VALUE CO-CREATION IN THE IoT ERA

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ABSTRACT

Purpose –The Internet of Thing (IoT) is a novel paradigm focused on the concept of a complex ecosystem (Leminen et al., 2012) where humans, things and objects interact with each other (Atzori et al., 2010). Specifically, the IoT is a set of connected surrounding objects *of human’s living space*, such as home devices, smartphones, transportation, big data storage, and equipments…etc (Said and Masud, 2013). It is revolutionizing codes and ways of both social and business communication, information exchange and interaction (Huang and Li, 2010). Given this, the IoT can be considered as a context that enables the process of resource integration (Colurcio and Verre, 2017).
The aim of the paper is to investigate the IoT according the marketing perspective of value co-creation (Vargo and Lusch, 2008) in order to draw out key elements for the set-up of a resource integration practice.

Design/Methodology/approach – The study adopts a qualitative research approach: the case study method (Yin, 2013). It is consistent with the objective of the analysis and with the complex nature of the phenomenon under investigation. Moreover, it appears the most appropriate in order to deeply investigate and understand contemporary phenomenon. The single case study method is particularly suitable to investigate unique phenomena as Predix, an Industrial Internet platform built by General Electric (GE).

Findings – Predix is a service platform that operates, according the PaaS (Platform-as-a-Service), as an open source model and consists of both tangible (i.e. machines and devices) and intangible components (information, processes, experience). “Predix platform provides rapid access to data and timely analytics while minimizing storage and compute costs. It offers a secure model that includes network-level data isolation and encrypted key management capabilities. It also supports the ability to plug in analytic engines and languages to interact and process the data” (Predix – GE, 2016, p.13).
In this case the IoT, considered as the technology resource, works both as operand and operant resource (Akaka and Vargo, 2014) that supports the value co-creation process (Vargo and Lusch, 2004; 2008) and enables the resource integration (Lusch and Nambisan, 2015)
Predix may enable and empower the three support mechanisms of value co-creation process: i) facilitating interactions among actors; ii) adapting internal processes to accommodate diverse actors and iii) enhancing the transparency of resource integration activities (Colurcio and Verre, 2017).

Practical implications– The work advances knowledge in management field about the IoT for the development of new competitive business. It provides interesting insights for the management and the improvement of resource integration process according to the emerging collaborative and technological issues.

Originality/value – This study provides new interdisciplinary insight on the role of the IoT in supporting value co-creation process. Specifically, the paper frames the IoT, which has been narrowed to technological and cybernetic field so far, within a marketing perspective advancing the knowledge about both the resource integration in practice and the IoT paradigm.

Keywords – IoT, value co-creation, resource integration, ecosystem.
Paper type – Research paper

1. Introduction

The Internet of Thing (IoT) is a novel paradigm focused on the concept of a complex ecosystem (Leminen et al., 2012) where humans, things and objects interact with each other (Atzori et al., 2010). The term ‘‘Internet of Things” is composed by two words. The word “Internet” recalls a dynamic global network infrastructure based on standard protocols, while the word "things" stresses they are network connected, each one providing data, many of them with the ability to act and influence the environment and to create the opportunity for citizens, businesses and other organizations and for the society as a whole (Haller et al., 2008; Coetzee and Eksteen, 2011).

The IoT consists of heterogeneously connected devices that are extending the borders of the world with physical entities and virtual components (Li et al., 2015). Specifically, it is a set of connected surrounding objects of human’s living space, such as home devices, smartphones, transportation, big data storage, equipments etc (Said and Masud, 2013), and can be defined as the network of smart objects - physical assets- that have the ability to connect each other and communicate data through communication protocols (Sharron and Tuckett, 2016).

The IoT is transforming both the social and the business ecosystem leading to a more “connected life”(Li and Li, 2017). From the social point of view, the IoT enables a smart life as it allows people to manage different activities – sport, health care, banking, education, housing, movement, entertainment, etc. - through their smartphones or notebook (Boulos and Al-Shorbaji, 2014) providing advantages in terms of time and everyday life simplifying.

