

Alma Mater Studiorum Università di Bologna
Archivio istituzionale della ricerca

Investigating the link between intellectual capital and open innovation processes: a longitudinal case study

This is the final peer-reviewed author's accepted manuscript (postprint) of the following publication:

Published Version:

Matricano D., Candelo E., Sorrentino M., Cappiello G. (2022). Investigating the link between intellectual capital and open innovation processes: a longitudinal case study. JOURNAL OF INTELLECTUAL CAPITAL, 23(3), 538-557 [10.1108/JIC-02-2020-0020].

Availability:

This version is available at: <https://hdl.handle.net/11585/881656> since: 2022-04-10

Published:

DOI: <http://doi.org/10.1108/JIC-02-2020-0020>

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (<https://cris.unibo.it/>).
When citing, please refer to the published version.

(Article begins on next page)

This is the final peer-reviewed accepted manuscript of:

Matricano, D., Candelo, E., Sorrentino, M. and Cappiello, G. (2022), "Investigating the link between intellectual capital and open innovation processes: a longitudinal case study", *Journal of Intellectual Capital*, Vol. 23 No. 3, pp. 538-557.

The final published version is available online at:

<https://doi.org/10.1108/JIC-02-2020-0020>

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (<https://cris.unibo.it/>)

When citing, please refer to the published version.

Investigating the link between intellectual capital and open innovation processes: A longitudinal case study

Abstract

Purpose: This paper investigates the link between Intellectual Capital (IC) and Open Innovation (OI). Scholars worldwide consider the topics as standing alone and so they give scarce attention to the possible link between them. Managerial experiences (and few theoretical contributions), instead, hypothesize a significant role that IC can play over OI processes in order make them successful.

Design/methodology/approach: The methodology of a single case study is used to investigate the link between IC and OI. In particular, an OI process managed by a global company, LEGO, and named *Mindstorms* is rebuilt and analysed herein.

Findings: Intermediate results achieved by LEGO through its OI process were unsuccessful since the company had not developed its own IC (made up of relational, human and structural capital). The subsequent development of IC, instead, has driven to successful results. This suggests that if companies do not develop their IC before launching OI processes, then these processes might be not successful.

Research limitations/implications: One limitation is the use of a single case study. Despite this, the present article is a warning for all the companies: before launching OI processes they need to develop their IC.

Originality/value: To the best knowledge of the authors, this is one of the first works that deepens the investigation of the link between IC and OI. Very often, scholars investigating IC shyly refer to OI, without mentioning it, while the scholars investigating OI allude to IC, without citing it. In this study, IC and OI are investigated together.

Keywords: intellectual capital; open innovation; human capital; structural capital; relational capital; longitudinal case study.

Paper type: Case study.

1. Introduction

Management scholars consider Intellectual Capital (IC) and Open Innovation (OI) as two standing alone fields of research. Generally speaking, when management scholars refer to IC they consider all the intangible resources companies can leverage on in order to attain and sustain their competitive advantage in the market (Galbraith, 1969; Bontis, 1996, 1998; Sveiby, 1997; Carayannis et al., 2014). At the same time, when they refer to OI they pay attention on inbound and outbound knowledge flows that can support and foster companies' innovation processes (Chesbrough, 2003; Gassman et al., 2010).

Over the last decade, some scholars have shyly suspected and investigated the existence of a link between IC and OI (Henkel, 2006; Elmquist et al., 2009; Michelino et al., 2014; Užiene, 2015; Barrena-Martínez et al., 2019; Najar et al., 2020). In particular, Elmquist et al. (2009) recall and support Henkel's view (2006) by underlying the role that IC and OI play in the field of intellectual property. Michelino et al. (2014) leverage IC to test and measure OI. Užiene (2015) argues that IC and OI are related topics since OI processes – concerning inbound and outbound knowledge flows – affect all the resources hold by a company, including the intangible ones, i.e. IC. Barrena-Martínez et al. (2019) propose integrating IC and OI while Najar et al. (2020) investigate the impact of IC on OI. However, despite the above studies, the link between IC and OI still results unrevealed. Undoubtedly it results that management scholars have not fully investigated the link between IC and OI and the implications that this link can have on firms' performance.

In order to fill in this gap, the paper is structured as follows. In section two, there is an extensive review of management literature focused on IC and on OI separately. After that, the research hypotheses rooted in dedicated literature are presented. In section three, the research method is defined. The decision to use a single case study methodology is due to the fact that LEGO Group is a global well-known company producing the so-famous bricks. In particular, LEGO case study is divided into two phases: the first when Lego launches the project named *Mindstorms*, and the second when LEGO launches the “right to hack” to *Mindstorms* license. In section four, some reflections about LEGO case study are presented and discussed. In the last section, after underlining the main limitations of the study, some implications for companies are discussed and some implications for management researchers are suggested in order to address the proceeding of future research.

2. Literature review

2.1 Intellectual Capital

IC stands for a set of intangible resources that companies can leverage on in order to attain and sustain their competitive advantage in the market (Galbraith, 1969). Over the years, the concept has been enlarged or enriched, modified or compressed in order to make it as fitting as possible with cognitive aims pursued – at each time – by academics, top managers, consultants and practitioners.

Brooking (1996), for example, maintains that IC is made up of four components. They are market, human, intellectual and infrastructural capitals. Market capital refers to brand, positioning, and distribution and it stands for the power that companies exert in the marketplace. Human capital is related to problem solving capacity, leadership and creativity that employees hold. Intellectual capital (i.e. patents, copyright and trademarks) stands for the intangible resources that companies can protect through legal mechanisms. Eventually, infrastructural capital represents the management philosophy and culture shared inside the company.

Some scholars (Sveiby, 1997; Roos et al., 1997; Stewart, 1997; Bontis et al., 2000) compress the concept of IC by assuming that it is made up of customer capital, structural and human capital while McElroy (2002) enriches the concept by replacing customer capital with social capital. The OECD (1999) proposes an even more compressed classification of IC by assuming that it is made up of structural and human capital. By the former, the OECD refers to software systems

and to networks consequently developed that companies can leverage on in order to compete in the market. By the latter, the OECD refers to all the resources available for ventures. These resources can be both internal and external. Recently, some scholars (Khalique *et al.*, 2011, 2015) have enlarged again the concept by considering six kinds of intellectual capital: human, customer, structural, social, technological and spiritual capital. Even if the debate on the components of IC is still ongoing, most management scholars (Sullivan, 1999; Brennan and Connell, 2000; Petty and Guthrie, 2000; Sanchez *et al.*, 2000; Roos *et al.*, 2001; Peña, 2002; Kaufmann and Schneider, 2004; Boedker *et al.*, 2005; Hormiga *et al.*, 2011; Musteen and Ahsan, 2013; Dhar, 2019) share the idea that IC is made up of three components: human, relational and structural capital. This view is the one embraced in this paper and thus the three components are briefly analyzed in the following lines.

Human capital refers to competences, attitudes and intellectual profile of the employees working in companies. In particular, by competences there is a clear reference to knowledge and capabilities, by attitudes there is a strong allusion to motivation and leadership and, eventually, by intellectual profile there is a reference to intellectual agility, originality or flexibility. Because of the relevance of employees for companies, it is easy to understand the importance that management scholars attribute to human capital (Bontis, 1998; Bontis *et al.*, 1999, 2000; Khalique *et al.*, 2015; Subramaniam and Youndt, 2005; Montequin *et al.*, 2006; Tovstiga and Tulugurova, 2007; Wu *et al.*, 2008; Hsu and Fang, 2009; Pedro *et al.*, 2018; Dhar, 2019).

Since the contribution proposed by Granovetter (1985), it is largely accepted the idea that companies need to be in contact and cooperate with other companies. Being in contact and cooperating with other companies is a way for getting tangible and intangible resources that companies are missing, and that they need in order to attain and sustain their competitive advantage (Powell, 1990; Burt, 1992; Uzzi, 1997). In reference to IC theory, relational capital concerns relationships established with stakeholders and the value discerning from them (Bontis, 2001; Montequin *et al.*, 2006; Cabrita and Bontis, 2008; Wu *et al.*, 2008; Hsu and Fang, 2009; Pedro *et al.*, 2018; Dhar, 2019).

