes," that is, the focus and strategic intent or orientation of the platform (*what*), the participating sides, actors and groups (*who*), the actions, flows and coordination mechanisms (*how*), and the value drivers, benefits and externalities (*why*), and the rules regulating the affiliation and interaction processes (*governance*). We also present and discuss 30 subtopics or management items that are associated with the five dimensions defined. We then apply the conceptual model to analyze a case in the climate change endeavor and to show how competitive and cooperative dynamics can be virtuously integrated to provide individual- and company-driven responses to a timely socioenvironmental issue. The article provides a new perspective on collaboration to enhance social development, and it offers theoretical and practitioner insights for a broad interdisciplinary audience including scholars, practitioners, business, and platform managers.

KEYWORDS

climate change, collective intelligence, management system, multisided platform, multistakeholder collaboration, sustainable development

1 | INTRODUCTION

Sustainable development, initially defined at the UNCED Earth Summit in Rio (UNCED, 1992), refers to the ability to meet the needs of the present generations without compromising the ability of future generations to meet their own needs (WCED, 1987). Hence, the overall goal of sustainable development is the long-term stability of economic systems, through the integration of environmental and social concerns throughout the policy and decision-making process. In 2015, the United Nations identified 17 sustainable development goals related to a set of universal and integrated problems that cover global and complex issues such as poverty, nutrition, instruction, sanitation, employment, climate change, preservation of natural resources, and justice (UN, 2015). The UN agenda represents a vast space of opportunity for organizations, institutions, and individuals willing to collaborate to build innovative solutions able to enhance global

socioeconomic wealth. In such view, sustainable development may represent an area for innovation (Cillo, Messeni Petruzzelli, Ardito, & Del Giudice, 2019; WBCSD, 2010) and an entrepreneurship field through the identification of promising business opportunities that emerge from the transition of problems to solutions (Eller et al., 2020).

Sustainability and sustainable development are wicked challenges, with many potential driving factors and no single formulation or valid solution, but only answers that are better or worse from different angles (Rittel & Webber, 1973). Three different types of complexity affects sustainability (Meckenstock, Barbosa-Póvoa, & Carvalho, 2016), that is, social complexity (diverging views and values among involved stakeholders), cognitive complexity (non-transparent causes and effects within the massive network of variables and data that describe the problem), and temporal complexity (uncertainty about evolution and long-lasting repercussions). Discussions and attempts to address sustainable development require thus knowledge beyond the boundaries of one organization (Goodman, Korsunova, & Halme, 2017) and require the cooperation of multiple stakeholders that are affected by the developmental benefits and/or risks (Saravanamuthu, 2018) in order to properly define, fully comprehend, and effectively attempt to solve the problem (Barnett et al., 2018).

The explosion of open innovation and collaborative systems is enabling unprecedented opportunities to create business value while facilitating multistakeholder conversation on sustainability issues. The emerging "digital sharing economy" (Cusumano, 2015; Hamari, Sjöklint, & Ukkonen, 2015; Pouri & Hilty, 2018; Sutherland & Jarrahi, 2018), also labelled platform or peer economy (Kenney & Zysman, 2016; Witt, Suzor, & Wikström, 2015), provides individuals and organizations with the opportunity to connect each other in interactive ecosystems to create, exchange, and capture value (Van Alstyne, Parker, & Choudary, 2016; Teece, 2018). Sharing economy is a growing segment and an information-intensive sector (Apte & Davis, 2019). The development of purposeful information systems and platforms is able to connect today different stakeholders to generate value by sharing their resources and capacities. Such new-generation platforms allow to convey, integrate, or support a number of different actors and activities in a multitude of scenarios.

Within such ecosystems, the combination of declining transaction costs and increasing connectivity (Frenken & Schor, 2017; Guttentag, 2015), along with factors such as flexibility, digital trust, and real-time matchmaking, is supporting disruptive business model innovation (Amit & Zott, 2012; Amit & Zott, 2015; Schor, 2016). In particular, the digital-enhanced interaction among users has driven the emergence of two-sided markets (Rochet & Tirole, 2006; Eisenmann, Parker, & van Alstyne, 2006), two-sided Internet platforms (Muzellec, Ronteau, & Lambkin, 2015), and multisided platforms (MSP), which operate as matchmakers and generate significant network effects (Hagiu, 2014). Examples include AirBnB in the accommodation industry, Alibaba, Craiglist, and Rakuten in retail, Fandango and Netflix in the movie industry, Uber and BlaBlaCar in transport, eDX and Coursera in education, WeChat in communications, SocietyOne in banking, and EatWithMe in the building of social connections.

Platform-based models have also gradually emerged as organizational archetypes able to facilitate cooperative dynamics among industrial actors, policy makers, academicians, and citizens. Recent literature (Curtis & Lehner, 2019) investigates the concept of the sharing economy from the perspective of sustainability science. From a sustainability perspective, the digital sharing economy may represent an interpretative framework to address sustainable development goals (Martin, 2016) by leveraging distributed knowledge and expertise possessed by thousands of individuals and articulate them to support better decisions and effective solutions. Strategies to address sustainable development goals have been discussed with reference to access-based and collaborative consumption (Bardhi & Eckhardt, 2012; Belk, 2014), and sharing economy (Botsman & Rogers, 2010) by promoting access over ownership (Martin, 2016), and by reducing overall consumption and resource use (De Leeuw & Gössling, 2016).

Despite such general discussion on the alignment of sustainability and sharing economy principles, literature on how multistakeholder collaboration can be adopted for the collaborative resolution of social challenges and sustainable development is limited, and the application of collective intelligence principles for public good is still poorly supported by collaborative social platforms (De Liddo & Buckingham Shum, 2014). In this article, we address this gap and use interdisciplinary business management and collaborative innovation literature to build the conceptual framework of a multistakeholder environment gathering actors willing to define and apply responses to sustainable development challenges. The framework is aimed to activate inter-organizational collaboration and crowdsourcing processes to exchange environmental knowledge and share competences for sustainable innovation (Messeni Petruzzelli, Dangelico, Rotolo, & Albino, 2011). We present five dimensions or "genes" of the platform associated with its strategic focus ("what"), the participating sides ("who"), the actions designed and undertaken ("how"), the value drivers motivating the participation ("why"), and the norms or policies regulating the affiliation and interaction processes ("governance"). Associated with those dimensions, we also present 30 subtopics or management items, and we apply the model in the climate change endeavor to show how competitive and cooperative dynamics can be virtuously integrated to provide individual- and company-driven responses to a timely socioenvironmental issue.

The application of the framework provides a preliminary conceptual validation and a first demonstration of the potential of using the model to build new strategies and tools for sustainable development. Besides, the study allows exploring the role of information systems to support collaboration and cooperative knowledge management for sustainable development goals (Cillo et al., 2019; Seuring & Gold, 2013).

The remainder of the paper is structured as follows. Section 2 introduces extant works on collaborative approaches to complex problem solving and sustainable development. The conceptual framework is derived and presented in Section 3. Section 4 illustrates the case of a platform operating in the climate change field. Section 5

provides a discussion of findings, and Section 6 concludes the paper with limitations and avenues for further research.

2 | BACKGROUND

The attempt to find possible solutions to complex societal challenges has been a major driver in the field of democratic participation and collaborative decision making. Whereas societal problems are wicked (Churchman, 1967), the explosion of open innovation and collaborative systems is allowing collective intelligence to emerge and gather with the aim to solve problems collectively with higher effectiveness than individually. Open innovation is defined as the "use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006), Through open innovation, organizations may thus favor purposive search for an inflow of knowledge originating beyond their boundaries to complement and renew the internal knowledge base (Ardito, Messeni Petruzzelli, Dezi, & Castellano, 2018). Similarly, organizations can explore the interest of external actors to use unexploited intellectual and technological assets and receive back some kind of benefits. This makes more porous and cooperative the boundary between organizations and their surrounding environment and stimulates cocreation and interfirm relationships for innovation (Del Vecchio, Di Minin, Messeni Petruzzelli, Panniello, & Pirri, 2018). The acquisition of external knowledge and exploitation of internal knowledge can increase the opportunities to recombine internal and external intellectual assets and favor the cross-fertilization among knowledge areas to enhance the performance of the innovation process (Natalicchio, Savino, Messeni Petruzzelli, & Cardinali, 2018).