From the business point of view, the IoT emerges as the” biggest opportunity to enterprises since the dawn of the internet age, and perhaps it will be bigger” (Olavsrud, 2017). It is revolutionizing codes and ways of both social and business communication, information exchange and interaction (Huang and Li, 2010) influencing the speed, the transparency and the rules of communication and decision making. The transformative power of the IoT affects all kinds of industries as - by collecting data from various connected sources, combining them with data from other sources and using big data analytics, decisions and actions - it may have important implications for firms, can be taken and made (Michel, 2014). By 2020, the IoT is expected to extend to about 26 billion network-connected devices, enabling the monitoring of nearly every machine and human activity, from how many steps we walk every day to the way machines run every second (Rivera and Goasduff, 2014).

Given this, the IoT appears as a context that enables the process of resource integration (). Specifically, Colurcio and Verre (2017) recognized that the IoT works as “service platform” (Lusch and Nambisan, 2015) that is “a modular structure that consists of tangible and intangible components (resources) and facilitates the interaction of actors and resources (or resource bundles)”through clear protocols of exchange (p.162): the service platform support the value co-creation process (Vargo and Lusch, 2004) enabling the resource integration by leveraging resource liquefaction and enhancing resource density.

Nevertheless, despite the link between the IoT and the process of companies’ value creation, to the authors’ best knowledge, studies that address this topic or more generally, approach the IoT according a marketing perspective, lack so far.

So, the paper aims to investigate the IoT according the marketing perspective of value co-creation (Vargo and Lusch, 2008) in order to draw out key elements for the set up of a resource integration practice.

Through the analysis of the Predix GE case study, we conjecture that the IoT is an infrastructure that may enable and empower the areas of support to value co-creation by facilitating the interactions and enhancing the transparency of resource integration process.

The paper advances knowledge in management field about the IoT for the development of new competitive business. It provides fresh insights about the role of the IoT in the value co-creation process. Specifically, it frames the IoT, which has been narrowed to technological and cybernetic field so far, in a marketing perspective advancing the knowledge about both the resource integration in practice and the IoT paradigm.

The remainder of this paper is organized as follows. First, we review the literature on IoT and value co-creation and resource integration. Then we present the methodology, in which we outline the case study, and discuss the findings. Finally, we conclude the paper, sketching the main implications, limitations, and directions for future research.

2. Literature review

This study developed from reflections and remarks regarding two main theoretical streams of research: studies on the Internet of Things (IoT) and research on the main contribution of value co-creation and resource integration.

2.1 Internet of Things

IoT is a paradigm where things have sensing, identifying, networking and processing capabilities which enable them to communicate with other devices and services over the Internet to accomplish objectives common (Whitmore et al., 2015; Balaji and Roy, 2017). It is not a single novel technology, but rather a set of several complementary technologies and smart objects that sharing information across platforms on large scale (Gubbi et al., 2013) and allows to creation of new independent networks, to improve new services and to apply new and different modes of communication between people and things and things themselves (Bryant et al., 2007; Dohr et al., 2010). It can be looked as a dynamic network of smart objects that using generally technologies as the Radio Frequency Identification (RFID), Global Positioning system (GPS), developments in sensor networks, Micro Electro-mechanical Systems (MEMS) (Dohr et al., 2010; Miorandi et al., 2012; Lee et al., 2016; Rathore et al., 2016).

Furthermore, the Internet of Things opens up many opportunities for companies to identify the hidden patterns, predict future trends and enable to access increasingly massive amounts of data and equip them with more powerful analytical tools to support strategic and tactical decisions (SAS, 2015; Li and Li, 2017).

