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# The Internet of Things: Building a knowledge management system for open innovation and knowledge management capacity

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ABSTRACT

New disruptive technologies in the context of the Internet of Things (IoT), especially, are changing the manner in which knowledge is managed within organizations, calling for a new and inventive knowledge management system and an open approach, to foster knowledge flows. This pattern expectedly should also enhance the development of internal knowledge management capacity, which in turn is a prerequisite of firm's innovativeness. In this context, the main goal of this research is to investigate the relationship among knowledge management system, open innovation, knowledge management capacity and innovation capacity. To reach this goal, the research employs structural equation modelling on a sample of 298 Italian firms from different sectors. The findings indicate that knowledge management system facilitates the creation of open and collaborative ecosystems, and the exploitation of internal and external flows of knowledge, through the development of internal knowledge management capacity, which in turn increases innovation capacity. The research further draws on its findings to identify significant scholarly and managerial implications, and to prescribe future research directions.



## 1. Introduction

The Internet of Things (IoT) concept has aroused much excitement in the last years. Descriptively, the IoT can be considered as a series of disruptive digital technologies, influencing the daily life of both individuals and businesses (Kim and Kim, 2016; Scuotto et al., 2016). In line with this phenomenon, firms are becoming more intelligent in developing, adopting and adapting disruptive technologies in their business processes, in order to increase their efficiency and innovativeness through knowledge flows and data/information gathering (Malhotra, 2000; Vrontis et al., 2012). Facing the knowledge and technology-driven contemporary economy – characterized by trends such as globalization, technological and industrial convergence – successful firms use specific mechanisms to manage knowledge (Gold and Arvind Malhotra, 2001). In fact, the widespread scholarly and applied interest in organizational knowledge has primarily addressed the issue of managing knowledge to increase organizational benefits.

Knowledge management regards the processes of organize and leveraging firm's collective knowledge to achieve sustainability (Argote and Ingram, 2000; Davenport and Prusak, 1998) and to improve innovativeness and responsiveness to environmental changes (Teece, 2007, Thrassou and Vrontis, 2008). Strikingly, though, little research exists on the design, use, or success of ICTs and systems to support knowledge management (Del Giudice and Della Peruta, 2016). This constitutes a significant gap in scientific business knowledge, as well as in its applied context, since many organizations are developing knowledge management system (KMS) designed specifically to facilitate the creation, sharing and storage of knowledge. Considering also the emerging and increasing momentum of the IoT phenomenon, which is changing the nature of innovation itself, firms can gain competitive advantage through data gathering and exchange, by building digital ecosystems through ICT tools and infrastructures, experimental technology platforms, and applications (Soto-Acosta and Cegarra-Navarro, 2016).

However, despite the significant advances in several knowledge management aspects, results have been inconsistent and confusing regarding the variables that affect knowledge management programs (López-Nicolás and Meroño-Cerdán, 2011). More specifically, the effects of knowledge management practices have been scarcely investigated in literature (Choi et al., 2008), and thus is not clear how firms benefit from these practices (Tseng, 2008). Thus, focus is naturally drawn to the relationship between knowledge management, innovativeness and firm performance (Darroch, 2005; López-Nicolás and Meroño-Cerdán, 2011). Moreover, knowledge management research, specific to internal knowledge, is often limited and neglects the integrative perspective of both internal and external knowledge (Teece, 2007).

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In fact, in the current dynamic environment, firms increasingly have to heighten internal knowledge management capacity (KMC) in order to manage inward and outward flows of knowledge exploiting and exploring external opportunities. Here, KMC refers to the ability of an organization to explore both internal and external knowledge, and to retain knowledge over time within the firm (Chen and Huang, 2009). Accordingly, when adopting an open innovation approach, firms tend to build up collaborations with actors of their own ecosystem acquiring knowledge (Wang et al., 2015; Bogers et al., 2016).

In this context, this research develops a conceptual model, proposing that firms can and should exploit the IoT through the development, implementation and sustainment of KMS that involve advanced ICTs and the exploration of external sources of knowledge; which in turn is translated into higher innovation performance (considered here as the ability to introduce new products/services, processes or opening of new markets).

This research thus aims at contributing to knowledge management, innovation management and open innovation literature by shedding light on whether and how an open KMS can facilitate higher innovation capacity. Specifically, we tested our hypotheses using the structural equations modelling (SEM), on a sample of firms from different manufacturing and service sectors.

The research has been structured in the following sections: Section 2 proposes the theoretical background of the paper regarding knowledge management, with focus on KMS and their relationship with open innovation theory; Section 3 develops the hypotheses and the conceptual model; Section 4 describes the methodology, including the sample information and variables; Section 5 analyses data; and Section 6 discusses the findings and provides conclusions of the research.

