

Openness to Innovation as a Driver of Knowledge Integration in High-Tech SMEs: The Roles of Social Capital and Network Competence

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ABSTRACT

This paper studies an original analytical framework to address the implementation dynamics of open innovation practices by discussing their impacts on SME social capital and knowledge integration. A total of 358 high-tech SMEs in the Democratic Republic of Congo participated in the survey. The collected data were statistically analyzed using structural equation modeling (SEM) in Smart PLS to verify the postulated hypothesis. The results reveal that open innovation practices promote knowledge integration, and social capital partially mediates open innovation and knowledge integration capability. The results further indicate that network competence moderates the practice of open innovation and social capital interactions with external knowledge sources. The theoretical implications of this study contribute to advance the discussion on the antecedent of social capital and knowledge integration in SMEs in developing countries and propose network competence as a moderator. The study also highlights the social capital nature of open innovation and reinforces the knowledge of scholars.

KEYWORDS

External Knowledge Sources, Knowledge Integration, Network Competence, Open Innovation, Social Capital

1. INTRODUCTION

Today's business environment is increasingly competitive, such that SMEs that often lack resources and technologies have difficulties coping in this system where the biggest challenge is to survive and grow (Centobelli and Esposito 2018). To face this environment, Congolese SMEs are exploiting and implementing various strategies to achieve market-leading business performance. Knowledge is becoming fundamental to any firm's success and competitive advantage (Shah and Cross 2018). SMEs in developing countries are struggling to maintain close contact with external knowledge sources (Salamzadeh and Radovic-Markovic, 2016). The diversity and competition of these external knowledge sources possessed by a firm are considered as indicators of innovation performance (Chiang and Hung 2010). In this perspective, as an intangible asset, knowledge is often seen as an essential source of innovation (Bhatt 2001). Bhandar (2007) demonstrated that knowledge is critical for High-Tech SMEs to establish a sustainable innovation advantage. Thus, Chesbrough (2003) argued that innovation is far from being a result of an isolated firm effort or an exclusive use of internal resources but a result of various collective resources.

DOI: 10.4018/IJKM.291102

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Thus, Chesbrough (2003) introduced the concept of open innovation by describing the inflows and outflows of knowledge that ensure an acceleration of internal innovation developed, commercialized by a firm, and innovation developed, commercialized by other firms. In this context, other researchers analyzed the characteristics of these “new models” of innovation management by exploring the capabilities and practices deployed, not only in intensive-knowledge industries but also in more traditional industries. Theoretically, models resulting from these studies include the Open Innovation (OI) paradigm popularized by (Chesbrough and West 2006); the theory of user-driven innovation introduced by (von Hippel 1986); approaches to innovation as a community introduced by (Amin and Cohendet 2004); or the ecosystem approach and business models initiated by (Moore 2006). All of these approaches view innovation as the result of interactions and collaboration between diverse institutions. That involves finding, selecting, combining, and integrating various tangible and intangible resources in different organizational and technological contexts, distributed within and across firm boundaries. Accordingly, research has demonstrated the effectiveness of OI in stimulating innovation (Chen, and Vanhaverbeke 2011; Mazur 2016; Rangus et al. 2017). Hence, OI has become a critical approach to promote firm innovation (Cassiman and Valentini 2016). However, results are still mixed regarding how OI fosters knowledge integration (Sivam et al. 2019).

According to (Koustab and P. 2020), OI implies entrusting to a third party (e.g. research laboratories, universities, partners..) all or part of the workforce to develop new knowledge or new concepts during the invention phase (Arthur 2007). This phase raises new challenges for innovative SMEs in Congo since OI involves adapting codified and cataloged practices, sharing and transferring, protecting, and exploiting knowledge (Saebi and Foss 2015). As a result, the knowledge created, even partially, externally, struggles be used as a complement to the firm’s internal knowledge (Spithoven and Knockaert 2010). This process requires applying mechanisms for integrating or combining knowledge that falls under specific capacities (Cohen and Levinthal 1990). Similarly, when collaborative or community-based organizational forms support firms enhance the stages of conceptualization and translation of the concept into operational technology, which constitutes the last two stages of the invention phase (Arthur 2007). Therefore, these stages require managing interactions between partners that differ from the traditional management model. Finally, the transformation of innovation models changes the way organizations manage the knowledge involved in the commercialization phase of innovation (Arthur 2007). These procedural requires the implementation of appropriation managements adapted to the challenges of interaction, collaboration, sharing, and openness (Teece 2010).

Therefore, in the quest for this issue, researchers have recently become more interested in the social interactions (Social Capital) between diverse external knowledge sources as an integral part of OI (Laxamanan et al. 2018). Nahapiet and Ghoshal (1998) describe social capital (SC) with three different dimensions: structural (the overall pattern of relations between actors), relational (the kind of personal connections people have established with each other through a history of interactions), and cognitive (those resources delivering shared representation, systems, and interpretations). In recognition of these social interactions existing in OI practices, studies have begun to investigate OI’s social capital aspects (Adler and Kwon 2002) by analyzing specific aspects of OI in favor of social capital. Thus, Fleming et al. (2007) and Kitsak et al. (2010)’s researches on SC highlighted the significant role of social interactions in the assimilation of knowledge in the innovation process. Besides Chiu and Wang (2006) shows that SC allows the dissemination of training activities, the organization’s workshops on current issues or events at the enterprise level, and the implementation of best practices. However, researchers have not developed a model that comprehensively explains social capital’s role within the OI framework in SMEs (Chen, and Vanhaverbeke 2011; Lichtenthaler and Lichtenthaler 2010). Moreover, there is no empirical study examining the effectiveness of OI and SC on the firm’s knowledge integration, particularly in developing countries.

