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Leading open innovation: The role of strategic entrepreneurial leadership in orchestration of value creation and capture in GitHub open source communities

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ABSTRACT

This study investigates the role of entrepreneurial leadership in the orchestration of resource domains towards effective value creation and capture in open innovation (OI). To do so, it proposes a threefold framework that, first it explores the role of OI leaders in cultivating an environment that supports diverse motivational drivers of network members in the input domain. Second, it explains the impact of establishing facets of power by emergent OI leaders on setting the direction of a dominant flow of innovation in the institutional domain. Third, it postulates the impact of entrepreneurial contributions of OI leaders — opportunity-seeking and advantage-seeking activities — in aligning knowledge-asset creation and monetization strategies with the dominant demands and dynamics in the market domain. The proposed model is discussed by drawing on instances from open source communities hosted on GitHub. This study makes contributions to literature on open innovation and entrepreneurial leadership. By highlighting the importance of entrepreneurial contributions of OI leaders, it expands the research on open innovation beyond the traditional focus on leaders' social and technical contributions. By examining the construct of entrepreneurial leadership from the OI perspective, this study offers insights into the complexities of developing and monetizing innovation in novel collaborative environments, which deviates from the organizational proprietary approach dominant in this literature.

1. Introduction

The information age has witnessed the prevalence of novel approaches to creating and capturing value from innovation that reach beyond organizational boundaries. These approaches are fueled by the proliferation of Information Technologies that facilitate interorganizational collaborations in the knowledge economy (West and Bogers, 2014; West et al., 2014; Gassmann et al., 2010). This shift has led to the increasing popularity of new forms of innovation networks and ecosystems such as open source communities, crowdsourcing innovation platforms, and virtual marketplaces for ideas (Chesbrough, 2004; Yoo et al., 2012; Birkinshaw et al., 2008; Natalicchio et al., 2014). The global pandemic intensified this shift, because in absence of face-to-face interactions, approaches such as open source became a dominant learning, co-creation, and social tool. For instance, open source project creation on GitHub, the most popular social coding and project hosting service, increased by 40% in the year 2020 (Forsgren, 2020).

To adapt, innovation leadership practices have evolved accordingly to focus on creating information and social capital through interactions and collaboration with other organizations and unaffiliated actors (Fountain, 1998). Leaders in such contexts improve economic performance by directing the flow of innovation toward recognizing new opportunities and mobilizing internal and external resources toward exploiting them (Fleming and Waguespack, 2007; Wang et al., 2015; Boxenbaum and Linda, 2011). However, leading these collaborative initiatives present unique challenges that are most evident in open innovation (OI). For instance, leading diverse actors, including transient members and unaffiliated innovators, with varying motivational incentives poses unique challenges (Von Krogh et al., 2003; Von Hippel, 2001a,b). Further, systematic internal and external exchange of knowledge in OI requires innovation leaders to adopt a dual focus on accelerating the development of innovation in pursuit of value creation, while growing outside markets in the quest for value capturing (Chesbrough and Crowther, 2006; Chesbrough, 2012; West et al., 2006; Lichtenthaler, 2011). Lastly, OI's lack of formal structure and bureaucratic functions warrants employing complex leadership techniques to ensure the success of innovation processes.

Despite noted challenges, OI initiatives are responsible for some of

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the most prominent technological innovations of the information age, including Firefox, Open AI, Linux, and Elon Musk's SpaceX, to name a few (Chesbrough, 2004; Garud and Karnøe, 2003). The success of these initiatives is commonly attributed to the high drive and motivation of its members to co-create value (O'Mahony and Ferraro, 2007; Hertel et al., 2003; Shah, 2006; Krogh et al., 2012). In contrast, despite the reinforcement of monetary rewards in the traditional organizational setting, motivating employees to innovate remain challenging. For instance, while enterprise developer activity drops on weekends and holidays, open source activity in GitHub projects jumps, suggesting differing motivations across these contexts (Forsgren, 2020). The motivations of developers contributing to open source projects are particularly complex. For instance, while offering cash prizes fails to improve developers' motivation to participate in GitHub projects significantly (Boudreau, 2012), an active and engaging community increases membership in a GitHub open source community considerably. Thus, when surveyed, 85% of developers viewed a *Welcome Community* as either a very important or somewhat important factor in their decision to join an open source community on GitHub (Geiger, 2017).

Developers' motivation to join and engage in these communities commonly result in technical and social contributions, recognized in the literature as the main criteria for emergence of leaders in OI (Fleming and Waguespack, 2007). However, the literature in this area overlooks that OI leaders emerging due to these contributions during value capturing phase, may not experience the same level of success during the value capture phase, which requires business- and market-related expertise. This paradox is more evident in industries, such as software, where embracing the open approach to innovation has forced leaders to adopt new roles, such as *keystone*, which require expertise beyond the conventional social and technical scope (Chesbrough and Crowther, 2006; Jansen, 2014; Enkel et al., 2009; Von Krogh et al., 2003; Von Hippel, 2001a,b). For instance, BigBlueButton, an open source Virtual Classroom Software that served as a global teaching platform during the pandemic, was developed in 2007 by Richard Alam, an engineer. However, it did not become commercialized until 2010, when the current CEO, Fred Dixon, adopted the role of the keystone in the OS community (Faridian, 2011).

Recent studies confirm the importance of other criteria in OI leadership, in addition to the social and technical contributions that dominate OI leadership literature (Fleming and Waguespack, 2007). For instance, in leading blockchain open source projects on GitHub, contradicting prior research findings, technical contributions of leadership were found to have little influence on open, collaborative innovation success. In contrast, internal and external social capital contributions were found to be impactful. However, ultimately, a combination of a commitment to the community's openness orientation, in addition to the technical and internal social capital contributions, were found to be most conducive to the success of open innovation (Mu et al., 2019).

In sum, the relevance and significance of the role of leaders in OI are indisputable. However, the research in this area can benefit for addressing several gaps and deficiencies. First, the literature on OI leadership is mainly concerned with the emergence of leaders due to social and technical contributions. However, recent studies and industry cases indicate the importance of other factors such as leaders' commitment to achieving community goals and upholding its values (Mu et al., 2019). In other words, the literature in this area tends to overlook the importance of leaders' effectiveness in managing human and social resources towards knowledge-asset creation and appropriation (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007). Furthermore, as recent studies suggest, effectiveness of OI leaders is contingent upon the interplay of various factors. However, the OI leadership literature tends to undervalue such complexities. As a result, the underlying processes and contingencies that mediate and moderate the emergence and effectiveness of OI leaders remain understudied.

To offer insights into addressing these gaps and deficiencies in OI leadership literature, this study investigates the role of entrepreneurial leadership in the orchestration of resource domains towards effective value creation and capture in open innovation (OI). To do so, it draws on constructs in entrepreneurship literature, namely bricolage, to examine the links between OI leadership and leveraging resources in input domain towards: (a) solving problems in the institutional domain, and (b) exploiting opportunities in the market domain (Baker and Nelson, 2005; Baker et al., 2003). Subsequently, this study proposes a threefold framework that, first, explores the role of OI leaders in cultivating an environment that supports diverse motivational drivers of network members in the input domain. Second, it examines the impact of establishing facets of power by emergent OI leaders on setting the direction of a dominant flow of innovation in the institutional domain. Third, it postulates the impact of entrepreneurial contributions of OI leaders — opportunity-seeking and advantage-seeking activities — in aligning knowledge-asset creation and monetization strategies with the dominant demands and dynamics in the market domain (Covin and Slevin, 2002). The proposed model is discussed by drawing on instances from open source communities hosted on GitHub.