This dynamics is much more emphasized in the sustainable development field, which requires an intense multidisciplinary approach to problem solving. The evolution of cyber based and online communities has allowed enlarging the discussion of such wicked problems by aggregating multiple viewpoints and expertise in the aim to shape collaboratively a more sustainable future (Ahmed & Hardaker, 1999). Virtual communities can be considered as both social spaces and tools for implementing open innovation (Ebner, Leimeister, & Krcmar, 2009; Elia, Messeni Petruzzelli, & Urbinati, 2020), similarly to crowdsourcing platforms (De Mattos, Kissimoto, & Laurindo, 2018), living labs (Yazdizadeh & Tavasoli, 2016), and systems for partners matching (Meulman, Reymen, Podoynitsyna, Romme, & Georges, 2018). They allow groups of people that are globally distributed to share ideas, exchange information and knowledge through computer-mediated and interactive communications, and execute actions to develop projects and implement innovative solutions. Virtual collaboration and online knowledge sharing can be framed under the paradigm of collective intelligence, which studies how people and computers can be connected to each other by sharing resources and using interaction mechanisms (Boder, 2006) so that, collectively, they act more intelligently than any individuals, groups, or computers have ever done before (Malone, Atlee, & Levy, 2008; Malone, Laubacher, & Dellarocas, 2010). Under conditions of diversity, independence, and aggregation, such "communities" can enhance the wisdom of crowds (Surowiecki, 2005) and support cognition, coordination, and cooperation (Engelbart & Ruilifson, 1999; Malone & Crowston, 1994). The potential of interconnectivity and collaboration embedded in the digital technologies (Bonabeau, 2009) can allow collective intelligence systems to support people-centered and democratized innovation (Von Hippel, 2005).

Research conducted at the crossroads of collective intelligence and social media help design appropriate decision support and management information systems for wicked problem resolution. The effectiveness of decision-making relies in fact on the capacity to link the varied contributions of the involved agents, which depend on their different interests, points of view, and values. Collective intelligence (Lévy, 1994; Tapscott, 2014) can be thus a strategy to address complex and multifaceted social challenges by involving people with different interests, worldviews, and values (Nogueira, Borges, & Wolf, 2017). Sociocomputational systems or collective intelligence systems (Malone et al., 2010) may allow the harvesting of distributed knowledge and experience possessed by potentially thousands of individuals, thus supporting more robust and shared decisions for the public good (De Liddo & Buckingham Shum, 2014).

Examples of collective intelligence systems supporting community-based resolution of wicked problems and challenges include Open Ideo (www.openideo.com) and the MIT Climate CoLab (www.climateCoLab.org; Introne, Laubacher, Olson, & Malone, 2013). These systems provide tools and resources for idea sharing, online voting, support, contribution, and expert mentoring. Partnerships for SDGs (https://sustainabledevelopment.un.org/partnerships) is an online platform representing the United Nations' global registry of voluntary commitments and multistakeholder partnerships facilitating global stakeholders' engagement in support of the implementation of Sustainable Development Goals. The Global Climate Action Portal NAZCA (https://climateaction.unfccc.int) is an online platform where actors from around the world (countries, regions, cities, companies, investors, and other organizations) can display their commitments to act on climate change. The UN Global Compact (www.unglobalcompact.org) is a voluntary initiative based on CEO commitments to implement universal sustainability principles and to take steps to support UN goals (Pereira et al., 2019). The EU2020 "Catalyst" project is a large-scale research effort aimed to generate and apply open tools for collaborative knowledge creation for public good.

CoPe_it! (http://copeit.cti.gr) is a web-based tool that complies with collaborative principles and practices and provides members of communities engaged in argumentative discussions and decision-making processes with the appropriate means to collaborate towards the solution of diverse issues (Karacapilidis & Tzagarakis, 2009). Debate graph (http://debategraph.org) is an award-winning web-platform for visualizing and sharing networks of thought and opening reasoning and action to collaborative learning and iterative improvement. The platform support individuals and communities in over

100 countries to deliberate and take decisions on complex issues. Finally, the CogNexus Institute (http://www.cognexus.org) works on wicked problems and dialogue mapping whereas the Swedish Morphological Society (http://www.swemorph.com) applies General Morphological Analysis (GMA) for structuring and analyzing the total set of relationships contained in multidimensional, nonquantifiable, problem complexes.

3 | RESEARCH METHOD

A design science approach was adopted to conceptualize and build the conceptual framework. Design science supports a pragmatic research paradigm that calls for the creation of innovative artifacts to solve real-world problems or design and experiment innovative solutions through the phases of problem identification, objectives definition, artifact development, solution demonstration, evaluation, and research communication (Hevner, March, Park, & Ram, 2004; Peffers et al., 2006).

Whereas the problem is represented by the rise of sustainable development challenges for both individuals and organizations, the objectives of this research is to support collaborative discourse, argumentation, and action on sustainability through the design of new platform-based archetypes. The artifact developed is a five-dimension framework of MSP which provides both process and information systems considerations for developing new services and applications. A case study was also conducted to provide an illustrative demonstration and application of the framework for extrapolating further insights (Eisenhardt, 1989). Case study represents a strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context (Yin, 2003). Case study method is usually chosen for the purpose of the first study because it gives more in-depth analysis of the research problem, more detailed information, and more comprehensive results (Creswell, 2003). We adopted the case study approach for illustration purposes, to provide a clearer view of how the theoretical framework could be applied in an empirical setting (Siggelkow, 2007).

We investigated the MIT Climate Colab, which is one of the most successful and recognized initiatives in the domain of climate change (a relevant topic in the sustainable development field). Data collection was conducted in February 2019 and was mainly based on the information sources available on the web site of the initiative (https://www.climatecolab.org). To support triangulation of data, we studied the scientific papers and technical reports published by the founders and sponsors of the initiative. Finally, we based our analysis on participatory observation and navigation of the web-based platform. The conceptual framework presented in the paper provided a collection and coding structure for the information on the case, which was then investigated in terms of the five dimensions or "genes" of the platform (strategic focus, participating sides, actions undertaken, value drivers, and participation norms) and the associated subtopics or management items. The result of data analysis is included in this paper, which represents a preliminary research report and scientific communication documenting the adoption of the MSP model for the design of sustainable development initiatives.

4 | FINDINGS: A MULTISTAKEHOLDER FRAMEWORK FOR SUSTAINABLE DEVELOPMENT

In this section, we define a model of multistakeholder collaboration for sustainable development. The model leverages the organization archetype embedded within the Multisided Platform (MSP). The concept of MSP was introduced in the early 2000s (Armstrong, 2006; Caillaud & Jullien, 2003; Parker & Van Alstyne, 2005) to describe an Internet-based system enabling direct interactions among customer groups and actors affiliated with the platform to access a variety of resources, information, and value-added services (Hagiu, 2014; Hagiu & Wright, 2015; Wang, Lai, & Chang, 2016). MSPs can operate as "transaction platforms" or "online marketplaces" that create value by facilitating the buying and selling of goods and services, as well as the creation and sharing of content. Platforms have the ability to reduce search and transaction costs and generate value by exploiting positive feedback loops and network effects (Cusumano, Yoffie, & Gawer, 2019). Different from transaction platforms, "innovation platforms" allow ecosystem partners to create new complementary products and services (e.g., apps or digital content for Apple iTunes or Netflix).

Using a digital entrepreneurship perspective (Cohen, Amorós, & Lundy, 2017; Giones & Brem, 2017; Nambisan, Lyytinen, Majchrzak, & Song, 2017; Richter, Kraus, Brem, Durst, & Giselbrecht, 2017), an MSP can be interpreted as a digital platform that offers a shared set of services and architectural components and hosts complementary offerings and software interfaces that guarantee communication and interoperability (Parker, Alstyne, & Choudary, 2016). The MSP can be also considered as a digital ecosystem (Gawer & Cusumano, 2002; Iansiti & Levien, 2004; Li, Badr, & Biennier, 2012), a digital entrepreneurship ecosystem (Elia, Margherita, & Passiante, 2020), and an emerging organizational form enabled by digital technologies (De Reuver, Sørensen, & Basole, 2018).

The MSP is characterized by a number of core aspects (Hagiu, 2009) related to the goal of the platform, the participants, the working mechanisms, and the overall governance. Using a classification adopted to study collective intelligence systems (Malone et al., 2010), four main "genes" of a MSP can be identified in terms of the focus ("what"), the participating sides ("who"), the actions undertaken within/through the platform ("how"), and the value drivers which characterize the MSP ("why"). Table 1 shows the four genes of the MSP and provides a general description of the same.

The *"what"* dimension refers to the strategic intent, orientation, and focus of the MSP. In general terms, an MSP is developed to support business transactions or innovation processes within specific business, industry, and organizational scenarios. In the sustainable

TABLE 1 Four genes of an MSP and distinguishing aspects

Genes	Description
WHAT (focus, strategic intent, orientation)	• Vision of the platform and specialization in relation to supporting discussion and actions into specific business or nonbusiness domains • Orientation in terms of being a transaction (marketplace), innovation (design and creation), or hybrid platform
WHO (sides, actors, groups)	• Groups of actors and other stakeholders impacted by or impacting on policies, goals and relevant actions of the platform • Stakeholders interested in interacting with other groups and agents, and affiliated to the platform (membership process)
HOW (actions, flows, mechanisms)	• Value adding coordination and relations/flows among members facilitated by matching algorithms and interaction tools • Working mechanisms of the platform and activities undertaken to support its strategic focus
WHY (value drivers, benefits, externalities)	• Benefits obtained by actors from participation, advantages from having their demand coordinated with other members/groups, direct and indirect network effects for nonlinear increases in utility (value) • Motivations driving stakeholders and actors to participate in the platform and contribute into discussion and coordinated actions

development endeavor, goals and capabilities enabled by the platform could be thus aligned with the achievement of one or more sustainable development goals, like poverty reduction, decrease of urban pollution, or improved access to healthcare and education services. The "specialization" of the MSP for sustainable development can be the result of top-down definition (e.g., provided by a sponsor institution or business entity) or rather emerging from open discussion, public argumentation, social innovation and entrepreneurship, problem breakdown and solving (Helfat & Raubitschek, 2018). The large participation of individuals and groups could contribute to comprehensively describe the sustainable development by a social, economic, and environmental point of view.