Structural capital can be seen as the formalization of human and relation capitals developed by companies. It comes to existence when companies convert human and relational capital into something new (like organizational culture and procedures, or even patents) that does not depend anymore on employees or stakeholders but belongs to the company itself (Sveiby, 1997; Bontis *et al.*, 2000; Subramaniam and Youndt, 2005; Cabrita and Bontis, 2008; Wu *et al.*, 2008; Hsu and Fang, 2009; Hormiga *et al.*, 2011; Pedro *et al.*, 2018; Dhar, 2019).

By embracing the idea that IC plays a relevant role in management studies, several scholars have investigated its role in reference to several topics such as business performance (Ahmed *et al.*, 2019), to companies' reputation (Ulubeyli and Yorulmaz, 2019), to business incubators (Calza *et al.*, 2014), to higher education (Kashyap and Agrawal, 2019) and to entrepreneurship (Peña, 2002; Hayton, 2005; Hormiga *et al.*, 2011; Link and Ruhm, 2011; Musteen and Ahsan, 2013) and achieved results always confirm the relevance of IC in management studies.

2.2 Open Innovation

Since Chesbrough's seminal work (2003) about OI, management scholars have largely investigated this topic of research. Some scholars have paid attention on the genesis (Enkel *et al.*, 2009; Loren, 2011) and the diffusion (Chesbrough and Crowther, 2006) of OI processes. Other scholars, instead, have addressed their research efforts toward the impact that OI can have on companies' strategies (Chesbrough and Appleyard, 2007; Kelley, 2011) or business models (Frankenberger *et al.*, 2014). Most scholars have paid attention on the implementation of OI processes (Chesbrough, 2004).

In reference to the implementation of OI processes, attention has been addressed toward leadership (Heim, 2011) and soft skills (Martino and Bartolone, 2011), crowd selection (Hopkins, 2011; Phillips, 2011) and motivations (Carpenter, 2011), absorption of in-bound knowledge

(Scuotto et al., 2019; Matricano et al., 2019) and web applications that can support OI (Rayna and Striukova, 2015). Eventually attention has also been addressed toward the most common mistakes that should be avoided (Gaule, 2011). Still other scholars have tried to foresee the possible developments of OI (Gassman et al., 2010; Shapiro, 2011; Chesbrough, 2012).

In line with most management scholars, attention is paid on the aspects linked to the implementation of IO processes (Chesbrough, 2004) **in the following lines**. As underlined by Heim (2011), top managers are compelled to foresee customers' needs and desires in advance. In this vein, according to the scholar, top managers are expected to manage them in the best way possible. They need to find the right people who (both inside and outside the company) are expected to join the OI process; to define the processes to be carried out; to shape the organization (make little but required changes, if necessary) and – strictly connected to the previous point – they need to define the tools, instruments and actions able to support the above-cited processes.

In particular, attention needs to be paid over soft skills (Martino and Bartolone, 2011) held by human resources. By soft skills, the scholars refer to ability of making the process appealing both for insiders and outsiders the company, communicating, building and maintaining good relationships, tolerating uncertainty and being optimists. These soft skills are the necessary premise to develop three categories of dynamic capabilities (Teece et al., 1997; Teece, 2007) inside the company: **1) sensing and shaping opportunities and threats; 2) seizing opportunities; 3) and reconfiguring assets and organizational structure.**

Selection (Hopkins, 2011; Phillips, 2011) and motivation (Carpenter, 2011) of the right crowd are two more critical challenges in OI processes. As for selection, in order to make the OI process as successful as possible, it would be great to involve who has “*high domain knowledge*” (Hopkins, 2011, p. 19) and who has not it but – on the contrary – has “*high creative skills*” (*ibidem*). Of course, it is not always possible to know in advance if one has domain knowledge or creativity. Thus, it can be difficult to select the right crowd. In this vein, it could be useful to offer some incentives, which can be financial or less tangible (Hopkins, 2011), in order to stimulate the crowd. Of course, to determine the right incentive in order to attract the right crowd is difficult as well.

Another critical aspect concerning the implementation of OI processes deals with web applications (Rayna and Striukova, 2015). Their relevance is constantly growing for at least two reasons. The first, from the company perspective, is that web applications can minimize costs and maximize knowledge flows (Whelan et al., 2010). In other words, they require minimum investments and they can yield maximum benefits. The second, from the crowd perspective, is that web applications facilitate interaction and communication with the company.

According to the above, it is clear that implementing and managing OI processes is risky (Gaule, 2011) and that top managers need to pay attention on all the firms-related intangible aspects since they can determine successful or unsuccessful OI processes (Kratzer et al., 2017; Candelo et al., 2018; Gruenhagen and Parker, 2020).

2.3 OI e IC: the missing link

The above literature reviews (respectively about IC and OI) suggest the idea that IC and OI are two different, standing alone fields of research. It is largely shared the idea that scholars investigating IC (Petty and Guthrie, 2000; Sanchez et al., 2000; Roos et al., 2001; Peña, 2002; Kaufmann and Schneider, 2004; Boedker et al., 2005; Hormiga et al., 2011; Musteen and Ahsan, 2013; Dhar, 2019) underline the relevance of intangible resources (human, relational and structural capital) that companies can leverage on in order to attain and sustain their competitive advantage. At the same time, it is confirmed that scholars investigating OI (Enkel et al., 2009; Loren, 2011; Chesbrough and Crowther, 2006; Chesbrough and Appleyard, 2007; Kelley, 2011; Kratzer et al., 2017; Candelo et al., 2018; Gruenhagen and Parker, 2020) highlight how inbound and outbound knowledge flows

can support and foster companies' innovation processes. In sum, management studies, respectively focused on IC and OI, seem to proceed along quite distinct trajectories.

At this stage, some reflections are needed. Scholars focusing on IC consider human, relational and structural capital as variables able to affect business performance (Ahmed et al., 2019), companies' reputation (Ulubeyli and Yorulmaz, 2019), and entrepreneurship (Peña, 2002; Hayton, 2005; Hormiga et al., 2011; Link and Ruhm, 2011; Musteen and Ahsan, 2013; Matricano, 2016). Scholars focusing on OI (Kratzer et al., 2017; Candelo et al., 2018; Gruenhagen and Parker, 2020) pay attention on the inbound and outbound knowledge flows that can support and foster companies' innovation processes, without clarifying the variables playing a certain role over these processes. At this stage one question spontaneously arises: is it possible to hypothesize a link between IC and OI? Put simply, if human, relational, and structural capitals are resources that play a relevant role in management studies (by affecting business performance, companies' reputation, and entrepreneurship), is it possible to assume that they can affect OI processes as well? Can OI processes be used as framework including the main components of IC (human, relational, and structural capital)?

As a matter of fact, from an extensive literature review it results that some scholars have already investigated IC and OI together (Henkel, 2006; Elmquist et al., 2009; Michelino et al., 2014; Užiene, 2015; Agostini and Nosella, 2017; Hussinki et al., 2017; Barrena-Martínez et al., 2019; Najar et al., 2020) and that they have already hypothesized a possible link between IC and OI. These contributions explicitly argue that is worth investigating IC and OI together since some connections between IC and OI are expected to exist. In particular, Barrena-Martínez et al. (2019) invite scholars to consider them as two join forces in management field.

Among the above-cited contributions, Najar et al. (2020) propose a theoretical framework rooted in the Resource Based View (RBV) – originally proposed by Penrose (1959) and then developed by other leading scholars (Barney 1991; Teece et al. 1997). According to this framework, certain resources affect the competitive advantage of the firms and so their performance. Najar et al. (2020) assume that IC main components can be considered as idiosyncratic resources affecting OI processes. In their view, only if firms hold and manage these components of IC in a proper way, then these firms can improve the results of OI processes. Specifically, IC components – and, in particular, the way they are managed, combined and exploited – are expected to have a significant role in OI processes. In line with the above contributions, it is undeniable that some steps have been taken in order to investigate and disclose the link between IC and OI. In this vein, the research questions at the basis of this paper are:

RQ1: Does IC play any role over OI processes?

RQ2: Can IC be an idiosyncratic resource determining the success of OI processes?

In line with the research questions presented above, the present paper aims to investigate a supposed link between IC and OI. The idea at the basis of the current research is that studies about IC consider its main components (human, relational, and structural capital) as resources, factors that can affect innovation processes launched and managed by firms while studies about OI describe the framework in which the above factors might play a role. In line with the contribution authored by Barrena-Martínez et al. (2019), it is conjectured that the main components of IC can have an impact on OI processes. Put simply, it is assumed that the main components of IC can foster and support, delay or impede OI processes.