This study makes contributions to literature on open innovation and entrepreneurial leadership. First, by highlighting the importance of entrepreneurial contributions of OI leaders, it expands the research on OI leadership beyond the traditional focus on leaders' social and technical contributions. In doing so, this paper also offers insights that address the research gaps in understanding the linkages and differences in criteria for the emergence and effectiveness of leaders in OI. Meaning, while social and technical contributions are most conducive to the emergence of OI leaders, entrepreneurial contributions are central to their effectiveness in achieving innovation objectives. Second, by examining the construct of entrepreneurial leadership from the OI perspective, this study offers insights into the complexities of developing and monetizing innovation in novel collaborative environments, which deviates from the organizational proprietary approach dominant in this literature (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007). In that light, by discussing how OI leaders emerge and achieve outstanding outcomes by utilizing a mix of technical, social, and entrepreneurial approaches, this paper invokes leadership research to better understand the complexities of leading in the information age. Third, this paper offers insights into the impact of entrepreneurial strategies on open innovation performance in two phases of value creation and capture. More specifically, by discussing the importance of deploying entrepreneurial strategies such as bricolage, in the value creation phase, and opportunity-seeking, and advantage-seeking, in the value capture phase, this paper sheds new light on strategizing OI initiatives in the hyper-competitive and fast-changing knowledge economy.

This paper is structured in five sections. A literature review discussing open innovation leadership and entrepreneurial approaches follows this introduction. Following said review, the integrative model proposed in this research is discussed in two subsections that address value creation and capture. To enrich research in this area of inquiry, each subsection offers propositions that are supplemented by discussions on open source projects on GitHub. Finally, a discussion on directions for future research, study's limitations, and implications for theory and practice concludes this paper.

2. Background and literature review

Open source communities offer a unique context to study the leadership complexities and challenges in collaborative innovation environment. First, they feature a complex network of diverse actors with varying motivations to join, participate, and contribute to these initiatives (Von Krogh et al., 2003; Von Hippel, 2001a,b). For instance, while affiliated actors, such as members of new technology ventures, are driven by extrinsic rewards in form of profiting from publicly available source code, most unaffiliated developers make voluntary contributions without expectations of monetary rewards (Hars, 2002). Second,

because these communities are often formed organically, they tend to adopt an informal structure that lacks the hierarchical form of authority (O'Mahony and Ferraro, 2007). Thus, the nature of power established by leadership in these communities is mainly rooted in a shared understanding of the leaders' legitimacy, relatability, and expertise, which demand meritocratic governance approaches (French et al., 1959; Podsakoff and Schriesheim, 1985).

2.1. Leadership and open innovation

The literature on the emergence of leadership in OI initiatives emphasizes two main criteria of leaders' social and technical contributions (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007). However, such contributions depend on not only the competencies of leadership candidates, but also their motivation in joining and participating in the project. OI environments that support members' motivations improve the likelihood of contributions. Informal structures of OI facilitate the development of intrinsic motivation, while extrinsic rewards are poorly determined (Hertel et al., 2003; Shah, 2006; Krogh et al., 2012). In the void of clear extrinsic drivers of motivation in OI, the effect of intrinsic motivations on behavior is expected to be strengthened (Gagné and Deci, 2005). As a result, individuals driven by intrinsic motivations, as opposed to extrinsic reward, may contribute more effectively in OI, than those with similar abilities, but lacking congruity with the intrinsic motivational drivers.

More specifically, intrinsic rewards and motivation in OI environment can be achieved by fulfilling an individual's three primary needs for autonomy, competence, and connection, as explained by Self-Determination-Theory (SDT) (Gagné and Deci, 2005). In doing so, OI leaders are required to foster a self-organized and autonomous working environment for innovation (e.g., West, 2002). For instance, to support the highest form of motivation, namely autonomous, an innovation environment should provide nutriments for basic psychological needs, such as intellectual challenge, choice, rationale, and feedback. The resulting autonomy-supportive work environment has been found to promote creativity and innovation, citizenship behavior, psychological wellbeing, job satisfaction, trust, and commitment (Gagné and Deci, 2005; Gonzlez-Rom et al., 2002; West, 2002; Hershberger et al., 1994).

2.2. OI environment and entrepreneurial leadership

In addition to establishing motivational drivers in the environment, recent research findings highlight the importance of employing various leadership style in achieving innovation objectives in OI, as Table 1 demonstrates. Further, the effect of these leadership approaches on innovation (Eisenbeiss et al., 2008; Jung et al., 2008) is strengthened in an environment that facilitates a strong focus on goal attainment and promotes a high level of performance standards (Rosing et al., 2011). However, in addition to leadership styles, leaders' effectiveness in hyper-competitive, collaborative, and fast-paced technologically-dependent environments, such as the open-source software industry, is also contingent upon leaders' entrepreneurial behavior and strategic actions that ensure survival and sustainability of the initiative (Howell and Shamir, 2005; Surie and Ashley, 2008). In that light, a strong body of literature on entrepreneurial leadership emphasizes the importance of leaders' strategic role and behaviors related to opportunity discovery, value creation and capture, and mobilization of resources, discussed below (Jones and Crompton, 2009; Gupta et al., 2004).

Mobilization of Resources. Successful innovation process requires leaders to act entrepreneurially and mobilize available resources by promoting change-oriented, opportunity-oriented, and intellectually stimulating behaviors (Yukl, 2012; Renko et al., 2015). This mobilization requires actions at micro-level, in terms of inspirational motivation, and macro-level, in terms of setting the culture and direction for growth, scaling, and expansion (Avolio and Bass, 1995; Darling et al., 2007).

Table 1
Research on innovation and Leadership*.

Leadership style	Innovation related variable	Level of Analysis	Research on the relationship between leadership and aspects of innovation
Leadership (general effect)	Innovation; Support for innovation; Innovativeness	Individual; Teams; Groups	Brutus and Facteau (2003); Burns and Christiansen (2011); Clegg et al. (2002); Mitchell et al. (2015); Shapiro and Weingart (2001); Slaughter and Greguras (2009); Pirola-Merlo et al. (2002)
Leadership style	Support for innovations; Innovation Culture	Individual	Senior and Swailes (2007); Lok and Crawford (2001)
Transformational Leadership	Climate of support for innovation; Organizational innovation; Innovation performance; Team innovation; Innovative behavior; Climate for innovation; Innovation implementation behavior; Innovation; Exploitative innovation; Exploratory innovation; Innovativeness; Number of innovations; Number of radical innovations; Innovative climate	Individual; Dyad; Teams; Groups; Organizations; Business Units &Departments	Aryee et al. (2012); Charbonnier-Voirin et al. (2010); Chen et al. (2013); Choi (2007); Eisenbeiss et al. (2008); García Morales et al. (2008); Jansen et al. (2009); Jiang et al. (2015); Jung et al. (2003); Jung et al. (2008); Lee (2008); Nijstad et al. (2014); Osborn and Marion (2009); Panaccio et al. (2015); Pirola-Merlo et al. (2002); Rank et al. (2009); Reuveni and Vashdi (2015); Wang and Rode (2010); Wang et al. (2013); Wang et al. (2015); Zhu et al. (2013)
Leader-Member Exchange	Innovation; Team innovation process; Team innovation outcome; Innovative behavior; Innovativeness; Innovative work behavior; Innovative job performance; Support for innovation	Teams & Groups; Individual; Dyad	Gajendran and Joshi (2012); Schermuly et al. (2013); Lee (2008); Agarwal and Bhargava (2014); Aryee et al. (2012); Janssen and Van Yperen (2004); Panaccio et al. (2015); Scott and Bruce (1994); Tordera et al. (2008); Wang et al. (2015)
Transactional leadership	Innovation; Exploitative innovation; Exploratory innovation; Innovativeness	Individual; Business Units & Departments	Rank et al. (2009); Jansen et al. (2009) Lee (2008); Pieterse et al. (2010)
Supportive leadership	Aggregated innovative climate; Innovative climate	Individual; Business Units & Departments	Pieterse et al. (2010); Choi (2007)
Operational leadership	Innovation quality;	Organizations; Individual	Makri and Scandura (2010)