Therefore, this study relies on the Resource-based view, Social Capital Theory, and Social Cognitive Theory to explore the influence of outcome expectations and facets of OI on the firm’s SC and knowledge integration. Following (Grant 1996) and (Chirico and Salvato 2008), proposed

the notion of knowledge integration capacity and deduced three related characters: the scope of integration, the effectiveness of integration, and flexibility. Chan and Liebowitz (2006) described knowledge integration as a process of applying and combining various types of knowledge. Also Tiwana et al. (2003) defined knowledge integration from how organizations acquire external knowledge and combine them with the current organizational knowledge and internal techniques. Although knowledge integration is not without problems when it comes to face-to-face, it is challenging when external knowledge sources come from a “learn” social network (Graetz et al. 1998). Thus, the firm’s performance cannot be limited by its partners’ absence of expertise, but rather by the firm’s inability to integrate all available information and knowledge (Reus and Liu 2004). Thus, we argue that SC-the set of resources established in the relationships between the actors of a social network and OI-reliance on external sources of knowledge such as universities, suppliers, competitors, governments, research centers etc., foster the firm’s knowledge integration.

Besides, network competence describes the ability to build, maintain, manage, and exploit the network’s resources. This skill is essential for SMEs to foster not only OI instruments but also firm’s SC (Jian and Osman 2015). In this perspective, (Nahapiet and Ghoshal 1998) were able to integrate the theory of social anchoring in strategic management by explaining the functioning of the internal generation of intellectual capital. Further, the study demonstrated the organizational competitive advantage of “communities of personal interaction” that represent an anchor of knowledge sharing within alliances. On the other hand, (Kale and Singh 2007) states that managing external partners or companies’ knowledge sources might help support organizational development. This capability enables the development of knowledge and social interactions as well as knowledge sharing at the partner management level already defined or cataloged by the company. A strong theoretical understanding and empirical testing, from the perspective of network competence, remain scanty. Therefore, specific gaps exist in the literature border limiting knowledge of network competence’s contribution to OI practice and social capital.

This study seeks to deepen how SMEs can improve their abilities to integrate new knowledge into the OI environment. Our findings make several significant contributions to literature. First, our study broadens the theoretical scope of OI paradigm by arguing that OI practices do affect social capital, as interactions with external sources of knowledge foster social interactions. Thus, this study deepens the previous research focused on the social aspect of OI in SMEs (Chege, Wang, and Suntu 2019). Second, although previous studies have implicitly suggested that OI practices positively influence knowledge sharing (J. Chen, Chen, and Vanhaverbeke 2011; Ferreras-Méndez et al. 2015) and innovation (Lu et al.), studies have not specified how OI can enable knowledge integration into SMEs. Therefore, this study contributes to the literature on the resource-based view related to knowledge integration. Thirdly, while studies such as (Fleming and Waguespack 2007a; Hoffman, Hoelscher, and Sherif 2005) have highlighted the importance of SC toward knowledge integration, these studies did not demonstrate the role that SC plays in the practice of OI and knowledge integration. Therefore, our studies contribute to the literature on SC antecedents by revealing the mediating role of SC in the relationship between OI and knowledge integration. Fourth, this study goes beyond the calls of innovation theory as a community (Amin and Cohendet 2004) by providing an empirical and theoretical contribution to network competence’s role on the relationship between OI and SC by revealing the role of network competence as the moderator. Finally, we respond to (Laxamanan et al. 2018)’s call for more empirical research on the social aspect of OI in SMEs by providing practical and theoretical contributions to the literature and identifying how OI practices can have repercussions on social interactions that in turn influence knowledge integration.

The rest of the paper is organized as follows: in the next section, we present a theoretical background; section three presents the research model and hypotheses. Data analyses and results are then explored in the fourth section, followed by the discussion of results in the fifth section. We present the practical and theoretical implications, limitations, and future research directions in the final section.

2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

According to (Bourdieu 1986) Social capital (SC) comprises three dimensions: the structural dimension, the relational dimension, and the cognitive dimension. The structural extent is the interpersonal configuration of individual relationships in a social network. It is characterized by the network's size, density, and diversity of relationships. The structural dimension of SC allows individuals to collectively develop and share common representations with other network members with which they identify over time. The relational dimension refers to the nature of personal relationships between individuals, manifesting itself at the level of "strong" and "weak" bonds. It creates trust, norms, obligations, and identity between network members. These values, which lead to a lasting attachment between individuals, influence individual behaviors such as cooperation, communication, and commitment to a common goal. In this light, (Nahapiet and Ghoshal 1998) report that trust between actors increases the chances for entrepreneurs to obtain relevant information and emotional support. The cognitive dimension refers to shared visions, interpretations, and codes that enable network members to make sense of information and classify it into perceptual categories (Carolis and Saporito 2006).