The *"who"* dimension of the MSP is related to actors, groups, and sides of the platform. Whereas most MSPs host basically two sides (e.g., Uber, Airbnb, and eBay), advantages may derive from increasing the number of groups in terms of larger cross-side network effects, scale, and potentially diversified sources of revenues. Societal problems are wicked, and they require collaboration and cooperation of multiple stakeholders over time in order to be defined and solved (Elia & Margherita, 2018; Introne et al., 2013). In a sustainable development endeavor, the MSP could thus convene a differentiated range of participants such as citizens, professionals, companies, scientists and researchers, policy makers, and complementors who can contribute actively into the sustainability discussion. In line with a collective intelligence logic, the participation in the platform should be free and open at any time (no formal authority decides on the participation). Nevertheless, roles or participation attributes (e.g., based on knowledge and expertise) could be identified in relation to specific discussions or actions based on the platform's contribution policy and by adopting purposeful matchmaking algorithms.

The *"how"* dimension refers to the strategy and processes (actions, flows, and procedures) aimed to setup and develop the MSP. Key issues include (Cusumano et al., 2019; Hagiu, 2014; Hagiu & Wright, 2015; Parker & Van Alstyne, 2005) the mechanisms and activities aimed to facilitate the development of network effects, the resolution of the "chicken-and-egg" problem (the initial small number of participants in one side of the platform could reduce interest and participation from other sides), the development of aggregation functions, and the monitoring of performance. In the sustainable development view, the network effects could be crucial in terms of direct and indirect externalities deriving from the participation to a public debate and contribution to relevant problem solving. Actions could include social innovation projects, social entrepreneurship initiatives, workshops, and awareness building actions. The chicken-and-egg problem may be relevant for the MSP on sustainability, and it will be thus critical to involve actors and organizations willing to sponsor the initiative and be available to provide a test-bed for initial experimentation and pilot initiatives aiming to encourage participation. Aggregation mechanisms and matchmaking functions should be designed in a way to ensure an optimal fit among sustainable development knowledge, expectations, and capabilities. Also, the monitoring of participants' behavior and the use of digital services should be effectively and purposefully designed to ensure stability of the system and the community developed around the same.

The last dimension of investigation is related to the *"why,"* that is, the motivating factors, benefits, and incentives (externalities and value sources) that bring participants to join the platform and operate actively within the same. Thanks to the (direct and indirect) network effects (Gawer & Cusumano, 2014), the more active participants operate from each side, the greater the potential value that the MSP can generate for stakeholders. In particular, key value-drivers that attract participants into an MSP (Hagiu, 2009; Hagiu, 2014; Hagiu & Wright, 2015) are resource optimization and matchmaking (e.g., price-based, quality-based, and reputation-based), audience building (e.g., opinions, comments, and visibility), efficiency seeking (e.g., economy of scale, speed, and information symmetry) and cost reduction (e.g., search, transaction, coordination, and new product development costs). Other motivations may include enhanced decision-making and problem solving, collaboration, and innovation (leveraging a large community and a pool of knowledge and resources). With reference to sustainable development, actors could be motivated to participate in the MSP by a sense of responsiveness about sustainability (e.g., responsibility for the planet, peaceful

cohabitation, and importance of decorous living conditions), and the desire to be informed and contribute to public discussion and shared problem analyses and solutions generation processes. Stakeholders and specific actors may also be motivated by philanthropy, passion (e.g., love for the topic and desire to contribute to human progress), glory (e.g., professional visibility and fame), and direct and indirect monetary rewards deriving from projects funding, professional assignments, and industrial collaborations.

The orchestration of the MSP requires a purposeful governance structure, that is, a set of explicit and implicit rules regulating the affiliation, participation, and interaction within the platform. Other issues to consider are the certification of contents and services provided, the financial and human resources management issues associated with the management of the platform (including the revenue and business model), and the resolution of potential conflicts arising within the MSP ecosystem. Figure 1 shows the MSP model for sustainable development organized around the five dimensions and the 30 management items that are associated, whereas next section applies the framework to a platform operating in the climate change scenario.

5 | AN ILLUSTRATIVE CASE: THE MIT CLIMATE COLAB

In this section, we apply the defined framework to describe a case study in the climate change endeavor. Climate change emerged as a major management issue in the sustainable development panorama to be dealt with by society in the next 20 years (De Sousa Jabbour, Vazquez-Brust, Jabbour, & Ribeiro, 2020; Shaw, Cumbers, McMaster, & Crossan, 2018) that may irreversibly create catastrophic effects for people and the planet (Bryant, griffin, & Perry, 2020).

The case analyzed is the Climate CoLab (www.climatecolab.org), a successful initiative launched by the CCI—*Center for Collective Intelligence* of the MIT—Massachusetts Institute of Technology. The vision of the CoLab is to harness the collective intelligence of thousands of people to define potential solutions to climate change through public argumentation and problem breakdown. The CoLab hosts a community of individuals with different background (e.g., scientists, experts, policymakers, business people, practitioners, investors, and citizens) which can be associated to three "sides" (see Figure 2). The first group is represented by people interested in creating proposals and launching initiatives in the field of climate change. The second side includes members willing to vote for and support existing proposals and initiatives, whereas the third group includes experts, advisors, judges and assessment fellows, catalysts, and staff members committed to analyze proposals and provide feedback. Whereas the first two sides autonomously join the platform, the third side includes individuals that are "appointed" by the CoLab governance based on their expertise, qualification, and networks (connections). The total number of members registered to the platform at the end of August 2019 was about 121,700, including 15 staff members, 122 advisors, 227 fellows, 343 judges, 123 catalysts, and 21 impact assessment fellows. The large volume of users also attracts sponsors and corporate initiatives, such as the recent Lufthansa's Changemaker Challenge on sustainable travel and mobility.

The CoLab is an example of *collective creativity platform* (Iasevoli, Michelini, Grieco, & Principato, 2018), capable to gather interest and integrate knowledge and competencies required to conceive, design, and build social innovation and entrepreneurship activities aimed to address climate change. Community members can propose ideas and build a team with other participants to work on a project *proposal*. All the proposals submitted are grouped into *contests* that are evaluated by expert judges using criteria such as novelty, feasibility, practicality, impact, relevance, acceptance, and presentation. The best proposals are selected by a committee, which provides recommendations for submitting more analytical versions, which are finally voted by the

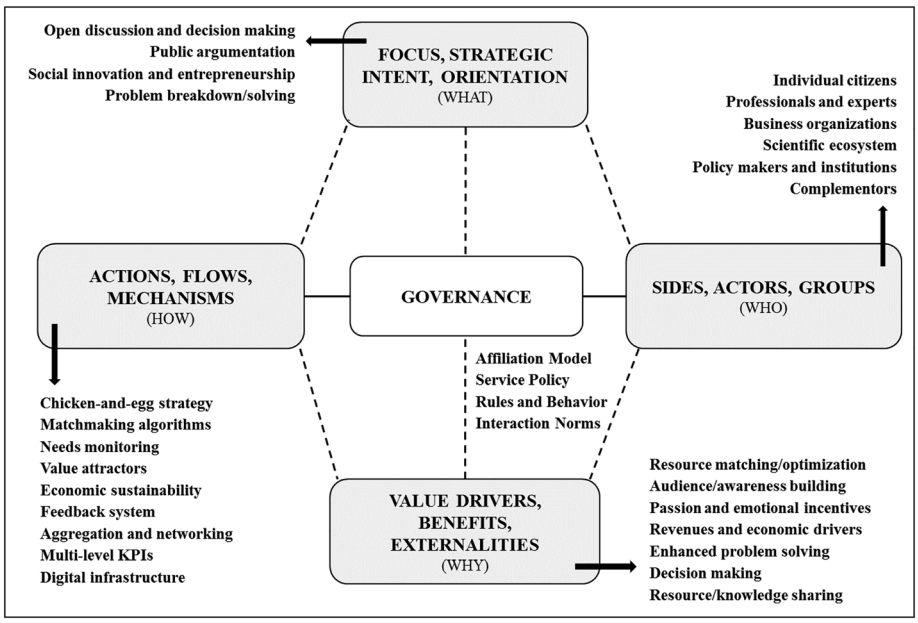

FIGURE 1 A model of multisided platform (MSP) for sustainable development

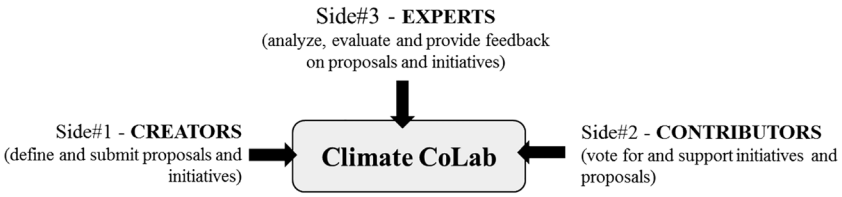

FIGURE 2 MIT climate CoLab as a three-sided platform

community to define the winners. Examples of contests are in the area of waste management (with proposals like large air purification systems and recycled materials to build solar water heaters), and the transition of cities towards circular economy (proposals include smartphone apps supporting enterprises to employ pyrolysis to turn low value waste plastic into fuel).