3. Research methodology and design

3.1 Research methodology and design

For the present paper, the methodology of single case study is adopted. The origins of this methodology can be dated back at the end of 1980s when Eisenhardt (1989) proposed to build theories from case study research. Over time, several scholars have then confirmed the relevance assumed by this methodology (Dyer and Wilkins, 1991; Yin, 1994; Flyvbjerg, 2006; Eisenhardt and Graebner, 2007; Lee *et al.*, 2007; Baxter and Jack, 2008). Two main conditions lie at the base of the appropriateness of the choice of single case study as research method. First, a single case study is appropriate when there are no copious theoretical and/or empirical investigations that can be used as references (Glaser and Strauss, 1967). Second, the selected case needs to embody some characteristics that make it critical (Yin, 1994). In this research, both these conditions are met. In reference to the first condition, the above literature review has shown that the link between IC and OI is still an embryonic field of research – previous contributions that investigated this issue are few. In reference to the second, in this paper the attention is going to be paid over LEGO *Mindstorms*, one of many innovation projects launched by Lego (such as Lego Architecture, Lego Ideas, Lego Games, Life of George, Cuusoo and Fusion over the last years). At least three characteristics of this project allow considering it as a critical case. The first is the high level of innovativeness and of interest that this project embodies. LEGO *Mindstorms*, in fact, has also been investigated in reference to other fields of research: Klassner (2002) evaluated its suitability for artificial intelligence and robotics courses; Nguyen (2013) investigated its programming language usability and Chao (2012) studied its influence on students creativity. This discloses that the case, because of its implementation and of its impact, can be used to investigate several managerial aspects. The second characteristic is related to the involvement of the company as a whole. As it will be shown in the next pages, in fact, in the LEGO *Mindstorms* case external sources are combined with internal ones, internal processes are modified, and top managers are involved. This means that many units of the company have been affected by this project and so links and cause-effect relationship can be fruitfully investigated. The third characteristic deals with the dynamics of the project. The fact that the process did not proceed as established (it was not successful in the beginning, but it was in the end) means that important changes have been introduced and this makes it a perfect a case for a single case study. Thus, given the uniqueness and the relevance of LEGO *Mindstorms* project, we feel confident that we selected a critical case.

Overall, the high level of innovativeness of the project together with the involvement of the company as a whole (in terms of external sources, internal processes and top managers) makes LEGO *Mindstorms* an interesting case also regarding the link between OI and IC. In fact, the aim of generating and adopting innovative ideas leveraging external sources directly recalls OI processes while the involvement of various intangible resources of the company in the management and implementation of the project refers to the IC components. Thus, focusing on LEGO project provides an opportunity to study the links between OI and IC.

Obviously, some methodological issues might deal with the choice to leverage on single case studies. Baxter and Jack (2008), who recall the seminal work published by Yin (2003), invite to question about caution required when conducting a single case study and about difficulties that can emerge when reporting it. Management scholars underline the difficulties in generalizing achieved results and in proposing theories or models leveraging a single case study (Dyer and Wilkins, 1991; Eisenhardt and Graebner, 2007).

At this stage, before focusing on LEGO *Mindstorms*, however, it is appropriate to specify the origin of collected data and to investigate the story of LEGO in order to understand the company's relationships and linkages with innovation.

Data and information on LEGO *Mindstorms* have been collected in a retrospective way starting from the inception of the project (1998). Collected data come from several sources. Some of them derive from chats and forums with key speakers belonging to the community of Adult Fans Of LEGO (AFOLs). These data give major insights about the case of LEGO. Others derive from websites (Davis, 2013), books (Robertson and Breen, 2013) and papers (Klassner, 2002; Antorini et

al., 2012; Chao, 2012; Jennings, 2019) concerning LEGO. They all are secondary data that enrich, complete and clarify the analysis. Because of used sources, noticeable interest has been paid to ethnography (Dilger et al., 2019; vom Lehn, 2019) and – above all – to chat-room or web-based ethnography (Shoham, 2004; Garcia et al., 2009; Hoffman and Novak, 2009). In particular, the focus of attention is addressed towards the scientific description of individuals and their cultures. Accordingly, in-depth content analyses (Neuendorf, 2016; Gaur and Kumar, 2018) have been carried out in reference to texts, chat-rooms and forums (Thelwall et al., 2010; Pollach, 2012). This allows identifying and highlighting specific written parts (i.e., statements, pronouncements, claims) that disclose the factual approach to the observed phenomenon. In line with Rowlinson et al. (2014), these written parts have been analysed as a means of interpreting the wider culture, trying to understand the historical actors under investigation on their own terms.

The description of the origin and the nature of collected data allows to better specifying the method adopted in this work. Since the LEGO *Mindstorms* case study is concerned with lived experiences and focuses on contextual distinctiveness of the research context (the individual case studied), it can be considered a “micro-history” (Miskell, 2018). The value of these studies “lies in the peculiarities and complexities of the individual cases studied, which allow for valuable insights to be generated into individual (and organizational) behaviours” (*ibidem*, 217). The generation of these insights is consistent with the widespread idea that a single case study can be used to build and/or corroborate theoretical developments (Eisenhardt, 1989; Dyer and Wilkins, 1991; Yin, 1994).

Eventually, it has been underlined that the investigation of the link existing between IC and OI is at the preliminary stage. Since exploratory research takes place when problems and issues under investigation are in a preliminary stage, our study can be considered as explorative (Babbie, 2007).

3.2 The story of Lego

As for the story of the company, the origins of Lego can be dated back in 1934, when Ole Kirk Christiansen, a carpenter based in Billund (Denmark), launched his company. By mixing two Danish words “*leg*” and “*godt*” (literally meaning “play” and “well”), it derived the name of the company. Ole Kirk Christiansen had already a woodworking business, started in 1916. In 1930, he decided to focus on the production of children’s toys.

Over the 1940s, LEGO underwent a very deep change by replacing the wood made toys with plastic toys. For the first time, children could assemble, disassemble, re-assemble and so on their plastic trucks. Later on, in 1949, after buying the patent from an English company named Kiddicraft, LEGO started working on interlocking bricks that were sold on the market only in 1953.

At the beginning, interlocking bricks were not fully accepted by customers. The main reason was that parents wanted their children to play with safe toys (made up of healthy materials, like wood, and not of plastic) and so the shift was not so fast. Ole Kirk Christiansen, however, decided to go on with interlocking bricks. In this vein, after patenting the basic brick (in 1958) that could be assembled, disassembled and re-assembled even more easily, LEGO decided to stop the production of wood made toys and to focus only on plastic interlocking bricks. Since then, the best cycle of LEGO story started and it lasted for a very long time.

By the end of 1990s, instead, it begun the worst cycle of Lego story since competitive dynamics in the toys market totally changed because of three main aspects. First, new competitors entered the market offering similar products at a lower price. As a consequence, LEGO started losing its primary position in the market. Second, LEGO realized that its supply chain was too expensive. Based on a strategy of differentiation, in fact, too many items were offered and, of course, to produce all of them caused diseconomies of scale (Andersen and Gadde, 2019). Third, children worldwide were asking for more technological plays (like videogames). Interlocking bricks did not look appealing any more. Based on these premises, in 2003, LEGO reported a loss of 240

millions US dollars. Analysts were sure that LEGO was destined to fail, but family management was not. For this reason, LEGO realized a huge investment of more than 170 million US dollars. Contemporarily, a radical change in the leadership was promoted: instead of another family member, an external CEO (Jørgen Vig Knudstorp) was assumed. In this new course, LEGO focused on cost reduction and on a new product development strategy (involving users as designers) in order to face an always-increasing competition. This new course was – and actually it is still being – successful. In fact LEGO reached again a positive financial performance in 2007 and financial results are more than satisfying nowadays.

3.3 Phase 1: Lego launches Mindstorms RIS

One of the choices that allowed LEGO to be successful again was its new product development strategy involving users as designers.

The origins of this new approach can be dated back in 1998 when the projects entitled *Mindstorms Robotic Invention System (Mindstorms RIS)* was launched. In order to involve users as designers, a computer scientist from MIT, Seymour Papert, and some of his graduated students were asked to design a programmable robot. The robot designed by the graduate students (they are outsiders of the company, but they are potential customers for Lego) was commercialized. However, LEGO top managers realized that other potential customers might not have been able to use the programming language adopted by MIT professors and students because of its complexity. For this reason, LEGO top managers commissioned another software, more simple than the previous one, to National Instruments, in order to involve as many customers as possible.