Therefore, working in a community or engaging in specific cooperation with a group of individuals and partners requires a certain level of trust, a common goal, sharing the same values, and even being in the same field. OI practices are not exempt from this fact as companies build relationships with external knowledge sources (e.g. university, competitions, suppliers etc.) through OI practices, and their mutual trust grows over time (Tsai and Ghoshal 1998). For example; (Cattani and Ferriani 2008) argue that trust generally relies on cooperation between entrepreneurial project teams. Thus, we propose that structural SC associated with OI practices allow the creation of relational social capital. Also, there is a positive relationship between developing structural SC and cognitive social capital. In other words, the growth of cognitive, SC is due to the evolution of shared norms and visions as organizations interact with each other (Gulati, Nohria, and Zaheer 2000). We put forward the idea that OI practices positively affect the firm's SC dimensions. We suggest that OI practices are directly related to the social interactions that are developing with OI instruments. Therefore, we propose the following hypotheses:

Proposition 1: The adoption of Open innovation practice is positively associated with social capital.

The literature demonstrates that OI practices enhance innovation performance (Chiang and Hung 2010; Flor, Cooper, and Oltra 2018). Firms that practice OI develop their innovation capability, and at the same time, they also establish reciprocal relations and trust with partners (J. Vanhaverbeke 2011). For such harmony to persist, a social relationship must build up over time because stable cooperation with partners within a network is formed when companies trust each other. Besides, (Miković et al. 2020) argue that firms get involved in OI driven by a clear understanding of their company target, mission, tasks and role, to build mutual trust and quickly integrate external knowledge.

In this perspective (Chan and Liebowitz 2006) described knowledge integration as a process of applying, absorbing, and combining various types of knowledge. Also (Tiwana, Bharadwaj, and Sambamurthy 2003) defined knowledge integration from how organizations acquire external knowledge and combine them with the current organizational knowledge and internal techniques. Researchers have further developed the concept of group knowledge integration to incorporate unique ideas and information to boost the group level production. Thus, for (Tiwana and McLean 2005) knowledge integration is the resume of the expertise of the individuals involved in the projects. This study describes knowledge integration capability as a company's ability to merge knowledge to achieve business objectives as well as the employees' ability to recognize relevant knowledge, share and absorb knowledge needed for the company's structure, understand the interrelationship

and complementarity between different types of knowledge, and combine these different types of knowledge in a flexible way to accomplish specific tasks.

Open innovation practices imply using internal and external knowledge sources to advance internal capabilities and competitive advantage (J. Chen, and Vanhaverbe 2011). In this vein, several authors such as (J. Chen, and Vanhaverbeke 2011; Ferreras-Méndez et al. 2015) demonstrated that the firm's internal capacity alone is not enough for it to innovate. It is necessary to involve external professionals who can maximize in-house knowledge. Therefore, the interactions with external partners suggest an exchange of knowledge. Once the exchange of knowledge occurs and social relations increase, knowledge integration becomes accurate and significant since trust and shared interest are essential for knowledge integration. The study of (Laxamanan et al. 2018) shows that knowledge integration is significantly correlated with the innovative culture and the firm's openness. Thus, knowledge integration depends on people's culture or attitude towards learning and external search knowledge (Malhotra, and Segars 2001). Therefore, we argue that OI promotes the culture/attitude of knowledge integration within the company. Consequently, SMEs that share relevant information with external partners are more likely to integrate new knowledge into the innovation process. Therefore, we propose the following hypothesis

Proposition 2 The adoption of open innovation practice is positively associated with knowledge integration capacity.

Besides, (Okoli and Oh 2007) described SC as “the characteristic of social organization that includes norms, trust, and networks that make society more effective by promoting coordinated action”. Employees with high structural SC are familiar with knowledge from other members (van den Hooff and Huysman 2009), able to identify relevant knowledge and add-on various types of knowledge. The extent of the social-relational network is the characteristic of a structural dimension (X. Chen, Huang, and Davison 2017). Network scope influences the development of entrepreneurial intentions through several mechanisms. First, individuals in a dense network have better access to information and resources than people with small networks (Sanchez-Famoso et al. 2020). As a result, they are more likely to recognize opportunities and relevant knowledge. Second, the relational dimension refers to the nature of the relationship that exists between partners in the network. High interaction rates allow the expansion of communication channels and lead to mutual trust between network members (Sanchez-Famoso, Maseda, and Iturralde 2014). As a result, network members will be more willing to enter cooperative and supportive relationships. Finally, the cognitive approach of SC uses cognitive aspects to study and explain employees' behavior to access information and integrate relevant information in the operational process (Nieves, Quintana, and Osorio 2014). (Wang 2016) has shown the importance of analyzing cognitive dimensions to understand employee behavior. (Y. C. Lee 2017) verified that social capital's cognitive dimension allows the transmission of values, beliefs, and attitudes to an individual through personal relationships in a social network. This third dimension of SC determines individual perceptions about what close partners share. For instance, common language, ideas, and attitudes can facilitate knowledge integration. Therefore, employees who develop a high degree of trust in social networks have the appropriate information and resources for the innovation project. We argue that SC influences knowledge integrations through SC factors that allow individuals to get closer, assimilate shared knowledge, and integrate knowledge. Thus, the following hypothesis is proposed:

Proposition 3: Social Capital is positively associated with the knowledge integration capacity

In addition, the relational dimension concerns the nature of social relations created and mobilized through interpersonal bonds. The literature highlights the importance of the trust relationship between

individuals to exchange resources (Nguyen et al. 2019). Furthermore, studies show that the external knowledge search is based on cooperation with universities, customers, suppliers, (e.g Ferreras-Méndez et al. 2015). These relationships are improved over time through mutual trust and shared social values (Ferreras-Méndez et al. 2015). The quotations that were underestimated in the previous literature are that interactions with external partners allow SC development across the organization's boundaries. As described by (Nahapiet and Ghoshal 1998) social network structure is a complex process where SC is created through interactions with different partners; individuals, collective interactions, exchanges with others generate reciprocal relationships; thus, SC can be defined as a personal link between people throughout their history of interaction.