The CoLab leverages the MIT brand and the value of its network of sponsors and collaborators to attract participants. By following a supply-domain strategy (Ott, Bremner, & Eisenhardt, 2018), an initial group of expert members connected with the founding organizations and sponsors is invited to develop proposals and participate in the online interactions. Then, by tuning the supply with the evolving demand, both sides grow via the promotion of partnerships with influential stakeholders. Indeed, the increasing number of members that submit project proposals into the community attracts experts, scientists, and companies that provide their contribution and enhance the quality of proposals (direct network effects). At the same time, the proliferation of members and the richness of their contribution in terms of knowledge and expertise attract and motivate new members to join the platform to provide suggestions and feedback, or create new proposals (indirect network effects). A matchmaking algorithm allows each participant to search and browse autonomously both the contests and proposals.

Proposals can be broken down into more manageable subsolutions, organized along four key dimensions: (a) typology of actions (e.g., mitigation actions and adaptation actions); (b) geographical scale (e.g., global level, regional level, and city level); (c) nature of leadership (e.g., governmental bodies, business organizations, and citizen); and (d) level of the intervention (e.g., physical, political, economic, and cultural). These dimensions allow to visualize and browse contests, as well as to aggregate the same into more systemic and coordinated actions. Figure 3 shows a list of contests.

The platform is promoted through an annual conference and the involvement of the media. At the platform level, three key indicators (measured at the end of August 2019) are (a) the total number of registered members (over 121,700); (b) the total number of proposals submitted (about 3,000); and (c) the total number of contests that collect the proposals (around 111). At the proposal level, key indicators used are the number of comments received, the number of votes collected, and the number of supporters. A crucial measure of quality of submitted proposals is the climate impact, which is calculated by an impact assessment fellow based on the application of ad-hoc models and simulators. At individual level, two indicators measure the quality of participation: (a) total number of performed actions (e.g., submission of new proposals, joining of proposals, support to existing proposals, and comments to existing proposals); and (b) CoLab points assigned to winning proposals and distributed among team members and contributors. The economic sustainability of the CoLab is based on donations made by participants or web visitors and fees paid by sponsors and collaborators. The digital backbone of the platform is represented by a virtual community hosted in the cloud and realized through the Climate CoLab Software (an open source suite available on GitHub).

The collaborative approach enhances the effectiveness of proposals in terms goal achievement and impact of results. Indeed, climate change issues are analyzed along multiple views, and this streamlines the elaboration of more robust, acceptable, and sustainable solutions. The presence of influential stakeholders operating in

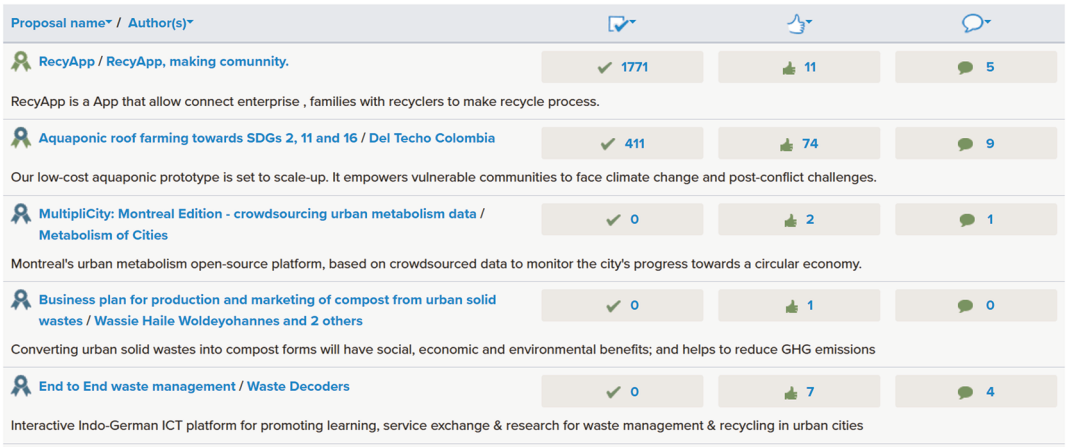

FIGURE 3 Example of list of Proposals that are included into a specific Context [Colour figure can be viewed at wileyonlinelibrary.com]

the business sectors and research communities at global level stimulates community members to develop original proposals and provides valuable contributions to comment on existing initiatives. Participation in the community generates value at two levels. At the individual level, participants experience a sense of belonging to a community engaged in solving complex problems for the future of the planet. At community level, the MSP allows to enlarge the professional network and expertise on climate change and to obtain funds for implementing initiatives. Table 2 summarizes the components or genes of the MSP framework for the case of the MIT Climate CoLab.

The governance of the platform is grounded on three main elements: (a) the terms of use that state users' obligations and permissions and copyright policy for shared materials; (b) the rules and guidelines for participating to contests; and (c) a set of community principles such as openness, honest brokerage, scientific evidence and rational argument, respect and courtesy, and value statement. A further aspect is the expert-based certification of the impact of proposals that provides a measure of novelty, feasibility, impact, and presentation.

6 | DISCUSSION

We developed a multisided platform (MSP) model to support a more nuanced and impactful discussion of sustainable development issues. The model is aimed to integrate and amplify experts' technical assessments and the collection of distributed intelligence, with a network of heterogeneous stakeholders that contribute with their knowledge, perceptions, experiences, and problem-solving approaches (Ardito, Messeni Petruzzelli, Peruffo, & Pascucci, 2019; Hojnik & Ruzzier, 2016; Saravanamuthu, 2018).

The MSP model enables an open innovation approach (Chesbrough, 2003), which considers innovation partially dependent on single individual-specific or organization-specific knowledge resources and strongly dependent on external-derived resources. The MSP allows to convey purposive inflows of external knowledge (possessed by the participating stakeholders), as well as the outflow of internally developed knowledge (within the platform), in order to enhance the efficiency and the effectiveness of the overall innovation process (Chesbrough, 2003). At individual level, people and experts can join the MSP to provide their knowledge, skills, capabilities, and opinions that are crucial to sustain the overall innovation processes (Natalicchio et al., 2018). Especially for "green" industries and sustainable development, collaboration and information exchange with a network of external stakeholders may be crucial for success (Messeni Petruzzelli et al., 2011; Xu, Wei, & Lu, 2019), although the pressure they exert related to the environmental regulations and customer needs (Song, Yang, Zeng, & Feng, 2020). Sustainability is a complex and multidisciplinary domain, and interorganizational collaboration with different stakeholders can thus be a crucial source of environmental knowledge and competences, as well as intraorganizational collaborations for environmental information exchange (Messeni Petruzzelli et al., 2011).

TABLE 2 Components of the CoLab as an MSP for sustainable development

Component/gene	Description
WHAT (focus, strategic intent, orientation)	- Open discussion on climate change and collaborative decision making - Public argumentation on climate change definition and causes - Breakdown of climate change in terms of subcauses and variables - Ideas about how to mitigate negative consequences of climate change - Social innovation and entrepreneurial initiatives on climate change
WHO (sides, actors, groups)	- Individual citizens willing to discuss about climate change - Professionals and experts - Business organizations working on climate-related issues - Ecosystem of academicians and researchers working on climate change - Policy makers and institutions focused on climate change - Complementors and providers of services of relevance for the community
HOW (actions, flows, mechanisms)	- Early expert involvement to overcome the chicken-and-egg problem - Matchmaking algorithms to intermediate needs - Value attractors for enhancing commitment - Economic sustainability of the platform based on sponsorship and feeds - Feedback system, aggregation and networking - Multi-level KPIs to measure performance at individual and community level - Digital infrastructure based on GitHub open source suite
WHY (value drivers, benefits, externalities)	- Resource matching and optimization - Audience building and awareness development - Passion and emotional incentives for participants - Revenues and economic drivers - Enhanced problem solving and robust decision making - Sharing of resources among experts - Collaboration and knowledge exchanges for innovation

We studied the case of the Climate CoLab, which is among the five most participated bottom-up initiatives at global level that address societal problems, along with Partnerships for SDGs, Sustainia100, Global Climate Action Portal, and UN Global Compact (Pereira et al., 2019). We found in the case an interesting application of the framework proposed. The strategic vision of the platform (*what*) is in line with the urgency to address sustainability and sustainable development issues in modern economies. This requires multi-stakeholder (*who*) view to identify latent and explicit needs, as well as

cross-disciplinary approach to envisioning potential solutions to climate change. The role of the platform would be to create the facilitating conditions and mechanisms to foster participatory deliberation on climate change (*how*) by individuals, organizations, institutions, and stakeholders moved by a large spectrum of monetary and non-monetary motivations (*why*). A set of explicit rules accepted by participants (*governance*) favors the development of interactions and activities carried out for problems resolution.