LEGO *Mindstorms* was a new set of LEGO robots centred on a programmable microchip that allowed a long range of movements and behaviours. The product became an instant hit and 80,000 sets were sold in the first three weeks so that the New York Times defined it as a “new revolution” for LEGO (Mindell et al., 2000, pg. 3).

Despite the positive premises, something was going wrong on the market. Within two/three weeks after the launch of LEGO *Mindstorms*, adult hackers started reverse engineering the firmware and started developing another software that could be used to program these robots. Suddenly LEGO top managers realized that a growing number of users were “hacking” the software and developing application and extensions to the original code.

From LEGO top managers’ perspective, the news was unexpected for two main reasons. The first reason was that more than 1,000 users were hacking the original software launched by LEGO. Despite the legal aspects (on which attention is going to be paid in the next lines), LEGO top managers thus realized that a big community of users had an unexpected need to satisfy. They were so interested in LEGO products to the extent that they were hacking the original software. This also meant that more projects than expected were going to be proposed about LEGO products. Surely, this was unexpected but positive news. The second and negative reason, instead, was that LEGO top managers had selected the wrong target when launching LEGO *Mindstorms*. In fact, users cracking the code and making their own toys and applications were not children, but adults. They were aged over 18 years old, they knew how to crack a code and to hacker a software. This meant that the main target identified by LEGO top management was not appropriate.

Immediately, LEGO top managers reacted in a defensive way by arguing that users were expected only to consume, not to develop, LEGO products. In-house product developers were expected to do this. As rebuilt by Robertson and Breen (2013, pg. 182): “Not surprisingly, some LEGO managers fretted that the hacking breakout, which spread across the Internet in a matter of weeks, would lead to people pirating the code and creating robotics kits that would bit into the *Mindstorms* market, which was still in its infancy. The company’s lawyers were even more alarmed. They pushed to hit the hackers with cease-and-desist letters ordering them to stop mucking with the company’s intellectual property”. Later on, the same LEGO top managers were not sure about what

they had to do in reference to LEGO *Mindstorms* since there were too many discrepancies between defined and implemented aspects of phase 1 of *Mindstorm* project (see Table 1).

Table 1. Discrepancies between defined and implemented aspects of phase 1 of *Mindstorm* project.

Topics...	...defined (before starting the project)	... and implemented (after starting the project)
Software	A simple software was thought to let customers design their robots	Customers hacked the simple software and started designing complex/unexpected robots
People involved	Several customers paid for the original software	Several customers downloaded the hacked software
Outcomes	Proposals of new robots by a selected target	Proposals of new robots by a not selected target, with several and different ideas

Source: authors' elaboration.

3.4 Phase 2: LEGO launches a “right to hack” to *Mindstorms* license

After carrying out proper evaluations, LEGO top managers had two main alternatives about the proceeding of the project *Mindstorms*. On the one hand, supported by the company's lawyers, LEGO top managers were inclined to stop hackers and protect the original code and software launched by LEGO's in-house product developers. On the other hand, supported by the members of *Mindstorms* development team, LEGO top managers tried to read and interpret what was happening from a market perspective.

From the development team perspective, LEGO top managers could learn three main lessons. First, as highlighted, LEGO top managers had selected the wrong target. The project was thought and implemented in reference to children (aged between seven and ten years old) but – instead – the users were adults (aged over eighteen) who could crack a code and hacker the software and, above all, who were already fans of LEGO. Second, top managers had to admit that original and creative ideas were coming from users (outside the company) and not from in-house product developers. The former were improving what the latter had done before in order to make LEGO products more fitting with their desires and expectations. The third, and maybe the most important one, was that LEGO realized that a community of adult users (aged over eighteen) were really interested in improving LEGO products. As noticed by Robertson and Breen (2013, pp. 182-183), in fact, “*unlike the LEGO Group's lawyers, the Mindstorms development team believed that the hacking signalled that they had come up with a winner. Adult hobbyists wouldn't take the trouble to dig into the brick and write alternative code if they didn't think the Mindstorms platform was worth developing*”.

By comparing the approaches shown by lawyers and by members of development team, LEGO top managers made up their mind. Unexpectedly, they decided to bit on what was happening and to radically change their strategy. They decided to make available source code, run competitions and – above all – they put a “right to hack” to the *Mindstorms* software license. The view sponsored by members of development team prevailed over the one promoted by lawyers. The reason why this happened has never been communicated officially. According to analysts and consultants, LEGO top managers realized that “*a sizeable number of adults (mostly men) were once again beckoned by the brick*” (Robertson and Breen, 2013, p. 130). Over the decades, in fact, many kids outgrown with LEGO were still interested in LEGO bricks. The creation of some dedicated websites (brickshelf.com and bricklink.com) favoured the exchanges of insights, ideas and projects among Adult Fans Of LEGO (AFOLs) that, as a matter of fact, are the “*hard-core LEGO*”

customers” (*ibidem*, p. 131). LEGO top managers realized that there was a community of adult users that had developed around LEGO *Mindstorms*.

The act of hacking *Mindstorms* software was a clear warning for LEGO top managers. Adult users had needs and desires that were totally different from children. They were asking for new products able to satisfy their more sophisticated expectations but LEGO was ignoring them because they were not part of its main target. The launch of the “*right to hack*” was a clear signal of the new approach toward adults.

According to the ongoing of *Mindstorms* project, the new approach that LEGO has adopted towards AFOLs has proven to be successful. As a consequence, in fact, in 2006 a new project named *Mindstorms NXT* was launched among the AFOLs. In reference to *Mindstorms NXT*, LEGO decided to establish a *Mindstorms* User Panel (MUP). Only key developers - in particular, users and designers - could work on new LEGO projects since the beginning. Of course, they were required to abide by a non-disclosure agreement. As for the incentives, the selected key developers could receive some LEGO products and *Mindstorms NXT* prototypes for free.

4. Discussion

LEGO *Mindstorms* project is a very interesting case in management studies, and particularly in the field of OI. The way LEGO launched the project, the risk of failure because of users hacking the software, the solution sponsored by members of development team and shared by LEGO top managers and the further ongoing of the project allow speculating on the link that can exist between IC and OI. In this vein, the following subsections (in particular 4.3) are useful to bring the concepts of IC and OI together.

4.1 Analysis of Phase 1

In 1998, when the project *Mindstorms* was launched, LEGO top managers did not seem so aware of what they were going to do. As noticed by Robertson and Breen (2013, p. 213), before the project – and actually even when the project was implemented – LEGO top managers were confident of the company’s traditional vision according to which “*unsolicited ideas*” were not accepted. In other words, new ideas about new products had to be thought and developed in-house. Only the development team was involved in these activities. For this reasons, when the project *Mindstorms* was launched, LEGO top managers were not interested in selecting a crowd to involve (as usual, the project was addressed towards children aged between seven and ten) and in developing the appropriate base of skills and capabilities able to decode outside in flows of knowledge.

By reading the above lines in the light of IC, then, it is clear that LEGO top managers did not seek for external opportunities since there was an internal team dedicated to this. For this reason, LEGO did not spend so much time in developing their relational capital. The usual target was expected to buy the license and play with it. No further implications were related to the launch of *Mindstorms* (again, the product became an instant hit and that was what LEGO top managers wanted). Eventually, LEGO top managers did not expect any ideas or insights coming back from crowd. For this reason, LEGO top managers did not spend so much time in developing their relational capital. On a dedicated forum, an AFOL argues: “*The usual target was expected to buy the license and play with it. No further implications were related to the launch of Mindstorms*”.

LEGO top managers did not expect any ideas or insights coming back from crowd. For this reason, members of development team were not expected to be ready to decode what the crowd wanted by LEGO.

Over phase 1, LEGO top managers totally ignored that new opportunities could come from the outside (structural capital), that other targets could be involved in the innovation process (relational capital) and that members of development team had to be ready to interact with external promoters of new ideas (human capital), see Table 2. As argued by Davis (2013), “*LEGO actually provides one of the great examples on how not to innovate*” during phase 1 of *Mindstorms* project.

Table 2. Results emerging from the analysis of Phase 1.