For example, OI practices include social interaction with external partners that extend beyond individual companies' boundaries. (Fichter 2009). The different participants with different experiences and backgrounds hold the knowledge that can potentially be exploited to generate innovative service, product, operation, or process. However, to value this knowledge, the combination and integration of knowledge are essential. Thus, (Nahapiet and Ghoshal 1998) pointed out that SC favors knowledge sharing and knowledge integration through this process. In the same line, the establishment of SC can facilitate the exchange that considers the advancement of the future innovation process or enhanced knowledge integration. Therefore, OI can perceive the effect of SC on knowledge integration in diverse forms. According to (Akram, Ghosh, and Joseph 2019), OI accelerates the possibility of having access to new knowledge while social interaction favors the integration of this knowledge; Therefore, we propose that SC plays the mediator between OI practices and knowledge integration capacity.

Proposition 4: Social Capital plays the role of mediator between Open innovation practices and the knowledge integration capacity.

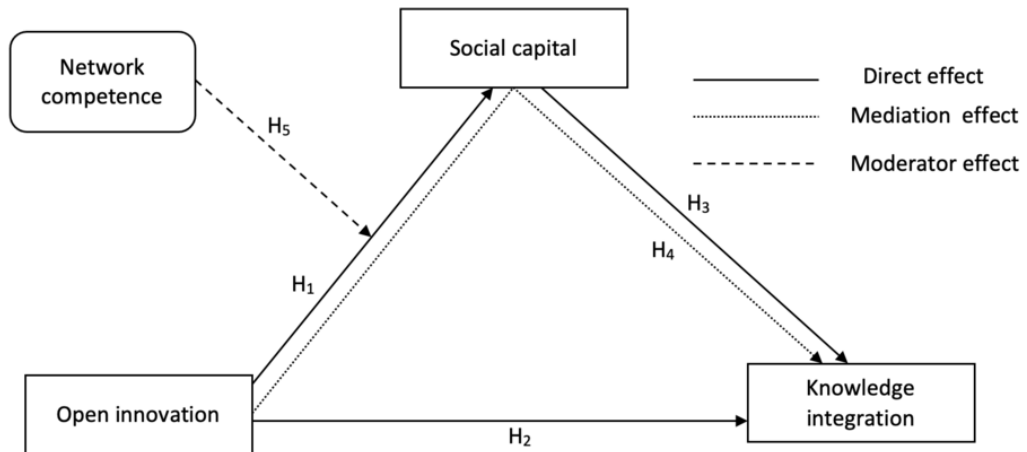
In addition, OI and SC instruments form partner's network composed by different internal and external knowledge sources., all are part of the network structure that facilitate transaction costs and production capacity. However, managing this network is also essential to support OI practices and SC to expand the network and maintain existing relationships. Thus, (Ritter and Gemünden 2003) describes network competence as the firm's ability to manage, use, initiate, and explore its partner's social network resources. In other words; the network competence involves identifying other firms' information, resources, and staff relevant to better comprehend the network's growth(Ritter and Gemünden 2003). Thus, network competence increases the structural dimension that concerns the social network configuration and the links that compose it. This competence influences how the network structure allows the exchange of resources between its constituent actors, their position within the network, and the kind of relationships that bind them. According to (Ridzwan et al. 2016) and (Ritter and Gemünden 2003) network competence focuses on two leading indicators for managing partner networks: the network's density and the strength of its links. The manager forges the link and maintains the crucial partners to keep the balance and the needed resources.

Furthermore, another aspect discussed here is the transferability or appropriation of a network's characteristics in another social context. Notably, the most important is the experience-based knowledge acquired through interaction with external partners, which may evaluate and anticipate problematic situations and choose relevant actions. Network competence can help SMEs work with partners and stakeholders to understand their potential needs and interests, thus fostering the employees and partners' social capital. A networking qualification is useful for conducting internal innovation processes as these processes also require social interaction and management skills to promote information exchange between partners. In other words, network competence moderate social interaction and OI practices. Hence, we propose the following hypothesis:

Proposition 5: Network competence moderates the relationship between Open innovation and social capital.

Fig 1 gives a illustration of the concepts and associations posited in the hypotheses. The model include open innovation, social capital and knowledge integration is the dependent variables. Also, the moderating effect of network competence is represented.