(*continued on next page*)

Table 1 (*continued*)

Leadership style	Innovation related variable	Level of Analysis	Research on the relationship between leadership and aspects of innovation
	Innovation quantity		
Ethical leadership	Climate for innovation; Support for innovation	Individual	Chen and Hou (2016)
Empowering leadership	Innovative behavior; Task innovativeness	Individual; Teams & Groups	Chen et al. (2011); Magni and Maruping (2013)
Charismatic Leadership	Innovation (Subordinates); Innovation (Self); Innovation	Individual	Berson and Sosik (2007); Dubinsky et al. (1995)
Change-oriented leadership	Team climate; Innovation	Individual	Lee (2008)
Shared leadership	Innovative behavior	Teams & Groups	Hoch (2013)
Servant leadership	Innovative behavior	Dyad	Panaccio et al. (2015)
Inspirational leadership	Innovation	Individual	Dubinsky et al. (1995)

*MetaBus [Beta] platform was used for collecting the findings in above table.

Entrepreneurial leadership in this context entails *s*ocial processes and interactions, such as (a) framing challenges and goals, (b) absorbing uncertainty by taking responsibility for future outcomes, (c) path clearing through negotiation, (d) building commitment through advocating a common purpose, and, (e) establishing a shared understanding of what seems feasible (Dess et al., 2003; Gupta et al., 2004). Some scholars view entrepreneurial leadership as a social process that hinges on institutional and social capital and is developed in the course of relational learning and active encounters (Leitch et al., 2014). More recent collective models suggest entrepreneurial leadership is formed through the co-action of participants in achieving entrepreneurial objectives (Sklaveniti, 2017). From a cognitive prespective, entrepreneurial leaders must form a complex cognitive model focused on being be both critical and creative (Greenberg, 2011). As Table 2 demonstrates, the relationship between many of these behaviors and innovation has been empirically investigated. However, surprisingly creativity and intellectual simulation play a less significant role in the effectiveness of entrepreneurial leaders. Because, while creativity is necessary for generating new ideas, not all ideas translate to viable entrepreneurial opportunities (Kao, 1989; Renko et al., 2015).

Value Creation and Capture. Entrepreneurial leadership requires developing a strategic vision while creating value through effective governance. In that sense, the successful entrepreneurial leaders possess ambidextrous characteristics that allow them to balance and integrate operational-related tasks with innovational-related ones (Mumford et al., 2009; Daily and Dalton, 1992; Daily et al., 2002; Gupta et al., 2004). From this strategic lens, the construct of *entrepreneurial leadership* has been defined as influencing others to manage resources towards both opportunity-seeking and advantage-seeking strategies (Ireland et al., 2003). In other words, successful entrepreneurial leadership is contingent upon aligning entrepreneurial opportunity-seeking behaviors with strategic advantage-seeking behaviors (Covin and Slevin, 2002). These behaviors are highly consequential in OI leadership, where achieving innovation objectives demands aligning value creation and value capture strategies (Chesbrough, 2004; 2012; West et al., 2006; Lichtenthaler, 2011). In that sense, seeking opportunities and managing resources toward exploiting them reflect some of the most critical challenges in leading OI initiatives during the value creation phase. Conversely, seeking strategic advantages that help sustain innovation in high velocity and uncertain environments pose a new array of challenges for OI leaders, during the value capturing phase (Surie and Ashley, 2008).

Table 2
Innovation and Leader's attributes and behaviors*.

Leader attributes and behavior	Innovation related variable	Level of analysis	Research on the relationship between leadership and aspects of innovation
Leader	Innovation	Individual	MacKenzie et al. (2009)
Number of leaders	Innovation-based task	Teams & Groups	Carton and Cummings (2013)
Multiple leader roles	Innovation task	Teams & Groups	Cummings & Hass (2012)
Leader traits (age, gender, education, nationality, tenure)	Team innovation; Innovative behavior	Individual; Teams & Groups	Jiang et al. (2015); Chen et al. (2011); Li et al. (2016)
Leader-member similarities (age difference; gender; tenure)	Innovative behavior; Team innovation; Innovative climate	Individual; Teams & Groups; Dyad	Schermuly et al. (2013); Madrid et al. (2016); Wang and Rode (2010)
Identification with the leader	Innovativeness; Innovative climate	Individual	Zhu et al. (2013); Wang and Rode (2010)
Leader affect (positive and negative)	Team innovation	Teams & Groups	Madrid et al. (2016)
Leader informing behavior	Innovation	Teams & Groups	Gonzlez-Rom et al. (2002)
Leader intellectual stimulation	Team innovation	Teams & Groups	Madrid et al. (2016)
Leader support	Support for innovation	Individual	Unsworth et al. (2005); Axtell et al. (2000)
Team leader coaching (TLC)	Team innovation effectiveness	Teams & Groups	Schaubroeck et al. (2016)
Leader relational transparency	Team innovation	Teams & Groups	Madrid et al. (2016)
Leader communication frequency with team	Team innovation as process; Team innovation as outcome	Teams & Groups	Gajendran and Joshi (2012)

*MetaBus [Beta] platform was used for collecting the findings in above tables.

Opportunity Discovery. The ultimate goal of opportunity-seeking behavior is to discover new opportunities. Opportunity discovery is a central dimension of entrepreneurial leadership and a distinctive feature of leading in entrepreneurial contexts (Cunningham and Lischeron, 1991; Koryak et al., 2015). To that end, the key element of entrepreneurial leadership, is viewed by some scholars, as adoption of opportunity-oriented behaviors by both leaders and subordinates (Renko et al., 2015). Effective opportunity discovery is dependent on knowledge acquisition and creativity, commonly noted as the main antecedents by scholars (Zahra and George, 2002). In that light, identifying opportunities in markets and technology is contingent upon the creativity of entrepreneurial teams in utilizing imagination (Choi, 2007). However, while the knowledge of the industry can improve the number of market opportunities identified by entrepreneurial teams (Shane, 2000; Gruber et al., 2013).

2.3. OI and entrepreneurial approaches

Leading OI initiatives demands novel approaches to managing resources towards exploiting new opportunities. Mobilization and management of resources, including human, social, and physical resources, commonly entail improvisation and experimentation with social and technical contributions in the network of actors. These activities are considered essential in entrepreneurial approaches such as bricolage, effectuation, and lean startup (Blank, 2013; Sarasvathy, 2001; Baker

et al., 2003). More specifically, the premise of entrepreneurial bricolage has been recognized for its role in managing resources in technology networks (Garud and Karnøe, 2003).