The platform supports the design and launch of high-impact initiatives by involving dozen of contributors and experts working in different industries and countries. Thus, the platform relies on a crowdsourcing strategy to collect ideas, resources, relationships, and funds to support sustainable development and, more specifically, to address the climate change problem. In such view, similarly to the approach based on crowd funding to realize sustainability-oriented initiatives (Messeni Petruzzelli, Natalicchio, Panniello, & Roma, 2019), this study allows for generalizing the process and experimenting crowdsourcing as effective strategy to achieve sustainable innovation in the climate change domain. The framework proposed satisfies the need to coordinate stakeholders, resources, and distributed capabilities to meet the challenges and opportunities arising from climate change (de Sousa Jabbour et al., 2020). The results that come from such collaborations can be considered as concrete examples of sustainable innovation, because they contribute to new business development and well-being of people while generating a positive social and environmental impact (Tello & Yoon, 2008).

The platform observed in the case study has also the potential to identify those technological solutions that may favor the economic growth by addressing at the same time the environmental issues, which is a condition of foremost importance (Ghisetti & Pontoni, 2015; Mowery, Nelson, & Martin, 2010). Moreover, looking at the participation of universities and research centers, the platform can activate new research collaborations that may lead to two types of positive externalities, which are knowledge creation and environmental benefits (Ardito, Messeni Petruzzelli, & Ghisetti, 2019). Alternatively, through the analysis of the attributes (e.g., the level of establishment, the scope of application, and the technological breadth) of different environmental technologies that constitute the background of the climate change solutions, the platform can also provide useful insights to understand what types of technologies can lead to the technological development of the industry (Ardito, Messeni Petruzzelli, & Ghisetti, 2019).

Besides, because there is little consensus on how to interpret, measure, and operationalize sustainability (Meckenstock et al., 2016), the MSP framework proposed can be interpreted as a contribution in such direction. The article contributes to the recent literature on sharing economy principles applied to sustainability development (Botsman & Rogers, 2010; Curtis & Lehner, 2019; De Leeuw & Gössling, 2016; Martin, 2016). Indeed, the case study described shows how a digital multisided platform can contribute to generate many positive environmental, economic and social outcomes, and advantages (Carrigan, Magrizos, Lazell, & Kostopoulos, 2020) by leveraging global flows of data, information, knowledge, and expertise that are driven by a collective purpose (Hamari, Sjöklint, & Ukkonen, 2016). Such evidence allows for considering multi-sided platform as a driver of the sharing economy for a more sustainable future. Besides, the analysis of the CoLab initiative and its description through the framework of multisided platform highlight the benefits related to the more efficient use of tangible and knowledge resources by substituting the ownership with access and harnessing the power of trust and decentralized peer-to-peer networks (Acquier, Daudigeos, & Pinkse, 2017; Ciulli & Kolk, 2019).

The approach presented is in line with the attempt to leverage the distributed knowledge and expertise possessed by thousands of individuals and articulate them to support better decisions and design effective solutions by relying on an existing community of individuals, a strong brand recognition, a trustful network of relationships, and real-time information (Wang et al., 2016). The possibility to access and valorize on a global scale a set of valuable intellectual assets, skills, and innovative ideas, together with the opportunity to generate benefits for the individuals, society, and environment makes the sharing economy a promising paradigm to face today sustainable development challenges (Gazzola et al., 2019).

The wide participation of a large community of heterogeneous people would ensure the social relevance and sustainability of the innovative solutions proposed, which is often a neglected dimension of sustainable development, in addition to the more debated and discussed environmental compatibility and economic impact (Eizenberg & Jabareen, 2017; Munzel, Meyer-Waarden, & Galan, 2018). This approach allows for proposing a multidimensional view to evaluate each solution through the analysis of the economic, social and environmental aspects. This element contributes to enrich the performance evaluation perspective of sustainable innovations, which is a topic underdeveloped in this research domain (Cillo et al., 2019). Moreover, the possibility to involve actively both primary and secondary stakeholders in design of the proposals and in the identification of the potential solutions contributes to enhance the level of acceptance of the final result (Goodman et al., 2017).

The article has illustrated a strategy and tool to solve problems by leveraging the collective intelligence of a community of individuals. Under conditions of diversity, independence and aggregation, digital-enabled communities can enhance the wisdom of crowds (Surowiecki, 2005) by exploiting the potential of interconnectivity and digital technologies. Collective intelligence systems may allow the harvesting of distributed knowledge and experience possessed by potentially thousands of individuals, thus supporting more robust and shared decisions for the public good (De Liddo & Buckingham Shum, 2014). The effectiveness of decision-making relies on the capacity to link the varied contributions of the involved agents, which depend on their different interests, points of view and values. The article provides evidence about the applications of collective intelligence paradigm for wicked problem resolution through a systemic view of collaborative knowledge creation for public good that encompasses ideas management, argumentative collaboration, visual mapping, and collaborative deliberation. Thus, the logical design of the platform contributes to explore the role of information systems for

sustainable development, enabling virtual collaboration between distributed teams, improving cooperative knowledge management, facilitating inter-organizational processes, and engaging with external stakeholders and other relevant organizations with heterogeneous preferences and expectations (Cillo et al., 2019; Seuring & Gold, 2013). Moreover, the diffusion of innovative models of interactions enabled by technological platforms and collaborative systems can allow participants to overcome organizational and technological limitations, thus pursuing open innovation goals (Del Vecchio et al., 2018). Such approach aims at addressing the difficulty to manage wicked problems due to the confluence of the complexity of the social embedding with the complexity of the cause-effect network and deep-running impacts (Meckenstock et al., 2016). Besides, the platform may be interpreted as an ecosystem in which inter-organizational collaboration assumes a strategic role to encourage collaboration, connectivity, and comparison between various perspectives and disciplines, in the aim of the success of the sustainable innovations addressing climate change (Cillo et al., 2019).

Concerning the components and features of an MSP, the article presents a conceptual framework of MSP as an ecosystem able to support sustainable development policies and actions. The framework proposed includes five building blocks related to "what" the platform exists for, "who" participates and "why," "how" the system works, and the set of "governance" policies and rules. The framework is a preliminary contribution to better define, analyze, understand, and size sustainable development challenges as wicked problems (Barnett et al., 2018), as well as to articulate the conceptual structure for a better operationalization and execution (Foss & Saebi, 2018). Moreover, the five-dimensional framework may represent a reference model to design new multisided platforms focused on debating, analyzing, and solving complex problems related to sustainability issues. In particular, the definition of the ambitious goal that the system aims to achieve, the identification of the heterogeneous nature of the participants' profiles and roles, the scheduling of the actions to be performed by each participants, the search of the motivations to join and participate actively to the platform, and the sharing of the rules and principles that regulate the virtual interactions constitute five core pillars that may drive the design of such collaborative systems to pursue sustainable innovations.

The study has a number of theory and practitioner implications. In terms of theory development, the article provides evidence about collaborative innovation processes implemented through a multi-stakeholder engagement effort for the collaborative identification of solutions to wicked social problems (Goodman et al., 2017). The case shows how collaborative innovation process includes actors from many organization of private and public sector, experts, and citizens, which are integrated into the innovation cycle (idea generation, selection, implementation, and diffusion) from the earliest stage onwards (van Genuchten et al., 2019). Indeed, both primary and secondary stakeholders, as well as the members of the platform, may be dispersed worldwide and possess differentiated knowledge background and expertise, but the aggregating interest is to make a joint effort to contribute to sustainable development through the collaborative conceptualization, design, and experimentation of innovative solutions that encompass the economic, environmental, and social aspects. The active participation of individuals as proponents or contributors is motivated by extrinsic and intrinsic drivers, including monetary and non-monetary benefits (Gazzola et al., 2019). Besides, the study contributes also to investigate how sustainability and open innovation can be combined to become a domain in its own right, which has been recently referred as "Sustainable Open Innovation" (Bogers et al., 2020). Another valuable evidence of this study relies on the application of multi-sided platform archetype to nonbusiness contexts, which often represent the typical application domains of such emerging models of the sharing economy. Moreover, the specific application to the climate change provides the opportunity to design in the near future new applications of multi-sided platform to address the sustainable development issues.