Figure 1. Conceptual model



3. METHODOLOGY

3.1 Research Setting

The study was conducted in Democratic Republic of the Congo (DRC), to support SMEs in improving their innovation performance. Several studies have converged to highlight the importance of SMEs as an essential component of market economies fabric for several years. SMEs have played an important role in innovation, job creation, and economic growth in industrialized countries over the last 20 years. However, in the DRC SMEs constitute almost the entire business population (i.e., about 90%) (Woldie, Laurence, and Thomas 2018). Despite the size, the contribution of SMEs to GDP is estimated at less than 20% (Kabongo and Okpara 2014). In addition, SMEs employ less than 30% of the workforce in the manufacturing sector, whereas this proportion is 74% in most Asian countries and 62% in Latin America. In this perspective, this study proposes a strategic model for SMEs to improve knowledge integration in open innovation practices.

3.2 Data Collection

Our research is a questionnaire-based quantitative empirical study. We contacted 484 Congolese SMEs operating in the High-Tech sector in Kinshasa (Table1), between November 2019 and May 2020. The questionnaires were e-mailed to the sample firms, followed by a phone call to non-respondents, to monitor the progression, with the support of Ph.D. students to follow up and stay in touch with the selected companies for further explanations. The Human Resources Department was our primary contact throughout the questionnaire administration phase. A letter was attached to the questionnaires explaining the strictly academic purposes of the survey and insisting on anonymity.

The targeted respondents were middle-level employees, operational managers, or ordinary employees with working experience and a good understanding of the firm's innovation strategies,

culture, and goal orientation (Table 1). The choice of this sector is guided by several factors. The selected SMEs are operating in knowledge-intensive sectors, whereby knowledge is both the primary input and output of the activity despite the poor economic and industrial level. Within these firms, work is highly resolatory and complex, calling for the combination of various knowledge sources and external expertise. The requirements for knowledge sharing and integration are compulsory. The SMEs in the research sample adopt flexible organizational configurations. In this type of configuration, knowledge flows are transversal, and communication is open. Targeting this type of structure made it much easier for us to control the existence of social interactions. A total of 484 questionnaires were collected. Only 358 of these were retained after eliminating unusable questionnaires, giving a return rate of 74%. Of the 358 respondents. The respondents' average age is 34 years, and the average seniority is 7 years and 4 months, Table 1.

3.3 Measurement Scale

The measurement scales used in the study were derived from previous studies. Participants were asked to provide responses based on a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree." The items related to OI were designed to describe the density or intensity of cooperation with external sources. The exploration and exploitation of external sources of knowledge represent the practice of OI (Hervas-Oliver et al. 2020). We are interested in the knowledge sources that SMEs interact with during the past three years, such as suppliers, competitors in the same sector, customers, consultants, commercial laboratories, and universities. We code open innovation practices with five scores when the firm reports that they used the five sources to a high degree and one if they do not use them. Besides, We measured network competence with five items from network assignment execution and network managerial qualification (Z. Jian and Wang 2013; Ritter 1999), describing the extent to which the company can forge technological and social relationships with partners, or the degree to which the company interacts with its environment to gain innovation. Knowledge integration was accessed by adapting the scale developed by (Cao et al. 2015; Yang 2005) with four variables describing the company's internal system. The variables describe to what extent SMEs integrate new knowledge into the firm operation. For SC, we adapted the approach of (Sanchez-Famoso and Iturralde 2014) that includes the three dimensions of social capital; structural, relational, and cognitive. We used 6 items that described the intensity of social interactions.

Several control variables have been identified in previous research as factors that can potentially influence a company's knowledge integration, including the level of education, firm age, and industry type (Laxamanan and Rahim 2018). Therefore, we used these factors as control variables in this study. The firm's age implies the superiority and experience to integrate new knowledge quickly, unlike a new firm (A. Lee et al. 2020). Thus, we consider the number of years since the foundation, as it could influence the firm's ability to integrate knowledge. The level of education was used as another control variable because the level of education determines the company's human capital. Therefore, we considered the number of employees with and without high school and university degrees in the company. We also controlled for the type of industry - five emerging high-tech sectors (Table 1). We give 1 to the high-tech industry and 5 to the lowest high-tech industry related to the Congolese classifications.

Table 1. Basic Characteristics of the sample

Title item	Type	Percentage%	High-tech sector	Participants %
Enterprises	Sole proprietorship	25	IT consulting	15
	Sole proprietorship with limited liability	65	Industrial chemicals, paint and soap	20
	Limited Liability Company (LLC)	10	Software publishers	35
Business Size	50 employees or less	55	Management, scientific, and technical consulting services	10
	51-100 employees	35	Industrial machinery	20
	100-500 employees	10		
Firm Age	3 years or less	15		
	3 -5 years	21		
	6-8 years	20		
	9-11 years	35		
	11-21 years	9		
Education	State's diploma	55		
	Bachelors	30		
	Ph.D.	10		
	Other	5		
Respondent's position	Top manager CEO	32		
	Middle Management	17		
	Heads of R&D departments	5		
	Production manager	10		
	Other	36		

3.3.1 Common Method Bias

In addition, to eliminate common method bias and common method variance, we combined questions related to the different variables with additional psychological separators when constructing the questionnaire. Not all the questions were in the questionnaire, such that, each respondent would have to answer only part of the questionnaire. The network competence question was answered by the heads of R&D departments or operation manager depending on the availability of the two respondents. The OI questions were responded by the top manager or the SMEs owner. Knowledge integration was answered by employees who work in the production or R&D departments. And finally, SC was answered by two respondents the CEO (structural and relational dimension), and the director of human resources (cognitive dimension).