Over Phase 1, LEGO top managers totally ignored that...
new opportunities could come from the outside (structural capital)
other targets could be involved in the innovation process (relational capital)
members of development team had to be ready to interact with external promoters of new ideas (human capital)

Source: authors' elaboration.

4.2 Analysis of Phase 2

The act of hacking *Mindstorms* software has caused an impressive change in LEGO's approach to innovation. In rebuilding and analyzing *Mindstorms* project, Robertson and Breen (2013, pg. 183) underline that "*LEGO switched from contemplating lawsuits against hackers to actively encouraging them to reinvent Mindstorms in ways that LEGO itself had never imagined*". The merits of this can be attributed to the members of development team that (against the view supported by the company's lawyers) sponsored the openness of LEGO innovation process and to LEGO top managers who decided to share their vision. According to this, LEGO top managers decided to encourage the proposal of new products (even if due to the hacking of the original software) instead of trying to control or restrict them. New unsolicited ideas were welcome and, actually, were even stimulated by the company itself. In order to foster this process, LEGO top managers decided to refer to several targets. On a dedicated website, An AFOL declares: "*Even if Mindstorms was born in reference to children, we (adults) could join it as well*".

Adults, rather than children, had proven to be more inclined to design and co-create new products since they are "*hard-core LEGO customers*" (Robertson and Breen, 2013, pg. 130). In this vein, LEGO started exploring a broader range of innovation sources. Eventually, in order to bring users' external ideas into the company, members of development team involved users themselves in annual conferences and meetings in order to interact with them and made AFOLs part of LEGO innovation process. Nowadays there are more than 20 million AFOLs in the world who are very close to the company and it seems possible to maintain that they are the primary source of innovations. As expressed by an AFOL on a platform: "*It is easy to understand that the new approach adopted by LEGO after launching the right to hack to Mindstorms license is totally different now*".

The new approach adopted by LEGO after launching the "*right to hack*" to *Mindstorms* license is totally different from the previous one (see Fig. 1). As underlined by Lindegaard (2013), in fact, LEGO has undergone very deep changes. In reference to its structural capital, LEGO has gone from "select strengths put to play" to "full potential realized strengths". In reference to its relational capital LEGO has moved from "creativity from the few" toward "systematic creativity from the many" and from "succeeding together" toward "succeeding more together with more people". This is also underlined by Antorini et al. (2012). Eventually, in reference to its human capital, LEGO has gone from "a relatively closed culture" toward "a culture of openness". Involvement of customers was a preeminent task to achieve (Andersen and Gadde, 2019).

The ones above are radical changes that cannot be ignored since they mainly deal with organizational culture (Zwick et al., 2008; Hatch and Schultz, 2010). According to a previous study (Di Minin et al., 2016, p. 44), one of the main risks emerging in most of industries is that "*shared cultures are extremely difficult to achieve and preserve*". LEGO has really faced this risk. When *Mindstorms* project was launched, in fact, organizational culture was still the one adopted when the company was launched (more that seventy years before). Another AFOL, in a chat-room, argues:

“Our act of hacking the license and the software has compelled LEGO to upgrade and modify their innovation culture in a fast and radical way”.

- INSERT FIGURE 1 ABOUT HERE -

4.3 Revealing the link between intellectual capital and open innovation processes

At this stage, it is possible to respond to the two research questions posed at the beginning of the paper. LEGO *Mindstorms* project – and in particular the passage from phase 1 to 2 – shows that human, relational and structural capitals play a significant role over OI processes and so a link between IC and OI does exist. Management scholars investigating OI processes cannot ignore IC and *vice versa*. Even if the terminology used really differs (see Table 3), concepts at the bases of IC and OI are linked. Structural capital, cited in reference to IC literature, stands for new opportunities that companies aspire to get to from the crowd; relational capital, the second component of IC, clearly refers to the crowd involved in OI processes; eventually, the third component of IC, i.e. human capital, represents competences, knowledge and skills that companies need to develop in order to internalize ideas coming from the outside. So, according to the above, IC does play a role over OI processes (the first research question).

Table 3. Similarities and differences between IC and OI studies.

Topics	Labels/definitions assigned to topics in reference to IC literature	Labels/definitions assigned to topics in reference to OI literature
New opportunities	Structural capital	New ideas coming from the crowd
People involved	Relational capital	The whole crowd or specific targets involved
Internal knowledge	Human capital	Tools useful to decode ideas coming from the outside

Source: authors' elaboration.

After matching the components of IC with the main concepts of OI, it is possible to investigate the role that IC plays over OI processes. As emerged by LEGO case study, companies need to define their structural, relational and intellectual capitals in a proper way in order to increase the chance of success of their OI processes (as it was for LEGO during phase 2). This seems to suggest that IC plays a priority role over OI processes. In other words, if companies do not develop their IC before OI processes are launched, then these processes might not be successful. This result is in line with framework of RBV (Penrose, 1959) and so it seems reasonable to argue that IC can be an idiosyncratic resource affecting the success of OI processes (the second research question).

5. Limitations of the study, managerial implications, and future research

This paper falls in the list of contributions aiming to investigate the link existing between IC and OI (Henkel, 2006; Elmquist et al., 2009; Užiene, 2015; Agostini and Nosella, 2017; Hussinki et al., 2017; Barrena-Martínez et al., 2019). Results achieved through the above contributions – related to manufacturing Spanish firms (Barrena-Martínez et al., 2019) or to micro firms and SMEs involved in the production of machinery or instruments and located in Italy (Agostini and Nosella, 2017) – confirm that connections between IC and OI exist and, in particular, it seems that OI has its

foundations in the IC theory. IC, in fact, is expected to have an impact on OI processes. Thus, they do support the idea that is worth investigating IC and OI together.

LEGO case study – in line with the above-cited studies – confirms that IC and OI concepts are closer than expected and that IC plays a key role over OI processes. Accordingly, it is reasonable to argue that even more cases about companies implementing OI processes are needed to prove or deny our findings.

In this vein, after highlighting the main limitations of this study, some implications for companies and management researchers are presented in the following lines.

Limitations

The main limitations of the present study are intrinsic with the methodology of case studies (Eisenhardt, 1989; Yin, 1994). Some misunderstandings (Flyvbjerg, 2006) and questions (Baxter and Jack, 2008) are generally referred to it. These misunderstandings and questions cannot be managed, reduced or even eliminated in the short run. For this reason, readers need to be conscious of the above limitations even if they also need to be aware that single case study methodology is the best one that can be used to investigate a complex and unique phenomenon that is not going to take place again according to a comprehensible format.

Implications for managers and scholars and conclusions

LEGO case study has major implications in terms of suggestions for companies aiming to implement OI processes. By reading and analyzing the case study with a critical approach, in fact, it seems that a link between IC and OI exists. Particularly, as emerged by LEGO case study, IC is prerequisite to implement successful OI processes. Companies should realize that IC is at the basis of OI.

The final aim of OI processes is to support and foster companies' innovation processes (Chesbrough, 2003; Gassman et al., 2010) that – in the long run – are going to be embodied by companies in the form of organizational culture and procedures. Simply put, the final aim of OI processes seems to be the development of structural capital (i.e. new ideas coming from the crowd). Of course, companies that are more able to drag external knowledge and that understand earlier the market needs will be able to offer a superior customer value but a managerial effort is required to sustain the process (Badir et al., 2019).

In order to develop their structural capital, companies implementing OI need to manage the whole process in the most effective way. Top managers need to be aware that inbound and outbound knowledge flows can be more or less than expected (in terms of quantity), specialist or unfocused (in terms of quality), difficult to decode or – on the contrary – they can be easily accessible and fruitful. The fact that inbound and outbound knowledge flows can be more or less than expected, specialist or unfocused, depends on the selection of the crowd for the OI process. A targeted or non-targeted crowd can positively or negatively affect the results of OI processes. In other words, a prerequisite to the launch of OI process seems to be the selection of relational capital. At the same time, the fact that inbound and outbound knowledge flows can be difficult to decode or easily accessible and fruitful seems to depend on the soft skills that employees working in the companies hold. These soft skills seem to recall competences, attitudes, and intellectual profile that employees are expected to have. This suggests that a prerequisite to the launch of OI process seems to be the availability of human capital.