Entrepreneurial bricolage is centered on leveraging available resources in three input domains— namely material, skills, and labor— towards solving problems in the institutional domain, and exploiting opportunities in the market domain (Baker and Nelson, 2005; Baker et al., 2003). In the context of technology entrepreneurship, bricolage is conducive to collecting technical inputs from distributed actors in a technology network. The accumulation of these inputs creates a momentum that, over time, forms an emerging technological path (Garud and Karnøe, 2003). As an emerging perspective, bricolage stresses the importance of human agency in shaping and implementing innovation through co-creation (Garud and Karnøe, 2003; Coviello and Joseph, 2012; Fisher, 2012; Desa, 2012). Bricolage is central to developing important capabilities in open innovation, including managing resource scarcity, making do with what is available, improvising when recombining resources, and networking with external partners. In addition to open innovation, these capabilities are viewed as conducive to other contexts, such as multinational corporations and private and public service innovation outcomes (Naqshbandi and Jasimuddin, 2018; Witell et al., 2017; Halme et al., 2012; Fuglsang, 2010).

3. Integrative framework of leadership in OI

In OI initiatives, technical and social contributions of network members accumulate tend to accumulate in an organic and ad hock manner to build the foundation of resources in physical, labor, and skill input domains. However, these contributions need to be directed, managed, and coordinated through effective leadership to ensure achieving desired innovation outcomes. To control this flow of resources, leaders must establish mechanisms in the institutional domain that help internalize contributors' motivation in the direction most conducive to achieving innovation objectives. Ultimately, the knowledge-assets created by managing these contributions must be aligned with the demands and dynamics present in the market domain to ensure effective monetization and value capturing. In other words, innovation performance in the market domain depends on a strategic allocation of contributions in a manner that aligns value creation and capture towards the overall success of OI. Leaders facilitate this alignment by harmonizing their exploratory opportunity-seeking activities with exploitative advantage-seeking activities.

Subsequently, this study proposes a threefold framework that, first, explores the role of OI leaders in cultivating an environment that supports diverse motivational drivers of network members in the input domain. Conversely, in OI, social and technical contributions are a byproduct of individual competencies and environmental drivers of self-determined motivation and choice (deCharms, 1968). Second, it examines the impact of establishing facets of power by emergent OI leaders on setting the direction of a dominant flow of innovation in the institutional domain. Establishing facets of leaders' power in OI require developing a shared understanding of their legitimacy and expertise among network members. Third, it postulates the impact of entrepreneurial contributions of OI leaders — opportunity-seeking and advantage-seeking activities — in aligning knowledge-asset creation and monetization strategies with the dominant demands and dynamics in the market domain (Covin and Slevin, 2002). The proposed model is discussed by drawing on instances from open source communities hosted on GitHub (Fig. 1).

3.1. Leading to create value in OI

Technical contributions, the emergence of expert power, and establishing a dominant flow of innovation. Making technical contributions is recognizes as one of the main criteria for the emergence of OI leadership. However, the extent of these contributions depends on whether intrinsic motivational needs of OI members have been met to offset governance challenges present in OI, including vaguely defined reward system, informal structure, ambiguous, roles and functions (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007; Fleming et al., 2011Harison and Koski, 2010; Hertel et al., 2003; Shah, 2006; Krogh et al., 2012).

To support the highest form of motivation, namely autonomous, an innovation environment should provide nutriments for the basic psychological needs of knowledge workers. These nutriments enable members to act as a causal agent, face intellectual challenges, exercise choice and rationale, and engage in peer-feedback (Gagné and Deci, 2005; Gonzlez-Rom et al., 2002; deCharms, 1968). Satisfying the need for autonomy by determining and directing one's actions helps internalize motivation (Gagné and Deci, 2005). Research findings support the positive effect of autonomy on innovation performance (Lu et al., 2012). More specifically, research suggests the conducive effect of autonomy on knowledge sharing, manifested in OI in form of utilizing one's expertise to make technical contributions (Srivastava et al., 2006). Further, autonomy in determining task characteristics, such as scheduling, has also been found to improve problem-solving and information processing, imperative in making technical contributions in OI (Morgeson and Humphrey, 2006). For instance, in open source communities, scheduling flexibilities have been found to significantly improve technical contributions of hobbyist developers, who play an essential role in the

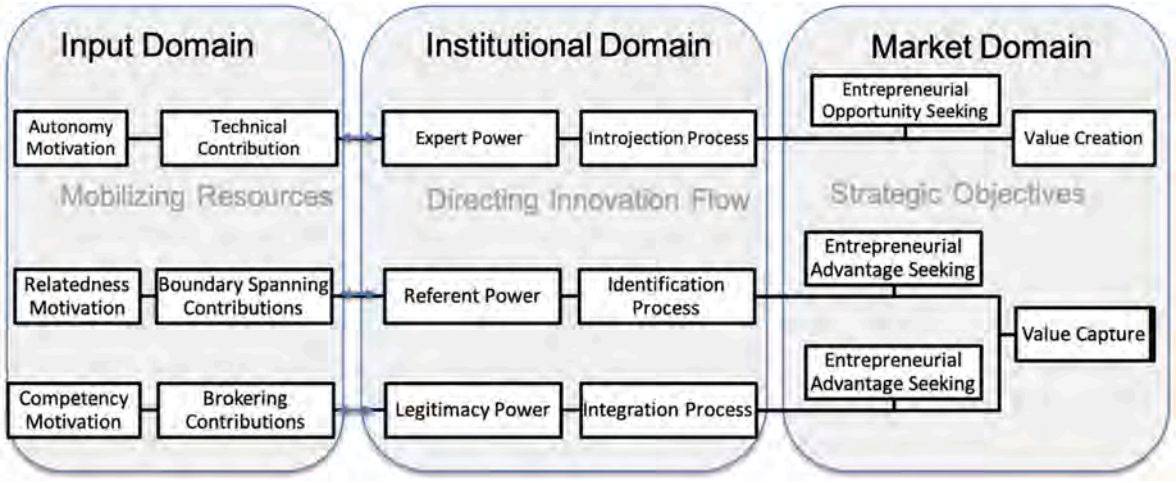

Fig. 1. Integrative model of leadership emergence and effectiveness in open innovation.

long-term viability of the source code (Shah, 2006).

Similarly, a recent study shows that enterprise developers respond positively to flexibility of GitHub projects, which gives them the autonomy them contribute in their own time during weekends and holidays (Forsgren, 2020). Further, during the lockdowns imposed by the global pandemic, developers' activities in GitHub open source projects increased in terms of time spent and amount of work, which suggests that a sense of autonomy in managing personal time and energy improve productivity (Forsgren, 2020).

In addition to the motivational impact on technical contributions, autonomy also plays a developmental role in preparing OI members to emerge as leaders. For instance, by exercising autonomy in choosing their form of involvement in OI, leadership candidates gain valuable knowledge about the overall state of resources in the input domain. This knowledge of resources serves as the building block of entrepreneurial bricolage and enables leaders to manage and mobilize resources effectively to achieve innovation objectives. Furthermore, in the process of making technical contributions, prospect leaders gain valuable insights into factors that facilitate or inhibit members' contributions. Once they take on leadership roles, this experience can help them make decisions about exercising varying degrees of control without constraining the perceived autonomy of contributors.