3.4 Measurement of the Model

The analysis was conducted using partial least squares PLS (Version 3.2.9). This software has the advantage of including several estimators adapted to the different natures of the treated variables (Sarstedt et al. 2014). Previous research has emphasized the importance of using Smart PLS to measure the path interactions and effects of moderating interaction for getting more precise effect

in predictions (Latan and Noonan 2017). Thus, as we seek to know the role of network competence, PLS seems to be the right choice. In general, the PLS path method is used in two phases. First, the measurement model is analyzed; then, the structural model is calculated, and the assumptions are tested. We conducted an Exploratory Factor Analysis beforehand. After the elimination of certain problematic items, all the scales used were found to be unidirectional. Following this purification work, the number of items retained was 5 for “network competence” and 6 for “SC”, 4 for “knowledge integration” and 5 for “OI”.

Table 2. Reliability and validity of the Construct

	VIF	Loading	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
SC6	1.819	0.747	0.845	0.850	0.889	0.616
SC5	1.872	0.788				
SC4	1.923	0.818				
SC3	1.885	0.781				
SC2	1.640	0.791				
SC1	1.456	0.748				
OPN5	2.039	0.801	0.868	0.885	0.903	0.652
OPN4	2.293	0.840				
OPN3	1.974	0.788				
OPN2	2.232	0.826				
OPN1	1.698	0.780				
NET5	1.478	0.763	0.815	0.864	0.865	0.564
NET4	2.010	0.761				
NET3	2.178	0.817				
NET2	1.691	0.790				
NET1	1.749	0.807				
KNIN4	2.021	0.785	0.789	0.797	0.864	0.616
KNIN3	1.270	0.837				
KNIN2	1.951	0.762				
KNIN1	1.575	0.842				

Note: ***P< 0.05, N: 358. Open innovation: OPN; Social Capital: SC; Knowledge integration: KNIN; Network competence: NET.

From the outset Table 2, all the Cronbach's alpha exceeds the threshold value of 0.7 and the factor loadings are above 0.5 which shows that the internal consistency of all factors fit well in the model. The average variance extracted (AVE) represents the convergent validity test above the threshold of 0.5 (Fornell and Larcker 1981). The composite reliability result also exceeds the threshold value of 0.7 (Fornell and Larcker 1981).

3.4.1 Model Fit

Table 3 shows the model fit. The value of the estimated model is 0.058, and the value of the saturated model is 0.053, which is within the required standards. In general, the model is defined as having a

good fit if its value is more significant than 0.01. The normalized fit index (NFI) from this point is determined to be equal to one minus the χ^2 value of the suggested model divided by the χ^2 value of the null model. Therefore, the results of the NFI range from 0 to 1. When the NFI is closer to 1, the best fit is obtained. Since the NFI value is higher than 0.9 for both estimated and 0.902, and the saturated 0.915 models, the fit criterion value is more significant than 0.90, which means that all required values are within the required standards (Table 3).

Table 3. Conceptual model values for model fit

Mode	Saturated Model	Estimated Model	Fit Criteria
SRMR	0.053	0.058	<0.08
Chi-Square	673.603	728.015	>0.01
NFI	0.915	0.902	>0.90

Table 4. Descriptive Statistic and correction

Variables	M	SD	1	2	3	4	5	6
1. Education	4.17	1.822	1					
2. Firm age	3.36	0.749	.134*	1				
3. Industry type	3.24	0.792	.140**	.566**	1			
4. KNIN	3.471	0.655	.253**	.536**	.602**	1		
5. NET	2.228	1.014	-.415**	-.131*	-.165**	-.175**	1	
6. OPN	3.242	0.87	.115*	.286**	.278**	.501**	-0.078	1
7. SC	3.474	0.809	.201**	.401**	.314**	.603**	-0.066	.531**

Note: N=358

Abbreviations: R&D; Recherche and Development, KNIN; knowledge integration, NET; Network competence, SC; Social Capital

*P<0.05

**P<0.01

Table 5. Discriminant validity Farnell-Larcker Criteria

		Control variables			Construct's variables			
	Variables	1	2	3	4	5	6	7
1	Education	1						
2	Industry type	0.14	1					
3	Firm Age	0.134	0.566	1				
4	Network competence	-0.417	-0.199	-0.146	0.751			
5	Open innovation	0.119	0.285	0.292	-0.113	0.807		
6	Social capital	0.201	0.317	0.404	-0.091	0.557	0.785	
7	knowledge integration	0.252	0.676	0.565	-0.217	0.507	0.599	0.777

Note: ***P<0.05.

3.3.2 Exploratory Factor Analysis and Scale Reliability

Table 4 presents some descriptive statistics as well as table 5 the results associated with correlation coefficients and discriminant validity.

Table 4 shows that the correlation coefficients between the indices vary between -0.9% and 55%. These coefficients did not reach sufficiently high levels to trigger multi co-linearity problems between the independent variables. The square roots in Table 5 of the values extracted from the mean variance (the numbers on the diagonal) are larger than any two-component correlation coefficient. This reflects a highly reliable discriminant validity, following the standards proposed by (Fornell and Larcker 1981).

Table 6. Heterotrait-Monotrait Ratio (HTMT)

	Constructs	1	2	3
1	Open innovation			
2	Social capital	0.617		
3	Knowledge integration	0.605	0.738	
4	Network competence	0.119	0.099	0.247

In addition, we tracked the test of discriminant validity to establish Heterotrait- Monotrait ratios (HTMT) across all variables. The result in table 6 indicates that the HTMT values were less than 0.84 which according to (Fornell and Larcker 1981) is the marginal value. This validates the adequacy of the discriminant test ratio.