From the above, it is clear that companies should apprehend a twofold lesson. First, they cannot underestimate the relevance of their IC (just like LEGO did during phase 1 of *Mindstorms project*) if they aim to implement successful OI processes. Second, IC needs to be developed according to an established order. For a start, companies need to clarify that they are trying to develop their structural capital. They need to define whether they look for a new organizational culture, original procedures or innovative products/services. Once clarified the aim to pursue, they

1
2
3 need to develop their relational capital. The selection of the right crowd to involve is a prerequisite
4 in order to get appropriate insights, ideas and knowledge. Eventually, in order to make the OI
5 process successful, companies need to have an appropriate human capital, able to decode inbound
6 knowledge flows.
7

8 Of course, LEGO case study has major implications in terms of suggestions for management
9 researchers as well. In particular, attention of management scholars should be addressed toward the
10 existence of the link between IC and OI.

11 First, worldwide management scholars are expected to propose new contributions able to
12 verify the link between IC and OI. As already said, the body of literature about this topic is not so
13 conspicuous (Henkel, 2006; Elmquist et al., 2009; Užiene, 2015; Agostini and Nosella, 2017;
14 Hussinki et al., 2017; Barrena-Martínez et al., 2019; Najar et al., 2020) and so more research is
15 evoked. Both qualitative and quantitative studies can be useful to strengthen this field of research
16 and make it accepted and shared by scholars.
17

18 Second, management scholars are expected to further investigate the link between IC and
19 OI. According to LEGO case study, IC is a pre-requisite to OI. If companies do not develop their
20 IC, OI processes are not going to be successful. This result differs from the result achieved by
21 Užiene (2015), arguing that OI processes affect all the resources hold by a company (including IC),
22 but is line with other and more recent contributions (Barrena-Martínez et al., 2019; Najar et al.,
23 2020) arguing that IC affects OI processes.
24

25 Because of the few cases available, an interesting avenue of future research might be to
26 investigate the influence relationship between IC and OI by linking it with the performance of the
27 OI processes. Quantitative studies that retrospectively try to link the direction of this relationship
28 with the (perceived and objective) performance of the OI efforts conducted by firms might be
29 appropriate.
30

31 Hopefully, other scholars could propose new contributions about the link between IC and OI
32 and add something to an emerging topic of research on which companies need to leverage more and
33 more in order to face an always increasing market competition.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

References

- Agostini, L. and Nosella, A. (2017), Enhancing radical innovation performance through intellectual capital components", *Journal of Intellectual Capital*, Vol. 18 No. 4, pp. 789-806.
- Ahmed, S.S., Guozhu, J., Mubarik, S., Khan, M. and Khan, E. (2019), "Intellectual capital and business performance: the role of dimensions of absorptive capacity", *Journal of Intellectual Capital*, Vol. 21 No. 1, pp. 23-39.
- Andersen, P.H., and Gadde, L.E. (2019). Organizational interfaces and innovation: the challenge of integrating supplier knowledge in LEGO systems. *Journal of Purchasing and Supply Management*, Vol. 25 No. 1, 1pp. 8-29.
- Antorini, Y. M., Muñiz, A. M., Jr., & Askildsen, T. (2012). Collaborating with customer communities: Lessons from the LEGO Group. *MIT Sloan Management Review*, Vol. 53 No. 3, pp. 73-79.
- Babbie, E. (2007) *The Practice of Social Research*, 11th Edition, Thompson Wadsworth, Belmont.
- Badir, Y.F., Frank, B. & Bogers, M. (2019), Employee-level open innovation in emerging markets: linking internal, external, and managerial resources. *Journal of the Academy of Marketing Science*, <https://doi.org/10.1007/s11747-019-00674-6>
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, Vol. 17 No. 1, pp. 99-120.
- Barrena-Martínez, J., Livio, C., Ferrándiz, E., Greco, M., & Grimaldi, M. (2019). Joint forces: Towards an integration of intellectual capital theory and the open innovation paradigm. *Journal of Business Research*, Vol. 122, pp. 261-270.
- Baxter, P. and Jack, S. (2008), "Qualitative case study methodology: Study design and implementation for novice researchers", *The qualitative report*, Vol. 13 No. 4, pp. 544-559.
- Boedker, C., Guthrie, J. and Cuganesan, S. (2005), "An integrated framework for visualizing intellectual capital", *Journal of Intellectual Capital*, Vol. 6 No. 4, pp. 510-527.
- Bontis, N. (1996), "There's a price on your head: managing intellectual capital strategically", *Business Quarterly*, Vol. 60 Summer, pp. 40-47.
- Bontis, N. (1998), "Intellectual capital: an exploratory study that develops measures and models", *Management Decision*, Vol. 36 No. 2, pp. 63-76.
- Bontis, N. (2001), "Assessing knowledge assets: a review of the models used to measure intellectual capital", *International Journal of Management Reviews*, Vol. 3 No. 1, pp. 41-60.
- Bontis, N. Dragonetti, N.C., Jacobsen, K. and Roos, G. (1999), "The knowledge toolbox: a review of the tools available to measure and manage intangible resources", *European Management Journal*, Vol. 17 No. 4, pp. 391-402.
- Bontis, N., Keow, W.C.C. and Richardson, S. (2000), "Intellectual capital and business performance in Malaysian industries", *Journal of Intellectual Capital*, Vol. 1 No. 1, pp. 85-100.
- Brennan, N. and Connell, B. (2000), "Intellectual capital: current issues and policy implication", *Journal of Intellectual Capital*, Vol. 1 No. 3, pp. 206-240.
- Brooking, A. (1996), *Intellectual Capital*, International Thomson Business Press, London.
- Burt, R.S. (1992), *Structural Holes: The Social Structure of Competition*, Harvard University Press, Cambridge.
- Cabrita, M.D.R. and Bontis, N. (2008), "Intellectual capital and business performance in the Portuguese banking industry", *International Journal of Technology Management*, Vol. 43 No. 1-3, pp. 212-237.
- Calza, F., Dezi, L., Schiavone, F. and Simoni, M. (2014), "The intellectual capital of business incubators", *Journal of Intellectual Capital*, Vol. 15 No. 4, pp. 597-610.
- Candelo, E., Matricano, D. and Sorrentino, M. (2018), "Top Management Involvement in Open Innovation Processes: Learning from a Global Carmaker", *International Business Research*, Vol. 11 No. 7, pp. 142-151.

- Carayannis, E., Del Giudice, M., & Rosaria Della Peruta, M. (2014), "Managing the Intellectual Capital within Government-university-industry R&D Partnerships: A Framework for the Engineering Research Centers", *Journal of Intellectual Capital*, Vol. 15 No. 4, pp. 611-630.
- Carpenter, H. (2011), Motivating the Crowd to Participate in Your Innovation Initiative. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 76-84.
- Chao, J. (2012), "The influences of LEGO Mindstorms NXT on creativity of aboriginal students in Taiwan. A case study of an energy, robotics and creativity course", *Lecture Notes in Information Technology*, Vol. 23/24, pp. 148-152.
- Chesbrough, H. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston (MA): Harvard Business School Press.
- Chesbrough, H. (2004), "Managing open innovation", *Research-Technology Management*, Vol. 47 No. 1, pp. 23-26.
- Chesbrough, H. (2012), "Open innovation: Where we've been and where we're going", *Research-Technology Management*, Vol. 55 No. 4, pp. 20-27.
- Chesbrough, H. and Appleyard, M. (2007), "Open innovation and strategy", *California Management Review*, Vol. 50 No. 1, pp. 57-76.
- Chesbrough, H. and Crowther, A.K. (2006), "Beyond high tech: early adopters of open innovation in other industries", *R&D Management*, Vol. 36 No. 3, pp. 229-236.
- Davis, S. (2013), "How LEGO Built Up From Innovation Rubble", Forbes article available at <http://www.forbes.com/sites/scottdavis/2013/09/24/how-lego-built-up-from-innovation-rubble/#414836159dcc>.
- Dhar, B. K. (2019). "Determining Effective Dimensions of Intellectual Capital", *Australian Academy*
- Di Minin, A., De Marco, C.E., Marullo, C., Piccaluga, A., Casprini, E., Mahdad, M. and Paraboschi, A. (2016), *Case Studies on Open Innovation in ICT* (No. JRC100823). Institute for Prospective Technological Studies, Joint Research Centre.
- Dilger, H., Pels, P., & Sleeboom-Faulkner, M. (2019). Guidelines for data management and scientific integrity in ethnography. *Ethnography*, Vol. 20 No. 1, pp. 3-7.
- Dyer, W.G. and Wilkins, A.L. (1991), "Better Stories, Not Better Constructs, to Generate Better Theory: A Rejoinder to Eisenhardt", *The Academy of Management Review*, Vol. 16 No. 3, pp. 613-619.
- Eisenhardt, K.M. (1989), "Building Theories from Case Study Research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.
- Eisenhardt, K.M. and Graebner, M.E. (2007), "Theory building from cases: Opportunities and challenges", *The Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.
- Elmquist, M., Fredberg, T. and Ollila, S. (2009), "Exploring the field of open innovation", *European Journal of Innovation Management*, Vol. 12 No. 3, pp. 326-345.
- Enkel, E., Gassmann, O., & Chesbrough, H. (2009), "Open R&D and open innovation: exploring the phenomenon", *R&D Management*, Vol. 39 No. 4, pp. 311-316.
- Flyvbjerg, B. (2006), "Five misunderstandings about case-study research", *Qualitative Inquiry*, Vol. 12 No. 2, pp. 219-245.
- Frankenberger, K., Weiblen, T. and Gassman, O. (2014), "The antecedents of open business models: an exploratory study of incumbent firms", *R&D Management*, Vol. 44 No. 2, pp. 173-188.
- Galbraith, J.K. (1969), "The consequences of technology", *Journal of Accountancy*, Vol. 127 No. 6, pp. 44-56.
- Garcia, A. C., Standlee, A. I., Bechkoff, J., & Cui, Y. (2009). Ethnographic approaches to the internet and computer-mediated communication. *Journal of contemporary ethnography*, Vol. 38 No. 1, pp. 52-84.