Finally, a number of qualitative propositions can be extracted from the conceptual development work and the case study analysis. Such propositions may support the design of further research studies based on case analysis as well as empirical data. First (Q1), diversification and heterogeneity of actors participating in the MSP (profiles and roles) is crucial to gather complementary perspectives in complex problem framing and solution. Second (Q2), the use of collective intelligence and collaboration tools provided by the MSP increases the integration of decisions and actions to be taken by each member for the public good. Third (Q3), the opportunity to contribute to sustainable development challenges is a powerful motivation for stakeholders willing to participate (actively) in the MSP. Fourth (Q4), virtual interaction within the MSP should be based on clear and shared rules and principles defined by the governance or built bottom-up.

In terms of practitioner development, the article offers a management checklist and operational model useful to design purposeful strategies and projects in the area of sustainable development. The CoLab is an example that could be replicated by other institutions to harnessing the collective knowledge and goodwill of societal actors to address further complex societal challenges. The case may provide students, practitioners and policy makers with inspiration about how open innovation may be deployed to achieve sustainability objectives like the seventeen SDGs (Bogers et al., 2020). Besides, the case shows how the open innovation paradigm can be adopted to address sustainability issues by emphasizing the role of an appropriate and meaningful community of stakeholders (Rauter et al., 2019).

From a policy-maker perspective, this research highlights the importance of adopting a radically different way of working to move towards a more sustainable society (van Genuchten et al., 2019). This encompasses the ability to address sustainability challenges through public-private partnerships and collaborations within industry and to leverage non-pecuniary motivations of participating actors (Bogers et al., 2020) and different governance mechanisms based on the interaction with citizens (Lee et al., 2012). Also, for policy-makers, the open innovation approach may represent a successful strategic choice along three lines of actions (van Genuchten et al., 2019): (i) involvement of citizens (the crowd) into ideation and innovation

challenges within online platforms; (ii) enhancement of management tasks by involving external actors in a systematic way; and (iii) involvement of large groups of people in policy making and implementation processes, thus realizing the collaborative democracy.

Finally, the framework proposed has also an educational value as it may support the design of cross-disciplinary curricula focused on the development and management of MSP for sustainable development. This would also contribute to sensitize all educational sectors of the society to implement programs on sustainable development (UNESCO, 2009) and develop sustainability-related competencies including (Faham, Rezvanfar, Movahed Mohammadi, & Rajabi Nohooji, 2017) the understanding of sustainability, sustainability skills (e.g., critical and systemic thinking, creativity, empathy, and interdisciplinary collaboration), and attitudes towards sustainability (e.g., commitment, responsiveness for present and future generations). Such dimensions are coherent with the long-term perspective of sustainability challenges, which encompass the "triple bottle line" of economic prosperity, environmental protection, and social equity (Elkington, 1998).

7 | CONCLUSION

Sustainable development is a key challenge of our times. Whereas the first concerns about sustainability were raised in the 1970s via the Rome Club (Hidalgo, Gabaly, Morales-Alonso, & Urueña, 2020; Sakalauskas, 2010), the uptake of the sustainability concept can be traced back to the increasing evidence on global environmental risks such as climate change, pollution, and biodiversity loss, and their impacts on complex, social-ecological systems (Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Ostrom, 2009). Institutions, policy makers, and business organizations are key players and need to cooperate with society in order to harness human initiative and energies to reach sustainable development goals. Multistakeholder collaboration is crucial to address the multifaceted views and contradicting perspectives about sustainability, and digital platforms may offer a significant support to collaborative discourse, new solution experimentation, and business model innovation based on an ecosystem-centered value creation logic (Van Alstyne et al., 2016).

In this article, we have presented a conceptual framework of digital-enhanced multistakeholder collaboration to support sustainable development decision making and actions. The paper complements consolidated and emerging streams of research focused on the study of sustainability development in different contexts (e.g., corporate social responsibility, integrating business reporting, and stakeholder management), and it can thus attract multidisciplinary interest for theoretical and applied research which leverages on the defined model to support more robust collaborative discourse and action on sustainability.

The research has some limitations, which represent also avenues for further research. First, the framework would benefit from the study of more cases of collective intelligence applications for social discussion and problem resolution. The analysis of other cases (e.g., OpenIdeo, MITSolve, and GiveMeDrug) would provide new insights about the application of multistakeholder collaboration and platform approaches to define more nuanced solutions to sustainable development challenge. Second, the "static" framework of components should be complemented with a more in-depth analysis of flows, knowledge exchanges, and relations among involved stakeholders. Such dynamic view would also contribute to investigate the lifecycle and evolution stages of the collaboration framework over time. At this purpose, the application of social networking analysis (Fronzetti Colladon, 2018; Gloor, Fronzetti Colladon, Grippa, & Giacomelli, 2017; Lipizzi, Iandoli, & Marquez, 2015) would allow to come up with a refined framework and guidelines that may shepherd the design of more effective collaborative processes and environments. Third, the case study did not report the feedback expressed by the members of the CoLab community. Their point of view, categorized according to the type of actor and involved partner (e.g., multinational companies, research actors, and local partners), may provide useful insights to design collaboration flows, drive more efficient solution design and prototyping, and achieve better performance of sustainability solutions (Ardito et al., 2019a). Finally, looking at the promising trend of using crowdfunding to collect money for sustainability-related goals (Messeni Petruzzelli et al., 2019), further research can be oriented to generalize this approach and unveiling the main dynamics of the relationship between crowdsourcing and sustainable development.

ORCID

Gianluca Elia https://orcid.org/0000-0002-7317-981X

REFERENCES

Acquier, A., Daudigeos, T., & Pinkse, J. (2017). Promises and paradoxes of the sharing economy: An organizing framework. *Technological Forecasting and Social Change*, *125*, 1–10.

Ahmed, P. K., & Hardaker, G. (1999). The role of on-line communities on the internet for sustainable development. *Business Strategy and the Environment*, *8*(1), 75–81.

Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, *53*(3), 41–49.

Amit, R., & Zott, C. (2015). Crafting business architecture: The antecedents of business model design. *Strategic Entrepreneurship Journal*, *9*(4), 331–350.

Apte, U. M., & Davis, M. M. (2019). Sharing economy services: Business model generation. *California Management Review*, *61*(2), 104–131.

Ardito, L., Messeni Petruzzelli, A., Dezi, L., & Castellano, S. (2018). The influence of inbound open innovation on ambidexterity performance: Does it pay to source knowledge from supply chain stakeholders? *Journal of Business Research*. in press.

Ardito, L., Messeni Petruzzelli, A., & Ghisetti, C. (2019). The impact of public research on the technological development of industry in the green energy field. *Technological Forecasting and Social Change*, *144*, 25–35.

Ardito, L., Messenipetruzzelli, A., Peruffo, E., & Pascucci, F. (2019). Inter-firm R&D collaborations and green innovation value: The role of family firms' involvement and the moderating effects of proximity dimensions. *Business Strategy and the Environment*, *28*, 185–197.

Armstrong, M. (2006). Competition in two-sided markets. *The Rand Journal of Economics*, *37*(3), 669–691.

Bardhi, F., & Eckhardt, G. M. (2012). Access-based consumption: The case of car sharing: Table 1. *Journal of Consumer Research*, *39*, 881–898.

Barnett, m. L., Henriques, I., & Husted, B. W. (2018). Governing the void between stakeholder management and sustainability. In *Sustainability, Stakeholder Governance, and Corporate Social Responsibility* (pp. 121–143). Emerald Publishing Limited.

Belk, R. (2014). You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research*, *67*, 1595–1600.

Boder, A. (2006). Collective intelligence: A keystone in knowledge management. *Journal of Knowledge Management*, *10*(1), 81–93.

Bonabeau, E. (2009). Decisions 2.0: The power of collective intelligence. *MIT Sloan Management Review*, *50*(2), 45–52.

Botsman, R., & Rogers, R. (2010). *What's mine is yours: The rise of collaborative consumption*. Harper Collins: New York City, USA.

Bogers, M., Chesbrough, H., & Strand, R. (2020). Sustainable open innovation to address a grand challenge. *British Food Journal*, (in press).

Bryant, A., griffin, J. J., & Perry, V. G. (2020). Mitigating climate change: A role for regulations and risk-taking. *Business Strategy and the Environment*, *29*(2), 605–618.

Caillaud, B., & Jullien, B. (2003). Chicken and egg: Competition among intermediation service providers. *The Rand Journal of Economics*, *34*(2), 309–328.

Carrigan, M., Magrizos, S., Lazell, J., & Kostopoulos, I. (2020). Fostering sustainability through technology-mediated interactions. *Information Technology & People*. in press. https://doi.org/10.1108/ITP-10-2018-0474

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Cambridge, MA: Harvard Business School Publishing.

Chesbrough, H. W. (2006). The era of open innovation. *Managing Innovation and Change*, *127*(3), 34–41.

Creswell, J. W. (2003). A framework for design. Research design: Qualitative, quantitative, and mixed methods approaches, 9–11.

Churchman, C. (1967). Wicked problems. *Management Science*, *14*(4), B141–B142.