Nevertheless, the innovation process in networks often follows organic and ad-hock patterns. For instance, in technology entrepreneurship, collecting and accumulating technical inputs from distributed network actors creates a momentum that, over time, forms an emerging technological path (Garud and Karnøe, 2003). In such a context, directing the human agency can shape and define innovation outcomes (Garud and Karnøe, 2003; Coviello and Joseph, 2012; Fisher, 2012; Desa, 2012). For instance, leading OI involves leveraging and organizing dispersed contributions from various actors towards creating dominant knowledge assets (Van de Vrande et al., 2009). However, exercising this control can be challenging in OI, mainly due to the fact that diverse OI actors are motivated by various conditions, including their intrinsic need for autonomy and/or extrinsic need for recognition and tangible rewards. For instance, in open source communities, releasing new versions of existing source code is commonly contingent upon coordinating and integrating contributions from two groups of (a) volunteer hobbyists, such as problems-solvers, who self-select to develop a solution (Natalicchio et al., 2017), and (b) developers affiliated with organizations and foundations that sponsor the community (Shah, 2006). Because these two groups are motivated by different factors in making contributions, coordinating and harmonizing their efforts can prove challenging.

In short, the effectiveness of OI leaders in creating value from innovation depends not only on their ability to mobilize resources in the input domain, but also on their efficacy in directing the flow of technical contributions in the institutional domain toward developing a dominant and predetermined technology. For network actors to adopt and adhere to the leader's decisions and vision, they must recognize and accept the leader as an authority in the relevant area of expertise. Demonstrating expertise through artifacts such as technical contributions is undoubtedly central to establishing the leader's qualification and authority among network members. Further, the technical contributions of leadership candidates should demonstrate an optimal cognitive model of tightly bounded rationality that help facilitate well-delineated innovation problems in the confines of a specific open source project (Natalicchio et al., 2017). After the emergence of leaders, this reputation and recognition lay the foundation for establishing a leader's expert power in OI, which is associated with improved goal clarity and employee satisfaction (Podsakoff and Schriesheim, 1985). In that sense, establishing expert power is conducive to adoption of a leader goals and objectives for developing a dominant innovation in the network. Adoption of a leader's goals and vision helps define the scope of contributions without imposing constraints on the perceived autonomy of network members.

Proposition 1a. *Motivation for autonomy in the input domain, mediated by technical contributions, is conducive to establishing the expert power of emergent OI leaders in the institutional domain.*

Proposition 1b. *Establishing the expert power of emergent OI leaders in the institutional domain is conducive to mobilizing resources in the input domain to pursue a dominant flow of innovation.*

The effectiveness of this approach depends on creating an autonomy-supportive environment, without jeopardizing the objectives established and set by the leader. In other words, in directing the flow of innovation, leaders must preserve the sense of autonomy in making contributions to ensure developers' motivation to be active in the network. Addressing this paradox requires establishing mechanisms that help contributors accept and internalize the leader's objectives as their own. Such mechanisms include positive feedback, challenging goals, and recognition and validation, to name a few forms of external motivations that can be internalized. The underlying process that facilitates the internalization of these external motivations is referred to as introjection (Gagné and Deci, 2005). Establishing mechanisms that support the introjection process helps regulate the otherwise unpredicted behavior of contributors and subsequently facilitate the organization of contributions towards value creation goals, such as specific product release dates.

For instance, by introducing a flexible tool that facilitates software workflows, known as Action, and making it available on the cloud, GitHub provided more autonomy for developers, while improving planning and tracking for OI leaders. This feature improved developers' willingness to contribute and, subsequently, increased productivity by 87% in 2021 (Forsgren, 2020; Forsgren et al., 2021). Additional studies show that developers perceive introjection mechanisms, such as peer-support for new ideas and job feedback, as essential determinants of satisfaction with self-reported productivity (Storey et al., 2019). For instance, GitHub communities that encourage mentorship and friendly feedback, on average, experience a higher productivity rate (16% to 46%) (Forsgren et al., 2021).

Additionally, to direct the flow of innovation in the institutional domain towards profitable outcomes, leaders must recognize and target new and novel opportunities in the market domain (Ireland et al., 2003). As discussed earlier, opportunity discovery is fundamental to value creation with knowledge-acquisition and creativity noted as the main antecedents to discovering opportunities that improve performance and growth (Koryak et al., 2015; Zahra and George, 2002; Shane, 2000; Gruber et al., 2013). The creativity of entrepreneurial leaders is conducive to imaginative use of limited resources in the input domain towards exploiting opportunities in markets (Choi, 2007). However, strategic value creation in market domain is further contingent upon several endogenous and exogenous factors, including environmental dynamism, change orientation, and contextual flexibility. Similarly, although opportunity-seeking behaviors are central to entrepreneurial leadership, this effect is contingent upon whether these behaviors lead to discovering new opportunities that fuel value creation (Koryak et al., 2015). In that sense, it can be deduced that more specifically, opportunity-oriented behaviors that lead to discovering new opportunities are central to success of entrepreneurial leadership.

However, the outcome of opportunity-seeking behaviors in discovering new opportunities depends on (a) the availability of new opportunities in the environment, and (b) exposure to such opportunities. The abundance of opportunities available in the environment is a function of changes in the environment and dynamism. For instance, in a highly dynamic environment, such as software development, opportunities to innovate arise more frequently, in comparison to hardware development. In that light, high-velocity environments, where opportunities to innovate are abundant, are conducive to the effectiveness of OI leaders in sustaining innovation (Surie and Ashley, 2008). This effect is accentuated by the leaders' knowledge of the industry, which increases the likelihood of recognizing new opportunities that emerge in the environment (Shane, 2000; Gruber et al., 2013).

However, to mobilize resources, recognized opportunities must to be framed and promoted as attractive options to pursue by leaders. To do so, OI leaders must make sense of opportunities and communicate their value in achieving innovation goals, to the members (Covin and Slevin, 2002). These framing attempts should aim at countering the view that new opportunities take resources away from existing and ongoing processes and thus, may present a threat to the collective as a whole (Ireland et al., 2003). To do so, the framing process should involve describing the potential strategic benefits of new opportunities, such as stimulating the development of competitive advantages (Covin and Slevin, 2002) (Fig. 2).

Proposition 2a. *Employing the introjection process in the institutional domain mediates the linkage between establishing the expert power of emergent OI leaders and their effectiveness in creating knowledge assets in the market domain.*

Proposition 2b. *The effectiveness of OI leaders in creating knowledge assets is contingent upon recognizing new and novel opportunities in the market domain to guide the flow of innovation in the institutional domain.*

3.2. Leading to capture value in OI

Social contributions, the emergence of referent and legitimacy power, and growth strategies. Making social contributions has been recognized as one of the main criteria for emergence of OI leaders. However, it is not clear why some individuals make considerable social contributions in OI initiatives compared to other members. Plausibly, examining the effect of intrinsic motivation needs that regulate behavior of members in OI can help explain heterogeneity in social contributions of individuals with similar social dispositions (Fleming and Waguespack, 2007; Fleming et al., 2011). Conversely, social contributions in OI are mainly driven by individuals' needs to interact with, relate to, and influence their environment. Thus, similar to technical contributions, making social contributions in OI, partially depends on the congruency of contributor's intrinsic motivational needs with the innovation OI fostered through governance drivers and processes in OI (O'Mahony and Ferraro, 2007; Harison and Koski, 2010; Hertel et al., 2003; Shah, 2006; Krogh et al., 2012). Existing literature identifies the impact of two major social contributions, namely boundary spanning and brokering, on the emergence of OI leaders (Fleming and Waguespack, 2007; Fleming et al., 2011). In this section, these social positions are discussed in terms of their impact on mobilizing resources, guiding a dominant flow of innovation, and implementing growth strategies.