4. ANALYSIS AND RESULTS

4.1 Structural Model Test

To test the effect of each variable, we used bootstrapping to investigate the direct and indirect effects

Table 7. Summary of hypothesis testing results

Hypothesis	Coefficient	T Statistics	P Values
Education -----> Knowledge integration	0.092	3.121	Supported
Industry ---> Knowledge integration	0.45	10.168	Supported
Firm Age ---> Knowledge integration	0.129	3.171	Supported
Open innovation ---> Social capital	0.543	14.63	Supported
Open innovation ---> Knowledge integration	0.157	3.413	Supported
Social capital ---> Knowledge integration	0.292	5.368	Supported
(NET*OI) ---> Social Capital	0.117	2.253	Supported

Note: ***P< 0.05. Open innovation: OI; Network competence: NET

(Table 7 and 8).

First, we examined the direct effect path of OI on SC ($\beta = 0.543$, $p > 0.005$), and then we proceeded by verifying the immediate effect of OI on knowledge integration ($\beta = 0.157$, $p > 0.005$). Thus, hypotheses H_1 and H_2 are supported. The mediator effect proposed by hypothesis 4 between OI and knowledge integration is accepted when the SC effect on knowledge integration ($\beta = 0.292$, $p > 0.005$), (hypothesis 3), is stronger than the direct impact of OI on knowledge integration ($\beta = 0.157$, $p > 0.005$). The results validate this statement, the indirect effect of OI on knowledge integration is positively significant and the coefficient is stronger ($\beta = 0.162$, $p > 0.005$), (Table 8) which represents a partial mediation and supports proposition 4.

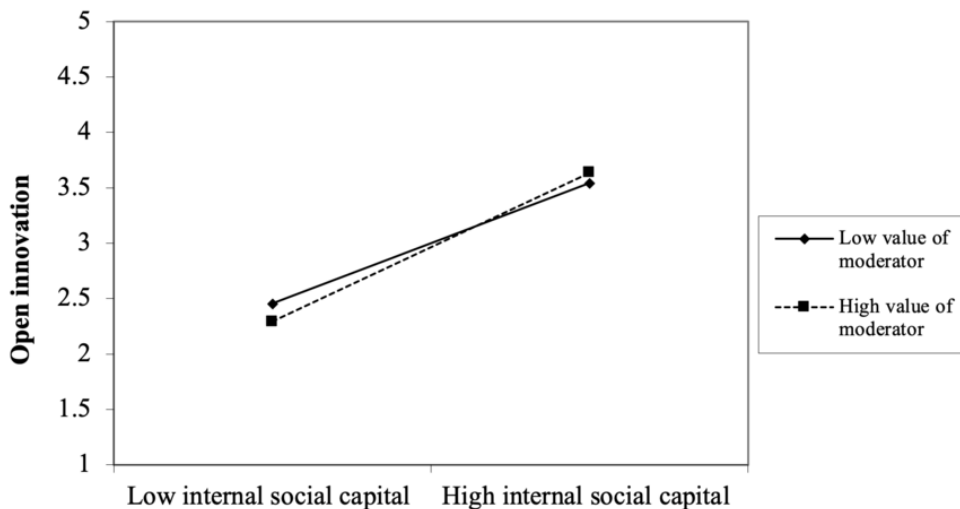
Table 8. Indirect Specific Effects

Indirect effects:	Coef.	T St.	P Values
(NET*OI) - -> SC ---> Knowledge integration	0.037	2.125	Supported
Network competence ---> SC ---> Knowledge integration	-0.01	0.704	0.482
Open innovation ---> SC ---> Knowledge integration	0.16	5.07	Supported

Note: *** $P < 0.05$. SC: Social capital; Open innovation: OI; Network competence: NET

To test the moderating effect of network competence on social capital, the hypothesis states that network competence moderates OI and SC relationship. The outcome shown in Table 7 and figure 2 indicate that interactions between OI and SC are significantly influenced by network competence ($\beta = 0.037$, $p > 0.031$). Therefore, hypothesis 4 is supported.

Figure 2. Network competence moderator effect



5. DISCUSSION AND CONCLUSION

This paper aims to study an original analytical framework to address the implementation dynamics of OI practices by discussing their impacts on SMEs' SC and knowledge integration. It proposes a model that conceptualizes SC as the intermediary between OI and knowledge integration moderated by network competence. As (Chirico and Salvato 2008) stipulated, studying the antecedents of knowledge integration is crucial for getting a competitive advantage position in today's business world. This study attempted to shed some light on SMEs in the Congo trying day by day to integrate new knowledge to boost the performance of their firms and subsequently the country's economic development and innovation. West et al. (2014) posit that innovation is a strength for economies. This study contributed to the literature on the role of SC patterns in OI and proposed network competence as a moderator. The proposed model offers the following theoretical and managerial implications.