Cillo, V., Messeni Petruzzelli, A., Ardito, L., & Del Giudice, M. (2019). Understanding sustainable innovation: A systematic literature review. *Corporate Social Responsibility and Environmental Management*, *26*, 1012–1025.

Ciulli, F., & Kolk, A. (2019). Incumbents and business model innovation for the sharing economy: Implications for sustainability. *Journal of Cleaner Production*, *214*, 995–1010.

cohen, b., amorós, j.e., & Lundy, L. (2017). The generative potential of emerging technology to support startups and new ecosystems. *Business Horizons*, *60*(6), 741–884.

Curtis, S. K., & Lehner, M. (2019). Defining the sharing economy for sustainability. *Sustainability*, *11*(3), 1–25. https://doi.org/10.3390/su11030567

Cusumano, M. A. (2015). How traditional firms must compete in the sharing economy. *Communications of the ACM*, *58*, 32–34.

Cusumano, M. A., Yoffie, D. B., & Gawer, A. (2019). *The business of platforms—strategy in the age of digital competition, innovation, and power*. New York, NJ: HarperCollins Publishers.

De Leeuw, T., & Gössling, T. (2016). Theorizing change revisited: An amended process model of institutional innovations and changes in institutional fields. *Journal of Cleaner Production*, *135*, 435–448.

De Liddo, A., & Buckingham Shum, S. (2014). Collective intelligence for the public good: New tools for crowdsourcing arguments and deliberating online. In *Internet, politics, and policy*. Oxford: University.

De Mattos, C. A., Kissimoto, K. O., & Laurindo, F. J. B. (2018). The role of information technology for building virtual environments to integrate crowdsourcing mechanisms into the open innovation process. *Technological Forecasting and Social Change*, *129*, 143–153.

De Reuver, M., Sørensen, C., & Basole, R. C. (2018). The digital platform: A research agenda. *Journal of Information Technology*, *33*(2), 124–135.

De Sousa Jabbour, A. B. L., Vazquez-Brust, D., Jabbour, C. J. C., & Ribeiro, D. A. (2020). The interplay between stakeholders, resources and capabilities in climate change strategy: Converting barriers into cooperation. *Business Strategy and the Environment*, *29*(3), 1362–1386.

Del Vecchio, P., Di Minin, A., Messeni Petruzzelli, A., Panniello, U., & Pirri, S. (2018). Big data for open innovation in SMEs and big corporations: Trends, Opportunities, and Challenges. *Creativity and Innovation Management*, *18*, 6–22.

Ebner, W., Leimeister, j.m., & Krcmar, H. (2009). Community engineering for innovations: The ideas competition as a method to nurture a virtual community for innovations. *R&D Management*, *39*(4), 342–356.

Eisenmann, T., Parker, G., & van Alstyne, M. W. (2006). Strategies for two-sided markets. *Harvard Business Review*, *84*(10), 92–101.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532–550.

Eizenberg, E., & Jabareen, Y. (2017). Social sustainability: A new conceptual framework. *Sustainability*, *9*(1), 1–16. https://doi.org/10.3390/su9010068

Elia, G., & Margherita, A. (2018). Can we solve wicked problems? A conceptual framework and a collective intelligence system to support problem analysis and solution design for complex social issues. *Technological Forecasting and Social Change*, *133*, 279–286.

Elia, G., Margherita, A., & Passiante, G. (2020). Digital entrepreneurship ecosystem: How digital technologies and collective intelligence are reshaping the entrepreneurial process. *Technological Forecasting and Social Change*, *150*, 1–12. 119791.

Elia, G., Messeni Petruzzelli, A., & Urbinati, A. (2020). Implementing open innovation through virtual brand communities: A case study analysis in the semiconductor industry. *Technological Forecasting and Social Change*, *155*, 1–14. 119994.

Eller, F. J., Gielnik, M. M., Wimmer, H., Thölke, C., Holzapfel, S., Tegtmeier, S., & Halberstadt, J. (2020). Identifying business opportunities for sustainable development: Longitudinal and experimental evidence contributing to the field of sustainable entrepreneurship. *Business Strategy and the Environment*, *29*, 1387–1403.

Engelbart, D., & Ruilifson, J. (1999). Bootstrapping our collective intelligence. *ACM Computing Surveys*, *31*(4), 1–21.

Elkington, J. (1998). The 'Triple Bottom Line'for 21st century Business. Published in the Earthscan Reader in Business & Sustainable Development (2001). Editors Starkey & Welford.

Faham, E., Rezvanfar, A., Movahed Mohammadi, S. H., & Rajabi Nohooji, M. (2017). using system dynamics to develop education for sustainable development in higher education with the emphasis on the sustainability competencies of students. *technological forecasting and social change*, *123*, 307–326.

Foss, N. J., & Saebi, T. (2018). Business models and business model innovation: Between wicked and paradigmatic problems. *Long Range Planning*, *51*(1), 9–21.

Frenken, K., & Schor, J. (2017). Putting the sharing economy into perspective. *Environmental Innovation and Societal Transitions*, *23*, 3–10.

Fronzetti Colladon, A. (2018). The semantic brand score. *Journal of Business Research*, *88*, 150–160.

Gawer, A., & Cusumano, M. A. (2002). *Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation*. Boston, MA: Harvard Business School Press.

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, *31*(3), 417–433.

Gazzola, P., Vătămănescu, E. M., Andrei, A. G., & Marrapodi, C. (2019). Users' motivations to participate in the sharing economy: Moving from

profits toward sustainable development. *Corporate Social Responsibility and Environmental Management*, *26*(4), 741–751.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The circular economy—A new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768.

Ghisetti, C., & Pontoni, F. (2015). Investigating policy and R&D effects on environmental innovation: a meta-analysis. *Ecological Economics*, *118*, 57–66.

Giones, F., & Brem, A. (2017). Digital technology entrepreneurship: A definition and research agenda. *Technology Innovation Management Review*, *7*(5), 44–51.

Gloor, P. A., Fronzetti Colladon, A., Grippa, F., & Giacomelli, G. (2017). Forecasting managerial turnover through e-mail based social network analysis. *Computers in Human Behavior*, *71*, 343–352.

Goodman, J., Korsunova, A., & Halme, M. (2017). Our collaborative future: Activities and roles of stakeholders in sustainability-oriented innovation. *Business Strategy and the Environment*, *26*(6), 731–753.

Guttentag, D. (2015). Airbnb: Disruptive innovation and the rise of an informal tourism accommodation sector. *Current Issues in Tourism*, *18*, 1192–1217.

Hagiu, A. (2009). Multi-sided platforms: From microfoundations to design and expansion strategies. *Harvard Business School Working Paper*, *07-094*, 1–26.

Hagiu, A. (2014). Strategic decisions for multisided platforms. *MIT Sloan Management Review*, *Sloan Select Collection Summer*, *2015*, 4–13.

Hagiu, A., & Wright, J. (2015). Multi-sided platforms. *International Journal of Industrial Organization*, *43*, 162–174.

Hamari, J., Sjöklint, M., & Ukkonen, A. (2015). The sharing economy: Why people participate in collaborative consumption. *Journal of the Association for Information Science and Technology*, *67*, 2047–2059.

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. *Journal of the Association for Information Science and Technology*, *67*(9), 2047–2059.

Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy*, *47*(8), 1391–1399.

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105.

Hidalgo, A., Gabaly, S., Morales-Alonso, G., & Urueña, A. (2020). The digital divide in light of sustainable development: An approach through advanced machine learning techniques. *Technological Forecasting and Social Change*, *150*, 1–7. 119754.

Hojnik, J., & Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature. *Environmental Innovation and Societal Transitions*, *19*, 31–41.

Iansiti, M., & Levien, R. (2004). *The keystone advantage: What the new dynamics of business ecosystems mean for strategy, innovation, and sustainability*. Boston, MA, USA: Harvard University Press.

Iasevoli, G., Michelini, L., Grieco, C., & Principato, L. (2018). Mapping the sharing economy: A two-sided markets perspective. *Sinergie*, *36*(106), 181–201.

Introne, J., Laubacher, R., Olson, G., & Malone, T. (2013). Solving wicked social problems with socio-computational systems. *German Journal on Artificial Intelligence*, *27*(1), 45–52.

Karacapilidis, N., & Tzagarakis, M. (2009). Supporting argumentative collaboration in communities of practice: The CoPe_it! Approach. In *Solutions and Innovations in Web-Based Technologies for Augmented Learning: Improved Platforms, Tools, and Applications*. IGI Global.

Kenney, M., & Zysman, J. (2016). The rise of the platform economy. *Issues in Science and Technology*, *32*, 61–69.

Lévy, P. (1994). *L'Intelligence Collective. Pour une Anthropologie du Cyberespace*. Paris: La Découverte.

Lee, S., Geum, Y., Lee, H., & Park, Y. (2012). Dynamic and multidimensional measurement of product-service system (PSS) sustainability: A triple bottom line (TBL)-based system dynamics approach. *Journal of Cleaner Production*, *32*, 173–182.