Boundary spanning. Boundary-spanning activities are conducive to dispersing information across boundaries (Fleming and Waguespack, 2007). Social interactions in OI, as a form of virtual networks, are commonly limited to impersonal Computer-Mediated-Communications (CMC). The use of CMC has shown to carry an adverse effect on developing social relationships and capital commonly associated with face-to-face communications (Pickering and King, 1995). At the micro-level, this adverse effect impacts individuals' desire to interact and connect with others, commonly known as *motivation for relatedness* (Baumeister and Leary, 1995). However, in innovation context, in the absence of contextual prerequisites for social interactions, social ties are formed in the process of disseminating information. As such, members view knowledge sharing as an opportunity to satisfy their need for relatedness. For instance, in GitHub open source project, an active and engaging community is considered as one of the main driving factors impacting developers' decision to join. Thus, when surveyed, 85% of developers viewed an active *welcome community* as either a very important or somewhat important factor in joining an open source community on GitHub (Geiger, 2017).

Additionally, the boundaries that separate communities and projects in virtual networks are less tangible, thus facilitating cross-boundary interactions. Subsequently, the members; need for social interactions in OI can also be addressed through cross-boundary connections and boundary-spanning activities. Further, cross-boundary interactions have the potential to broaden one's stock of knowledge by gaining information exclusive to members in other network (Van de Vrande et al., 2009). In terms of implications for the OI initiative in general, research findings suggest the conducive effect of acquiring externally developed knowledge on innovation performance (Natalicchio et al., 2018). In short, OI members maybe motivated to engage in boundary spanning activities for a variety of reasons that include addressing the intrinsic need for motivation, acquiring new knowledge in the process, and improving the innovation outcome. To perform boundary-spanning activities that benefit OI, emergent leaders may adopt a cognitive model oriented towards loosely bounded rationality. This form of cognitive models tends to facilitate a broader approach to varying innovation problems across open source projects (Natalicchio et al., 2017). The impact of boundary-spanning activities is evident in deploying a recent GitHub tool called *Discussions*, which allows collaborations and information sharing across projects and repositories. An exploratory analysis of the use of Discussions shows that 47% of developers, who participated in discussions eventually made contributions to the open source projects (Forsgren, 2020).

In addition to the motivating member to engage in boundary-spanning, the intrinsic need for relatedness plays a developmental role in acquiring skills for leading in complex and impersonal contexts, such as OI. For instance, through interacting with other actors, while dispersing information across boundaries, emerging leaders gain experience and insights into engaging and mobilizing resources in the input domain towards cross-boundary collaboration. Initiating these collaborations requires leaders to persuade outside parties through framing and articulating the objectives of their community. However, for OI leaders to succeed in this role, outsiders must first view them, the objectives they promote, and their communities as relevant to their activities in open source space. In other words, OI leaders must establish their referent power across boundaries to facilitate collaborations. The boundary-spanning activities help establish the public image of emergent leaders as active contributors interested in dispersing and sharing information across boundaries. Thus, these activities lay the foundation for establishing the leaders' referent power in OI (Podsakoff and Schriesheim, 1985). In short, establishing referent power is central to the effectiveness of OI leaders in inspiring network contributors to relate to the project objectives and share their knowledge and expertise towards achieving them. Additionally, establishing referent power inhibits withdrawal and instead increases member engagement, which is essential to ensuring survival of the initiative.

Proposition 3a. *Motivation for relatedness in the input domain, mediated by boundary-spanning activities, is conducive to establishing referent power of emergent OI leaders in the institutional domain.*

Proposition 3b. *Establishing referent power of emergent OI leaders in the institutional domain is conducive to mobilizing resources in the input domain to pursue cross-boundary collaborations.*

In addition to OI leaders' role in inspiring collaboration and knowledge exchange, through establishing referent power, the

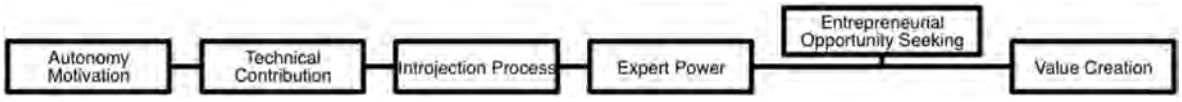

Fig. 2. Role of autonomy and technical contributions in creating value in open innovation.

environment should also support and promote developers' social engagement. As social interactions are at the center of engagement, the environment should incorporate mechanisms that address the need for relatedness. In OI, common interactions are limited to computer-mediated communications. Thus, leaders must actively create opportunities for satisfying the need for relatedness in the environment through mechanisms such as the relational design of tasks and increased interaction amongst members based on information exchange to improve motivation for pro-social behavior. These tools and mechanisms that help members identify with the community, other members, and overall objectives are commonly conceptualized as identification processes (Gagné and Deci, 2005). OI leaders can use identification mechanisms to regulate the social behaviors of internal and external contributors. For instance, the majority of surveyed developers on GitHub — roughly 53% — either strongly agree or somewhat agree with the statement that they consider themselves to be a member of the open source community (Geiger, 2017). An even larger percentage, around 61%, either strongly agree or somewhat agree with the statement that the open source community values contributions from developers like themselves.

Cross-boundary collaborations can lead to capturing value from innovation. However, to effectively capture value from the cross-boundary collaboration is contingent OI leaders must employ several entrepreneurial strategies. First, they must seek strategic advantages in markets and identify opportunities for exploiting contributions across boundaries (Ireland et al., 2003). Second, OI leaders must integrate contributions from other communities with knowledge assets created in their community. Third, they must manage complexities of intellectual property in licensing and appropriation of cross-boundary collaboration outcomes in the market domain (Faridian and Neubaum, 2021). Existing studies show that employing entrepreneurial change-oriented approaches by Ol leaders can empower internal contributors to seek, integrate, and diffuse new ideas and knowledge, and subsequently, improve open innovation outcomes (Naqshbandi et al., 2019). Further, recombination of contributions across boundaries may also require engaging OI leaders in other communities (Naqshbandi et al., 2019) (Fig. 3).

Proposition 4a. *Employing identification processes in the institutional domain mediates the linkage between establishing the referent power of emergent OI leaders and their effectiveness in the appropriation of knowledge assets in the market domain.*

Proposition 4b. *Effectiveness of OI leaders in the appropriating knowledge assets is contingent upon guiding cross-boundary collaborations, in the institutional domain, towards strategic advantages prime for exploitation in the market domain.*

Brokering. Brokering activities aim to modify network structure by identifying and exploiting structural holes. In the process, brokers connect actors and create new network links. In doing so, brokers can control their position in the network for self-serving purposes, among other objectives (Fleming and Waguespack, 2007). In OI, members can modify their position in the network in terms of connectedness and centrality by engaging in social brokering. These activities are facilitated by OI's fluid and organic structure, combined with a lack of a clear hierarchy. However, lack of hierarchical ranking and positions and the more tangible privileges and rewards that accompany such titles can lower extrinsic motivations in OI. However, social brokering activities are mainly motivated by intrinsic needs of individuals to act as causal agents in excreting control and shaping their surroundings.