5.1 Theoretical Implications

We postulated that OI practices impact SC and knowledge integration positively. The result supported this proposition. This finding can be explained by the fact that the concept of OI for firms can be seen as a means of acquiring useful information and integrating them into the innovation process (J. Chen, Chen, and Vanhaverbeke 2011; Fleming and Waguespack 2007). Besides, the work of (Laxamanan et al. 2018) shows that openness is a tool that promotes social interaction between the different external actors involved in the development of a firm's social capital. However, a purely technical interaction approach alone would probably not be sufficient. Besides, social capital, through a dynamic framework and supportive measures builds trust, exchange, and cooperation. Therefore, SC is developed through the interactions that occur in OI practices.

We further postulated that SC with its cognitive, relational, and structural dimensions plays a mediating role in the interaction between OI and knowledge integration. The results reveal that SC partially mediates the relationship between OI practices and knowledge integration. This finding is not surprising since OI practices develop social interactions and are worthy tools for external knowledge search. Other studies have looked at this issue, attempting to adopt either internal or external SC (Bai, Liu, and Zhou 2020; Skirnevskiy, Bendig, and Brettel 2017). No research has determined the exact nature of the SC that illustrate the total mediation role of social capital. We suggest further research on this issue. However, other research works with similar results to our findings are based on social network structures, such as (Hall, Waguespack, and Smith 2007) who explain the importance of strong ties in the network. Others like (Coleman 1988) argue about the importance of weak ties in the less dense network. For example, the research of (Burt 1992; Wang 2016) shows that weak ties impede knowledge, and strong ties are essential for knowledge sharing. In the same vein, (Ahuja 2000) shows that the direct and indirect linkage value depends on the network orientation and purpose. And, (Adler and Kwon 2002) shows that having a less dense network in homogeneous contexts is conducive to innovation, and in heterogeneous contexts, the network is even more appropriate. Further research by (Papa et al. 2018) shows that strong ties in a less dense network are conducive to knowledge creation. And the study of (Guan, Yan, and Zhang 2017) and (Aragón Amonarriz et al. 2019) shows that the structural hole plays the role of a bridge over which innovation or knowledge straddles the boundary of social groups, but however, they have no value without strong ties. Therefore, this study suggests that an overestimation of social relations exists in the literature on OI and indicates that future research should focus on the role of SC in OI.

We postulated that network competence moderates the OI effect on social capital. The results support the posited hypothesis, which extends previous research on entrepreneurial network competence (Z. Jian and Liu 2014). Previous studies have not been oriented in this direction. Still, we notice that studies like (Z. Jian and Wang 2013) show that network competence plays a crucial role in promoting social interactions without considering its effect on the OI aspect. Thus, this study extends the research on the impact of network competence in OI strategy. The literature review on

network competence characterizes network competence in four distinct dimensions; integration of the communication structure and openness of the firm's culture, access to resources, and the orientation of human resource management towards the network (Ridzwan et al. 2016). By definition, knowing how to choose the right partner in the production process is essential for knowledge integration (Chen, and Vanhaverbeke 2011). The result demonstrates that through network competence, a company can moderate its external relations and improve its social ties at the same time with external and internal actors. Therefore, Network competence improves not only the sources of knowledge but also social capital. Also, the role of network competence is to strengthen and mobilize the firm's growth (Ridzwan et al. 2016). The focus is on implementing relationships and social links to enhance members' trust (Ritter 1999). The result also emphasizes that network competence is essential for the successful flow of information and internal technological competence. This finding supports the study of (Ritter and Gemünden 2003) showing that network competence enhances knowledge transfer, innovation, trust, and support distribution channels to manage resources successfully.

5.2 Managerial Implications

The Congolese's High-Tech SMEs need to be aware of the additional benefits of OI related to knowledge integration and social capital. Hence, SMEs could use the SC resources accumulated through various external channels to effectively exploit the potential benefits of new information flows within the network and integrate this knowledge into the innovation process. In most developed countries, access to finance is evident. This is not the case in Africa, particularly in Congo, where, for most SMEs, access is very limited. Consequently, SMEs investment in R&D is also limited. Thus, SC management and network Competence can play an important role in integrating new relevant knowledge and facilitating innovation of SMEs in developing countries. Therefore, SMEs are invited to pay attention and consider the indirect effects described in our model regarding SC expansion. High-Tech SMEs need to recognize that social features are an essential element in OI instruments, to the extent that SC also includes collective actions and trust and the common objective (Leenders and Dolfsma 2016). Further, SMEs need to know how to improve these contacts/relations for getting the necessary resources within the whole partner network. Likewise, it is necessary to be aware of the peculiarities of network competence that are important for developing SC and thus improving OI. Besides, the study of (Ridzwan et al. 2016) demonstrated that network competence is integrated throughout the enterprise, as contributions come from various sources. Network competence is inseparable from the firm itself. Thus, network competence is a company-wide responsibility and is both limited and supported by the company's characteristics.

6. STUDY LIMITATIONS

We recognize some limitations to this research. Firstly, we could not collect a wide range of data to cover the entire population, given the ongoing global pandemic of Covid19. Furthermore, researchers could study the differences between industries since the proposed model may differ from one sector to another. While SC and network competence measurement have been taken as a block, more recent studies show that it is more interesting to study its components separately to know which of these components can be moderated by network competence. We suggest that the entire model needs to be validated by further empirical analysis. This validation could be a fruitful direction for future research. We believe that our conclusions do not apply to every country. Replication to other sectors and countries would allow us to contribute to the literature on OI and knowledge integration and identify distinctions due to diverse cultural or market environments.

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