Li, W., Badr, Y., & Biennier, F. (2012). Digital ecosystems: Challenges and prospects. In *Proceedings of the International Conference on Management of Emergent Digital Ecosystems* (pp. 117–122).

Lipizzi, C., Iandoli, L., & Marquez, J. E. R. (2015). Extracting and evaluating conversational patterns in social media: A socio-semantic analysis of customers' reactions to the launch of new products using Twitter streams. *International Journal of Information Management*, *35*(4), 490–503.

Malone, T. W., Atlee, T. and Levy, P. (2008). *Collective intelligence: Creating a prosperous world at peace*.

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys*, *26*(1), 87–119.

Malone, T. W., Laubacher, R. J., & Dellarocas, C. (2010). The collective intelligence genome. *MIT Sloan Management Review*, *51*(3), 21–31.

Martin, C. J. (2016). The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecological Economics*, *121*, 149–159.

Meckenstock, J., Barbosa-Póvoa, A. P., & Carvalho, A. (2016). The wicked character of sustainable supply chain management: Evidence from sustainability reports. *Business Strategy and the Environment*, *25*(7), 449–477.

Messeni Petruzzelli, A., Dangelico, R. M., Rotolo, D., & Albino, V. (2011). Organizational factors and technological features in the development of green innovations: Evidence from patent analysis. *Innovation: Management, Policy & Practice*, *13*, 291–310.

Messeni Petruzzelli, A., Natalicchio, A., Panniello, U., & Roma, P. (2019). Understanding the crowdfunding phenomenon and its implications for sustainability. *Technological Forecasting and Social Change*, *141*, 138–148.

Meulman, F., Reymen, I. M., Podoynitsyna, K. S., Romme, L., & Georges, A. (2018). Searching for partners in open innovation settings: How to overcome the constraints of local search. *California Management Review*, *60*(2), 71–97.

Mowery, D. C., Nelson, R. R., & Martin, B. R. (2010). Technology policy and global warming: Why new policy models are needed (or why putting new wine in old bottles won't work). *Research Policy*, *39*, 1011–1023.

Munzel, A., Meyer-Waarden, L., & Galan, J.-P. (2018). The social side of sustainability: Well-being as a driver and an outcome of social relationships and interactions on social networking sites. *Technological Forecasting and Social Change*, *130*, 14–27.

Muzellec, L., Ronteau, S., & Lambkin, M. (2015). Two-sided Internet platforms: A business model lifecycle perspective. *Industrial Marketing Management*, *45*, 139–150.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly*, *41*(1), 223–238.

Natalicchio, A., Savino, T., Messeni Petruzzelli, A., & Cardinali, S. (2018). Open innovation and the human resource dimension: An investigation in the Italian manufacturing sector. *Management Decision*, *56*(6), 1271–1284.

Nogueira, F., Borges, M., & Wolf, J. H. (2017). Collaborative decision-making in non-formal planning settings. *Group Decision and Negotiation*, *26*(5), 875–890.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, Vol.*, *325*(5939), 419–422.

Ott, T., Bremner, R., and Eisenhardt, K. (2018). "Beyond the chicken and egg: Strategy formation in two-sided marketplace ventures", Working

paper available at www.kenaninstitute.unc.edu/wp-content/uploads/2018/05/Beyond-the-Chicken-and-Egg-Ott-1.pdf

Parker, G., & Van Alstyne, M. W. (2005). Two-sided network effects: A theory of information product design. *Management Science*, *51*, 1494–1504.

Parker, G.G., Alstyne, M. W., and Choudary, S. P. (2016), *Platform revolution: How networked markets are transforming the economy and how to make them work for you*. WW Norton.

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2006). The design science research process: A model for producing and presentinginformation systems research. In *Proceedings of the first international conferenceon design science research in information systems and technology (DESRIST 2006)*, (pp. 83-106).

Pereira, L., Asrar, G. R., Fisher, L. H., Hsu, A., Nel, J., Sitas, N., … Zhang, Y. (2019). *Bottom-up Initiatives and Participatory Approaches for Outlooks-Global Environment Outlook (GEO-6): Healthy Planet, Healthy People Chapter 23*. Global environment outlook (GEO-6): Healthy planet, Healthy People.

Pouri, M. J., & Hilty, L. M. (2018). Conceptualizing the digital sharing economy in the context of sustainability. *Sustainability*, *10*(12), 1–19. 4453.

Richter, C., Kraus, S., Brem, A., Durst, S., & Giselbrecht, C. (2017). Digital entrepreneurship: Innovative business models for the sharing economy. *Creativity and Innovation Management*, *26*(3), 300–310.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169.

Rochet, J. C., & Tirole, J. (2006). Two-sided markets: A progress report. *The Rand Journal of EconomicsThe RAND Journal of Economics*, *37*(3), 645–667.

Rauter, R., Globocnik, D., Perl-Vorbach, E., & Baumgartner, I. (2019). Open innovation and its effects on economic and sustainability innovation performance. *Journal of Innovation & Knowledge*, *4*(4), 226–233.

Sakalauskas, L. (2010). Sustainability models and indicators. *Technological and Economic Development of Economy*, *16*(4), 567–577.

Saravanamuthu, K. (2018). How risk information and stakeholder-participation affect the sustainability of collaborative decisions: A case study on how the sustainability of stakeholder decisions is affected by different levels of stakeholder participation in preparing risk information. *Business Strategy and the Environment*, *27*(7), 1067–1078.

Schor, J. (2016). Debating the sharing economy. *Journal of Self-Governance and Management Economics*, *4*(3), 7–22.

Seuring, S., & Gold, S. (2013). Sustainability management beyond corporate boundaries: From stakeholders to performance. *Journal of Cleaner Production*, *56*, 1–6.

Shaw, D., Cumbers, A., McMaster, R., & Crossan, J. (2018). Scaling up community action for tackling climate change. *British Journal of Management*, *29*(2), 266–278.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal*, *50*(1), 20–24.

Song, M., Yang, M. X., Zeng, K. J., & Feng, W. (2020). Green knowledge sharing, stakeholder pressure, absorptive capacity, and green innovation: Evidence from Chinese manufacturing firms. *Business Strategy and the Environment*, *29*, 1517–1531.

Surowiecki, J. (2005). *The wisdom of crowds*. New York: Anchor.

Sutherland, W., & Jarrahi, M. H. (2018). The sharing economy and digital platforms: A review and research agenda. *International Journal of Information Management*, *43*, 328–341.

Tapscott, D. (2014). *The digital economy anniversary edition: Rethinking promise and peril in the age of networked intelligence*. New York: McGraw-Hill.

Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, *47*(8), 1367–1387.

Tello, S. F., & Yoon, E. (2008). Examining drivers of sustainable innovation. *International Journal of Business Strategy*, *8*(3), 164–169.

UN - United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. UN Publishing.

UNCED - United Nations Conference on Environment and Development. (1992). *Earth summit '92*. Regency Press.

UNESCO. (2009). Learning for a Sustainable World: Review of Contexts and Structures for Education for Sustainable Development.

Van Alstyne, M. W., Parker, g.g., & Choudary, s.p. (2016). Pipelines, platforms, and the new rules of strategy. *Harvard Business Review*, *94*(4), 54–62.

Von Hippel, E. (2005). *Democratizing Innovation*. Cambridge, MA: MIT Press.

van Genuchten, K. M., Calderón González, A., & Mulder, I. (2019). Open Innovation Strategies for Sustainable Urban Living. *Sustainability*, *11*(12), 3310.

Wang, J., Lai, J.-Y., & Chang, C.-H. (2016). Modeling and analysis for mobile application services: The perspective of mobile network operators. *Technological Forecasting and Social Change*, *111*, 146–163.

WBCSD - World Business Council for Sustainable Development. (2010), Vision 2050—The new agenda for business (available at https://docs.wbcsd.org/2018/02/Vision2050.pdf)

WCED - World Commission on Environment and Development. (1987). *World commission on environment and development: Our common future*. Oxford, UK: Oxford University Press.

Witt, A., Suzor, N., & Wikström, P. (2015). Regulating ride-sharing in the peer economy. *Communication Research and Practice*, *1*, 174–190.

Xu, J., Wei, J., & Lu, L. (2019). Strategic stakeholder management, environmental corporate social responsibility engagement, and financial performance of stigmatized firms derived from Chinese special environmental policy. *Business Strategy and the Environment*, *28*(6), 1027–1044.

Yazdizadeh, A., & Tavasoli, A. (2016). Living labs as a tool for open innovation: A systematic review. *International Journal of Human-Computer Studies*, 1681–1695.

Yin, R. K. (2003). *Case Study Research: Design and Methods - Vol. 5*. Newbury Park: Sage Publications.

How to cite this article: Elia G, Margherita A, Petti C. Building responses to sustainable development challenges: A multistakeholder collaboration framework and application to climate change. *Bus Strat Env*. 2020;1–14. https://doi.org/10.1002/bse.2514