The desire and motivation to control the environment are referred to as the need for competency (White, 1959). Satisfying this need by exerting control in connecting otherwise distant actors and creating new social ties in the process, help internalize motivation to contribute to OI (Gagné and Deci, 2005). In that sense, in addition to the social disposition needed to engage in making introductions and brokering new ties, the social contributions of brokers are contingent upon their intrinsic need for competency. In other words, without intrinsic motivation to satisfy the need for competency, emerging leaders may not utilize their social skills to broker activities. In addition to the motivation to satisfy the need for competency through social brokering activities, this need leads to the development of leadership abilities necessary to connect dispersed members with the OI network. Through social brokering, prospective leaders learn how to influence others and persuade them to join the initiative or connect with specific members. These activities help emergent leaders establish themselves as influential social architects, in the void of hierarchies and clear structures.

This emphasis on inter-personal influence is central to recruiting new members to the OI communities. Additionally, the social brokering activities provide prospective leaders with the experience and knowledge needed to establish their locus of control and causality among network actors and initiate structural changes. In other words, social brokering activities serve as prerequisites to the leadership skills in influencing network actors to connect and collaborate. Because brokering activities in OI legitimize leaders as influential actors in the network, they lay the foundation for establishing a leader's legitimate power in OI (Podsakoff and Schriesheim, 1985). For instance, research findings suggest that GitHub function that allows developers to follow other users and projects improves their popularity and, by extension, the influence in the community (Blincoe et al., 2016). Leveraging the Follow feature on GitHub is presumed to be even more conducive to establishing influence and power than making technical contributions.

In addition to expanding the network by recruiting new members, the expansion and evolution of OI initiatives are contingent upon improving network density. To improve network density, brokers must first identify structural holes in the network, and then fill them by linking members to one another. In doing so, brokering activities allow OI leaders to learn about pockets of knowledge embedded in the network and integrate contributions of individuals who possess them with the innovation appropriation objectives of the entire network. In this capacity, OI leaders need to act as knowledge-seekers searching for knowledge-owners with specialized expertise and competencies that can fill the knowledge gaps in the network (Natalicchio et al., 2014). For instance, in knowledge networks, experts on radical and disruptive innovations tend to occupy the network's periphery.

Thus, brokering activities are central in identifying knowledge-owners in the input domain and connecting them to others. Creating these new linkages facilitate use of unique skills and competencies towards innovation appropriation in the market domain. Social brokerage activities can prove more effective through employing improvisation strategies of bricolage. These strategies help leaders not only learn about knowledge and expertise embedded in the network but also to formulate ways to direct these resources towards a dominant flow of innovation effectively. Combining improvisation strategies with social brokering activities can help OI leaders gain a realistic understanding of resources and means available to them(Fig. 4).

Proposition 5a. *Motivation for competency in the input domain, mediated by brokering activities, is conducive to establishing the legitimacy power of*

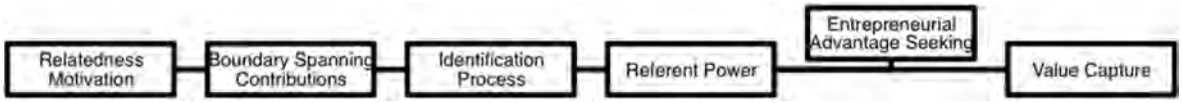

Fig. 3. Role of relatedness motivation and social boundary spanning in capturing value in open innovation.

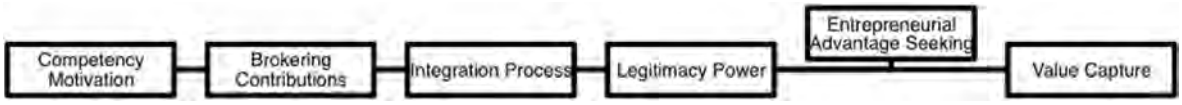

Fig. 4. Role of competency and brokering activities in capturing value in open innovation.

emergent OI leaders in the institutional domain.

Proposition 5b. *Establishing the competency power of emergent OI leaders in the institutional domain is conducive to mobilizing resources in the input domain to expand and sustain network ties.*

In addition to social brokering activities, the effectiveness of OI leaders in mobilizing external partnerships and collaborations is contingent upon creating a supportive environment that motivates such behavior (Naqshbandi and Tabche, 2018). More specifically, institutional mechanisms that provide opportunities to fulfill network members' intrinsic need for competencies are conducive to achieving collective mental models that encourage social contributions. Examples of such institutional mechanisms include creating opportunities in social setting, where actors become aware of others' expertise and knowledge. These mechanisms allow OI members to make strategic decisions in creating internal and external social ties that are central to achieving appropriation objectives. For instance, social brokers utilize the GitHub Sponsor feature to promote support for individual developers, in specific, and the project, in general. These social activities facilitate the exploitation of co-created knowledge assets.

To initiate social ties, members exercise agency in sharing their knowledge and expertise to the extent that external conditions accommodate their needs. The underlying process that helps regulate members' behavior in the process is referred to as the integration process (Gagné and Deci, 2005). In that light, a large majority of surveyed OS developers on GitHub (85%) have received help from others while learning how to use or contribute to open source projects (Geiger, 2017). In most cases (56%), developers were helped by total strangers with whom they had no previous connections. On other hand, most respondents (74%) expressed that they have offered help to someone experiencing challenges in making contributions or trying to use an open source project. In most cases (64%), help was offered to total strangers.

By establishing legitimacy, OI leaders can improve capturing value from innovation through creating strategic partnerships that best serve their vision for the community (Ireland et al., 2003). However, the mere appropriation of innovation, while essential to effective OI leadership, is not sufficient to satisfy strategic entrepreneurial objectives. To ensure effective value capturing, OI leaders should make sense of how appropriation strategies fit the overall strategic vision of the community (Covin and Slevin, 2002). For instance, the Open Source for Good project on GitHub has provided an opportunity for communities and developers to exploit their contributions and knowledge assets towards solving societal issues that carry collective long-term impact, such as responses to COVID-19. Additionally, develops benefit from the resulted connections with the leaders of such projects in future.

Proposition 6a. *Employing the integration process in the institutional domain mediates the linkage between establishing the legitimacy power of emergent OI leaders and their effectiveness in the appropriation of knowledge assets in the market domain.*

Proposition 6b. *Effectiveness of OI leaders in appropriating knowledge assets is contingent upon recognizing strategic advantages prime for exploitation in the market domain to guide network governance strategies in the institutional domain.*

4. Conclusion

The discussions and theoretical postulations in this study elucidate the complexities of the emerging landscape of OI leadership and governance. The theoretical and practical implications of these novel complexities are immense, especially amid a global pandemic that fueled the need for collaborative innovations. In this section, first, the inferences related to the theoretical implications of this study are discussed, followed by the practical implications. Next, the potential areas for future research are noted, while acknowledging some of the limitations of this study.