- 1
- 2
- 3 Gassman, O., Enkel, E. and Chesbrough, H. (2010), "The future of open innovation", *R&D*
- 4 *Management*, Vol. 40 No. 3, pp. 213-221.
- 5 Gaule, A. (2011), Common Mistakes and Stress Points, in: Sloane, P. (ed.), *A Guide to Open*
- 6 *Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.
- 7 Gaur, A., & Kumar, M. (2018). A systematic approach to conducting review studies: An assessment
- 8 of content analysis in 25 years of IB research. *Journal of World Business*, Vol. 53 No. 2, pp.
- 9 280-289.
- 10
- 11 Glaser, B., & Strauss, A. (1967). The Discovery of Grounded Theory, Chicago IL Aladine.
- 12 Granovetter, M. (1985), "Economic action and social structure: the problem of embeddedness", *The*
- 13 *American Journal of Sociology*, Vol. 91 No. 3, pp. 481-510.
- 14 Gruenhagen, J. H., & Parker, R. (2020). Factors driving or impeding the diffusion and adoption of
- 15 innovation in mining: A systematic review of the literature. *Resources Policy*, Vol. 65,
- 16 101540.
- 17
- 18 Hatch, M. J., & Schultz, M. (2010). Toward a theory of brand co-creation with implications for
- 19 brand governance. *Journal of Brand Management*, Vol. 17 No. 8, pp. 590–604.
- 20 Hayton, J.C. (2005) "Competing in the new economy: the effect of intellectual capital on corporate
- 21 entrepreneurship in high-technology new ventures", *R&D Management*, Vol. 35 No. 2, pp
- 22 137-155.
- 23
- 24 Heim, M. (2011), Leadership issues and challenges in the OI world, in: Sloane, P. (ed.), *A Guide to*
- 25 *Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page
- 26 Publisher, pp. 65-75.
- 27 Henkel, J. (2006), "Selective revealing in open innovation processes: the case of embedded Linux",
- 28 *Research Policy*, Vol. 35 No. 7, pp. 953-69.
- 29 Hoffman, D. L., & Novak, T. P. (2009). Flow online: lessons learned and future prospects. *Journal*
- 30 *of Interactive Marketing*, Vol. 23 No. 1, pp. 23-34.
- 31
- 32 Hopkins, R. (2011), What is crowd-sourcing?, in: Sloane, P. (ed.), *A Guide to Open Innovation and*
- 33 *Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 15-21.
- 34 Hormiga, E., Batista-Canino, R.M. and Sánchez-Medina, A. (2011), "The role of intellectual capital
- 35 in the success of new ventures", *International Entrepreneurship and Management Journal*,
- 36 Vol. 7 No. 1, pp. 71-92.
- 37
- 38 Hsu, Y.H. and Fang, W. (2009), "Intellectual capital and new product development performance:
- 39 the mediating role of organizational learning capability", *Technological Forecasting and*
- 40 *Social Change*, Vol. 76 No. 5, pp. 664-677.
- 41 Hussinki, H., Ritala, P., Vanhala, M. and Kianto, A. (2017), "Intellectual capital, knowledge
- 42 management practices and firm performance", *Journal of Intellectual Capital*, Vol. 18 No.
- 43 4, pp. 904-922.
- 44
- 45 Jennings, N. A. (2019). "It's All About the Brick": Mobilizing Adult Fans of LEGO. In *Cultural*
- 46 *Studies of LEGO* (pp. 221-243). Palgrave Macmillan, Cham.
- 47 Kashyap, A. and Agrawal, R. (2019), "Scale development and modeling of intellectual property
- 48 creation capability in higher education", *Journal of Intellectual Capital*, Vol. 21 No. 1, pp.
- 49 115-138.
- 50
- 51 Kaufmann, L. and Schneider, Y. (2004), "Intangibles: a synthesis of current research", *Journal of*
- 52 *Intellectual Capital*, Vol. 5 No. 3, pp. 366-388.
- 53 Kelley, B. (2011) The importance of a strategic approach to open innovation. In: Sloane, P. (ed.), *A*
- 54 *Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan
- 55 Page Publisher, pp. 37-42.
- 56 Khaliq, M., Bontis, N., Shaari, J.A.N. and Isa, A.H.B. (2015), "Intellectual capital in small and
- 57 medium enterprises in Pakistan", *Journal of Intellectual Capital*, Vol. 16 No. 1, pp. 224-
- 58 238.
- 59
- 60

- Khalique, M., Shaari, J.A.N. and Isa, A.H.B. (2011), "Intellectual capital and its major components", *International Journal of Current Research*, Vol. 3 No. 6, pp. 343-347.
- Klassner, F. (2002). "A case study of LEGO Mindstorms suitability for artificial intelligence and robotics courses at the college level", *ACM SIGCSE Bulletin*, Vol. 34 No. 1, pp. 8-12.
- Kratzer, J., Meissner, D., & Roud, V. (2017). Open innovation and company culture: Internal openness makes the difference. *Technological Forecasting and Social Change*, Vol. 119, pp. 128-138.
- Lee B., Collier P.M., Cullen J. (2007), "Reflections on the use of case studies in the accounting, management and organizational disciplines", *Qualitative Research in Organizations and Management: An International Journal*, Vol. 2 No. 3, pp. 169-178.
- Lindegaard, S. (2013), *Innovation Culture: The Big Elephant in the Room*, Executive White Paper, available at <http://innovationupgrade.com/wp-content/uploads/2014/01/Innovation-Culture-The-Big-Elephant-in-the-Room.pdf>.
- Link, A. N., & Ruhm, C. J. (2011). Public knowledge, private knowledge: the intellectual capital of entrepreneurs. *Small Business Economics*, Vol. 36 No. 1, pp. 1-14.
- Loren, J.K. (2011), What is Open Innovation?, in: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 5-14.
- Martino, G. and Bartolone, J. (2011), Soft Skills for Open Innovation Success, in: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 98-105.
- Matricano, D. (2016), The impact of intellectual capital on start-up expectations, *Journal of Intellectual Capital*, Vol. 17 No. 4, pp. 654-674.
- Matricano, D; Candelo, E; Sorrentino, M; Martinez-Martinez, A. (2019), "Absorbing in-bound knowledge within open innovation processes. The case of Fiat Chrysler Automobiles", *Journal of Knowledge management*, Vol. 23 No. 4, pp. 786-807.
- McElroy, M.W. (2002), "Social innovation capital", *Journal of Intellectual Capital*, Vol. 3 No. 1, pp. 30-39.
- Michelino, F.; Cammarano, A.; Lamberti, E.; Caputo, M. (2014). "Measurement of open innovation through intellectual capital flows: framework and application", *International Journal of Intelligent Enterprise*, Vol. 2 No. 2-3, pp. 213-235.
- Mindell, D., Beland, C., Chan, W., Clarke, D., Park, R. and Trupiano, M. (2000), *LEGO Mindstorms: The Structure of an Engineering (R)evolution*. 6.933J Structure of Engineering Revolution, available on <http://web.mit.edu/6.933/www/Fall2000/LegoMindstorms.pdf>.
- Miskell, P. (2018) Reflections on the integration of history and organization studies, *Management & Organizational History*, 13:3, 213-219, DOI: 10.1080/17449359.2018.1550286
- Montequín, V.R., Fernández, F.O., Cabal, V.A. and Gutierrez, N.R. (2006), "An integrated framework for intellectual capital measurement and knowledge management implementation in small and medium-sized enterprises", *Journal of Information Science*, Vol. 32 No. 6, pp. 525-538.
- Musteen, M. and Ahsan, M. (2013), "Beyond cost: the role of intellectual capital in off-shoring and innovation in young firms", *Entrepreneurship Theory and Practice*, Vol. 37 No. 2, pp 421-434.
- Najar, T.; Dhaouadi, K.; Zammel, I. B. (2020). "Intellectual Capital Impact on Open Innovation: The Case of Technology-Based Sectors in Tunisia", *Journal of Innovation Economics Management*, I69-XXXII.
- Neuendorf, K. A. (2016). *The Content Analysis Guidebook*. Sage.
- Nguyen, K. A. (2011), "A case study on the usability of NXT-G programming language", *Proceeding of 23rd Conference in Psychology of Programming*, 6th-8th September, University of York, UK.