## 2. Theoretical framework

### 2.1. Knowledge management

Knowledge management has already been recognized as a key managerial process necessary for achieving competitive advantage (Carayannis, 1999; Argote and Ingram, 2000; Dias and Bresciani, 2006). In fact, the knowledge-based view has reached growing interest in both information technology and systems, strategic management, innovation management and organizational literature (Nonaka, 1994; Spender, 1996; Nonaka and Takeuchi, 1995; Alavi and Leidner, 2001; Soto-Acosta and MeroñO-Cerdan, 2008; Bresciani, 2010). Specifically, it assumes that tangible resources are sources of competitive advantage only when they are applied with certain knowledge and they are hard to imitate (Grant, 1996). However, the true competitive advantage is built through the ability of the firm to apply effectively existing and new knowledge to create new products and processes (Thrassou et al., 2012). Thus, knowledge management regards the identifying and leveraging of knowledge to foster innovation processes (Darroch, 2005).

Knowledge and its management, however, relate even to the more basic work processes of the firm. Typically, Hernaus and Mikulić (2014) find that even with regard to the existence and importance of the interaction between work characteristics and work outcomes, only knowledge characteristics of work design exhibit a significant effect on both dimensions of work behaviour. In the opposite side of the spectrum, Aziz and Rizkallah (2015) measure the relationship between the idea generation of employees and the organizational factors that affect innovation performance. In detail, they find that while many factors proved to be significantly correlated with employees' innovative idea generation, the functional and motivational factors appear to be the most important.

Two main dimensions are essential in knowledge management, namely enablers and processes. Enablers are mechanisms that facilitate knowledge management activities, such as codifying and sharing among individuals and teams (Ichijo et al., 1998). Moreover, they stimulate knowledge creation, sharing and protection, and provide the infrastructure necessary to improve the knowledge processes (Yeh et al., 2006). In turn, knowledge management processes refer to the structured coordination of managing knowledge effectively, such as knowledge creation, sharing, storage, and application (Lee and Choi, 2003). In this paper, we focus on the role of technology, which is seen as crucial in removing the boundaries to communication and knowledge flows and therefore can be considered an enabler of knowledge management (Allameh and Zare, 2011). In particular, following Alavi and Leidner (2001) we consider and discuss the role of ICTs as a fundamental part of KMS.

### 2.2. Knowledge management systems in the IoT context

The IoT can be considered as a series of disruptive technologies influencing the daily life of both individuals and companies (Kim and Kim, 2016). In fact, modern firms are increasingly developing and implementing disruptive ICTs in several business processes in order to increase their efficiency and innovativeness through new methods of knowledge flow and data/information gathering (Del Giudice and Straub, 2011; Del Giudice and Della Peruta, 2016). Therefore, the management of knowledge can be strongly supported by advanced ICTs. As pointed out by both knowledge management and information system's literature, KMS is essentially based on ITCs (Alavi and Leidner, 2001), because innovative ITCs (for example the internet, intranets, extranets, data warehouses, data mining techniques, and software agents) can be used to systematize knowledge.

In detail, KMS refers to information systems applied to manage organizational knowledge and to improve the creation, storage, transfer, and application of knowledge. Thus, from a knowledge-based perspective, a KMS can be considered as a knowledge management enabler, since it allows the capturing of individuals' knowledge, so that the broader organization can benefit from its dissemination (King and Marks, 2008). Effective KMS is mainly comprised of three components:

- IT infrastructures, namely the physical technology that helps in manage knowledge effectively such as hardware, software components, extranet, intranet and LAN (Soto-Acosta and MeroñO-Cerdan, 2008).
- Collaborative technologies, including discussion forums, shared databases, document repositories and workflows (Merono-Cerdan et al., 2007).
- The ICT adoption, which can integrate different collaborative technologies, and whose use orientation regards three primary implementation aims (Bafoutsou and Mentzas, 2002; Lopez-Nicolas and Soto-Acosta, 2010): (a) The ICT informative orientation aims at providing commercial information to several stakeholders, across organizational and functional boundaries; (b) the ICT communicative orientation allows costs' reduction and interaction with several business agents within and outside the organization; and (c) the ICT workflow orientation, through which electronic processes within corporate technologies are established.

In addition, in an open and collaborative IoT-driven environment, firms can and should integrate technologies (Soto-Acosta et al., 2014). This technology integration regards: a) the integration of the website with back-end systems and databases; and b) the integration of internal databases with databases of external stakeholders.

### 2.3. Knowledge management and open innovation theory

As noted in the previous section, knowledge management is recognized as a necessary process in sustaining and maintaining competitive advantages in this knowledge-driven global economy. Nevertheless, research in this field is often focused on internal knowledge (Lichtenthaler and Lichtenthaler, 2009), while a more integrative perspective, which considers both internal and external knowledge, is relatively scarce

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