Regarding the theoretical implications, the results of this study help address several gaps and deficiencies in literature on OI leadership. First, the literature on OI leadership is primarily concerned with the emergence of leaders due to social and technical contributions, and subsequently tend to overlook the importance of leaders' effectiveness in managing human and social resources towards knowledge-asset creation and appropriation (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007). The proposed framework in this paper addresses this gap by highlighting the importance of entrepreneurial contributions of OI leaders. In doing so, it expands the research on OI leadership beyond the traditional focus on leaders' social and technical contributions. In doing so, this study also offers insights that address the research gaps in understanding the linkages and differences in criteria for the emergence and effectiveness of leaders in OI. Meaning, while social and technical contributions are most conducive to the emergence of OI leaders, entrepreneurial contributions are central to their effectiveness in achieving innovation objectives.

Further, as recent studies suggest, effectiveness of OI leaders is contingent upon the interplay of various factors. However, the OI leadership literature tends to undervalue such complexities. As a result, the underlying processes and contingencies that mediate and moderate the emergence and effectiveness of OI leaders remain understudied. The propositions and discussions in this study, help address these gaps twofold. First, it sheds light on the importance of mediating effect of establishing (a) various facets of power, namely expert, referent and legitimacy, for emergent OI leaders, and (b) processes that motivate contributions in OI, namely introjection, identification, and integration processes. Second, the proposed model elucidates the moderation effect of entrepreneurial OI leaders' opportunity-seeking and strategic advantage-seeking activities on value creation and capture process.

The theoretical postulations on facets of power as antecedents of leadership emergence explicate the importance of developing shared mental models that form the perceptions of the emergent leaders held by the network actors. More importantly, by linking these facets of power to various forms of motivation, the proposed model advocates a view of leadership emergence in OI beyond the commonly explored meritocratic and ad-hoc process. Instead, it portrays emergence of OI leaders as a highly intentional process that demands exercising a strong locus of control similar to that pursued by entrepreneurial leaders. These findings suggest the potential for enriching the research on OI leadership by shifting the focus to integrating the entrepreneurship and strategy literature.

Additionally, this study contributes to the literature on entrepreneurial leadership. By examining the construct of entrepreneurial leadership from the OI perspective, this study offers insights into the complexities of developing and monetizing innovation in novel collaborative environments, which deviates from the organizational proprietary approach dominant in this literature (O'Mahony and Ferraro, 2007; Fleming and Waguespack, 2007). In that light, by dissecting how OI leaders emerge and achieve outstanding outcomes through a mix of technical, social, and entrepreneurial approaches, this paper invokes leadership research to further investigate the complexities of leading in

the information age.

Lastly, this paper sheds new light on employing strategies that ensure survival of OI initiatives in the hyper-competitive and fast-changing knowledge economy. The propositions offered in this study explicate the impact of entrepreneurial strategies on OI performance in two phases of value creation and capture. More specifically, this study postulates the importance of deploying entrepreneurial strategies such as bricolage, in the value creation phase, and opportunity-seeking, and advantage-seeking, in the value capture phase, Overall, the proposed model in this paper offers insights into the understudied role of entrepreneurial leadership and strategies in OI. These insights shed new light on addressing the complexities of mobilizing and orchestrating resources and harmonizing innovation development and monetization. The overarching approach to discussing OI leadership that spans three domains of entrepreneurial bricolage revealed not only the multifaceted nature of OI leadership but also the interdependencies between factors dominating the emergence and effectiveness of leaders. This discussion offers insights into addressing the current gaps in OI leadership literature regarding managing innovation appropriation in the market domain. The insights on the role of opportunity and advantage-seeking activities offered in this paper emphasize the importance of integrating and adopting novel perspectives, such as strategic entrepreneurial leadership, to advance research on OI leadership.

In short, by adopting a multifaceted lens to exploring OI leadership, this study contributes to the literature on open innovation, strategic entrepreneurship, and leadership. It offered insights on the joint effect of harmonizing not only technical and social activities but also entrepreneurial and strategic approaches central to the emergence and effectiveness of leadership in OI. More specifically, this paper helps understand the theoretical linkages and interplay among relevant constructs in the intersection of strategic entrepreneurship and OI leadership by investigating the underlying mechanisms and processes related to entrepreneurial strategies, such as, mobilization and orchestration of resources across domains, and opportunity recognition and advantage seeking strategies.

With regards to practical implications, this study informs practitioners about the complexities of leveraging external and internal resources to achieve OI objectives. These complexities can prove detrimental to the effectiveness of leaders in the knowledge economy, where ignoring or poor integration of external sources of knowledge can threaten survival in the face of fast-paced technological change. For instance, GitHub experienced an unprecedented increase in OS project development, which demonstrated the potential of this context, but also raised questions about governance strategies needed to manage the increased workflow while supporting contributors' work-life balance (Forsgren, 2020). The discussion on the heterogeneity of motivations essential to the three types of contributions in open source projects explicates the complexity of governance mechanisms and processes required to mobilize and sustain a healthy and active environment for innovators. This study highlighted the practical implications of this subject by discussing GitHub's efforts to enrich the innovation environment by implementing novel tools, including *Discussions*, *Action*, Sponsor, *Follow*, and *OS for Good*.

The relevance of these practical implications is magnified in the light of the global pandemic that fueled virtual collaborative innovations. In that light, while increased open source project activities during the pandemic supported developers' intrinsic needs for competency and autonomy, project owners should caution that developers social needs for relatability are not scarified in the process. Ignoring the delicate balance among the drivers of these needs in OI can result in detrimental side effects such as screen fatigue, poor work-life balance, and burnout (Forsgren, 2020).

To avoid such adverse effects, project owners, in particular, and OI leaders, in general, should be attentive to not only technical objectives, such as developing the repositories, but also enriching the experience of contributors by creating vibrant and lively *Discussion* forums and taking advantage of *Follow* features. Similarly, project owners should avoid generalizing dominant assumptions about developers' lack of expectation and motivation for extrinsic and monetary rewards. And instead, strive to establish mechanisms that create opportunities for improving career development and raising funds for the community. In GitHub open source projects, brokering network ties with external actors through initiatives, such as the GitHub Sponsor program, can help develop the community aspects of OI in the institutional domain while achieving monetization objectives in the market domain.

Regarding challenges and limitations, this study aimed to advance the research on OI leadership by offering a comprehensive view through consolidating a wide range of theories, as opposed to theoretically anchoring the construct in one field or another. To address this challenging task, it investigated the intersections of the three fields of open innovation, strategic entrepreneurship, and leadership. While this cross-pollination of multiple fields facilitated achieving a comprehensive theoretical model and set of propositions that can offer novel direction for advancing future research on OI leadership, it posed challenges in balancing both depth and breadth of discussions. Further, while examining the GitHub platform guided and enriched the over-encompassing theoretical postulations in this study, qualitative approaches, such as the grounded theory that focus on single aspects of the proposed multifaceted model, can offer more in-depth analysis under this overarching area of inquiry.

Additional areas for future research include theory-building approaches, such as conceptualizing the construct of OI leadership using multi-level models that integrate foci from multiple streams of literature. This approach would create a stringent theory, structured around the emergence and effectiveness of OI leaders at the individual, clique, community, networks, and cross-boundary levels. Undoubtedly, this area of research can benefit from a shift in methodology from empirical surveys to more contextual and process-oriented approaches. Future studies should investigate additional contextual contingencies that influence the innovation outcome of OI leadership. Lastly, future studies should integrate other novel entrepreneurial perspectives, such as effectuation and lean startup, to explain the role of entrepreneurial approaches and processes in leading innovation in the knowledge economy.

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