- OECD - Organization for Economic Co-operation and Development (1999), "Guidelines and instructions for OECD Symposium", *International Symposium Measuring Reporting Intellectual Capital: Experiences, Issues, and Prospects*, Paris.
- Peña, I. (2002), "Intellectual capital and business start up success", *Journal of Intellectual Capital*, Vol. 3 No. 2, pp. 180-198.
- Pedro, E., Leitão, J. and Alves, H. (2018), "Back to the future of intellectual capital research: a systematic literature review", *Management Decision*, Vol. 56 No. 11, pp. 2502-2583.
- Penrose, E. T. (1959), *The Theory Of The Growth Of The Firm*, New York: Oxford University Press.
- Petty, R. and Guthrie, J. (2000), "Intellectual capital literature review: measurement, reporting and management", *Journal of Intellectual Capital*, Vol. 1 No. 2, pp. 155-176.
- Phillips, J. (2011) Open innovation typology, in: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 22-36.
- Pollach, I. (2012). Taming textual data: The contribution of corpus linguistics to computer-aided text analysis. *Organizational Research Methods*, Vol. 15 No. 2, pp. 263-287.
- Powell, W.W. (1990), "Neither Market nor Hierarchy: Network Forms of Organization", *Research in Organizational Behaviour*, Vol. 12 No. 1, pp. 295-336.
- Rayna, T. and Striukova, L. (2015), "Open innovation 2.0: is co-creation the ultimate challenge?", *International Journal of Technology Management*, Vol. 69 No. 1, pp. 38-53.
- Robertson, D.C. and Breen, B. (2013), *Brick by Brick: How LEGO Rewrote the Rules of Innovation and Conquered the Global Toy Industry*, Crown Business Publishing, New York.
- Roos, G., Brainbridge, A. and Jacobsen, K. (2001), "Intellectual capital as a strategic tool", *Strategy & Leadership*, Vol. 29 No. 4, pp. 21-26.
- Roos, J., Roos, G. Dragonetti, N. and Edvinsson, L. (1997), *Intellectual Capital: Navigating in the New Business Landscape*, Macmillan Business, London.
- Rowlinson, M., J. Hassard, and S. Decker. (2014). "Research Strategies for Organizational History." *Academy of Management Review*, Vol. 39 No. 3, pp. 250-274. doi:10.5465/amr.2012.0203.
- Sanchez, P., Chamichade, C. and Olea, M. (2000), "Management of intangibles: the role of strategy, industry structure and entrepreneur", *Journal of Intellectual Capital*, Vol. 1 No. 4, pp. 188-209.
- Scuotto, V., Del Giudice, M., Bresciani, S., & Meissner, D. (2017), "Knowledge-driven preferences in informal inbound open innovation modes. An explorative view on small to medium enterprises", *Journal of Knowledge Management*, Vol. 21 No. 3, pp. 640-655.
- Shapiro, S. (2011) Envisioning the Future of Innovation, in: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher, pp. 203-207.
- Shoham, A. (2004). Flow experiences and image making: An online chat-room ethnography. *Psychology & Marketing*, Vol. 21 No. 10, pp. 855-882.
- Stewart, T.A. (1997), *Intellectual Capital: The New Wealth of Organizations*, Doubleday – Currency, London.
- Subramaniam, M. and Youndt, M.A. (2005), "The influence of intellectual capital on the type of innovative capabilities", *Academy of Management Journal*, Vol. 48 No. 3, pp. 450-463.
- Sullivan, P.H. (1999), "Profiting from intellectual capital", *Journal of Knowledge Management*, Vol. 3 No. 2, pp. 132-142.
- Sveiby, K.E. (1997), *The New Organizational Wealth: Managing and Measuring Knowledge Based Assets*, Berrett Koehler, San Francisco.
- Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319-1350.

- 1
- 2
- 3 Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management",
- 4 *Strategic Management Journal*, Vol. 18 No. 7, pp. 509-533.
- 5 Thelwall, M., Buckley, K., Paltoglou, G., Cai, D., & Kappas, A. (2010). Sentiment strength
- 6 detection in short informal text. *Journal of the American Society for Information Science*
- 7 *and Technology*, Vol. 61 No. 12, pp. 2544-2558.
- 8 Tovstiga, G. and Tulugurova, E. (2007), "Intellectual capital practices and performance in Russian
- 9 enterprises", *Journal of Intellectual Capital*, Vol. 8 No. 4, pp. 695-707.
- 10 Ulubeyli, S. and Yorulmaz, D. (2019), "Intellectual capital based reputation for market
- 11 internationalization: The case of engineering consultancy firms", *Journal of Intellectual*
- 12 *Capital*, Vol. 21 No. 1, pp. 40-61.
- 13 Uziene, L. (2015), "Open Innovation, Knowledge Flows and Intellectual Capital", *Procedia Social*
- 14 *and Behavioral Sciences*, 213, pp. 1057-1062, paper presented at 20th International Scientific
- 15 Conference Economics and Management - ICEM.
- 16 Uzzi, B. (1997), "Social structure and competition in interfirm networks: the paradox of
- 17 embeddedness", *Administrative Science Quarterly*, Vol. 42 No. 1, pp. 35-67.
- 18 vom Lehn, D. (2019). Phenomenology-Based Ethnography for Management Studies and
- 19 Organizational Analysis. *British Journal of Management*, Vol. 30 No. 1, pp. 188-202.
- 20 Whelan, E., Teigland, R., Donnellan, B. and Golden, W. (2010), "How internet technologies impact
- 21 information flows in R&D: reconsidering the technological gatekeeper", *R&D Management*,
- 22 Vol. 40 No. 4, pp. 400-413.
- 23 Wu, W., Chang, M. and Chen, C. (2008), "Promoting innovation through the accumulation of
- 24 intellectual capital, social capital and entrepreneurial orientation", *R&D Management*, Vol.
- 25 38 No. 3, pp. 265-277.
- 26 Yin, R. K. (1994), *Case Study Research, Design and Methods*, second edition, Sage Publications:
- 27 Thousand Oaks.
- 28 Yin, R. K. (2003). *Case Study Research, Design and Methods*, third edition, Sage Publications:
- 29 Newbury Park.
- 30 Zwick, D., Bonsu, S. K., & Darmody, A. (2008). Putting consumers to work: Co-creation and new
- 31 marketing govern-mentality. *Journal of Consumer Culture*, Vol. 8 No. 2, pp. 163–196.
- 32
- 33
- 34
- 35
- 36
- 37
- 38
- 39
- 40
- 41
- 42
- 43
- 44
- 45
- 46
- 47
- 48
- 49
- 50
- 51
- 52
- 53
- 54
- 55
- 56
- 57
- 58
- 59
- 60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

Figure 1.
Decisions about structural, relational and human capital over phase 1 and 2 o