Nowadays, a number of leading global companies have begun the journey towards adopting the IoT (Li and Li, 2017). Adopting IoT technologies is essential to achieving competitive advantage (Iansiti and Lakhani, 2014; Balaji and Roy, 2017) and the date can be used to gain newer insights into value creation and a better positioning (Porter and Heppelmann, 2014; Balaji and Roy, 2017). Furthermore, the IoT enables to innovatively improve the flexibility, integration, agility and to sharing information with all partners allows to develop efficient and effective optimal solutions based on the unique situation of each individual case (Liu et al., 2011; Vivaldini and Pires, 2013; Reaidy et al., 2015; Balaji and Roy, 2017). IoT can be adopted in different sectors such as the transportation and logistics domain (Atzori et al., 2010; Gubbi et al., 2013), health (Nussbaum, 2006; Luo et al., 2010; Gubbi et al., 2013; Mulani and Pingle, 2016), Smart Homes/Smart Buildings (Miorandi et al., 2012; Gubbi et al., 2013; Camarinha-Matos and Afsarmanesh, 2014; Whitmore et al., 2015), personal and social application (Atzori et al., 2010; Gubbi et al., 2013; Whitmore et al., 2015), and smart cities (Miorandi et al., 2012; Rathore et al., 2016).

2.2 Value co-creation and Resource Integration

Vargo and Lusch in 2008 affirmed value is "always co-created, jointly and reciprocally, in interactions among providers and beneficiaries through the integration of resources and application of competences" (Vargo and Lusch, 2008) and as it is "uniquely and phenomenologically determined by the beneficiary" (Vargo et al. 2008; Vargo and Akaka, 2009). These fundamental premises imply two main assumptions: i) the roles of producers and consumers are not distinct into the value co-creation process but all social and economic actors are resource integrators (Vargo and Lusch, 2008; Vargo et al., 2008) and ii) resources do not have value per se, as value is the outcome of activities and interactions in which resources are integrated. Resources express a dynamic concept (Zimmerman, 1951; Pels et al., 2009) that is constituted and reconstituted through the practice of resource integration itself: "*resources are not: they become. The usefulness of any particular potential resource from one source is moderated by the availability of other potential resources from the other sources, the removal of resistances to resource utilization, and the beneficiary's ability to integrate* *them*" (Vargo and Lusch, 2011, p. 184). Therefore, resources are becoming (things, persons, machines, money, institutions, or concepts) only when they are integrated through interaction to perform an intended activity (Löbler, 2013).

Interaction allows actors to access additional resources, and thus to create new exchangeable resources through integration (Vargo and Lusch, 2011). The resource integration, instead, is the means through which resource integrators (actors) co-create phenomenologically determined value through process(es) and forms of collaboration (Kleinaltenkamp et al. 2012). According to Edvardsson et al. (2014), resource integration "*consists of cooperative and collaborative processes between actors, leading to experiential outcomes and outputs, as well as mutual behavioral outcomes for all actors involved*". Although some authors underline the role of customer as resource integrator (Hibbert et al., 2012) linking the concept of resource integration to the customer's participation in a company's value creating process (Hakanen and Jaakkola, 2012; Jaakkola and Alexander, 2014; Nambisan and Baron, 2007), recent contributions extend the concept of value co-creation from a dyadic perspective (firm-customer) to the actor to actor (Lusch and Webster, 2011), many-to-many (Russo-Spena and Mele, 2012) or network to network context (McColl-Kennedy et al., 2012) as multi-stakeholder and service beneficiary centered process (Singaraju et al., 2016).

Lusch and Nambisan (2015) highlighted the centrality of resource integration process in the service innovation and defined the concepts of *resource liquefaction* and *resource density* which relates respectively to the decoupling of information and to the mobilizing of resources (*maximum density occurs when the best combination of resources is mobilized for a particular situation*). They frame value co-creation, as a process of multiple interactions and multidirectional resource integration (Vargo and Lusch, 2008) that require the dynamic alignment/matching of resources between actors within a service ecosystem (Vargo and Lusch, 2011) which considers service platforms as "modular structures that comprise tangible and intangible components (resources) and facilitate the interaction of actors and resources (or resources bundles)" (p. 166) through the setting of shared rules and protocols of exchange.

3. Research design

3.1 Methodology

The study adopts a qualitative research approach: the case study method (Yin, 2013). It is consistent with the objective of the analysis and with the complex nature of the phenomenon under investigation. Moreover, it appears the most appropriate in order to deeply investigate and understand contemporary phenomenon within its real-life context (Yin, 1984). The single case study method is particularly suitable to investigate unique phenomena as Predix, an Industrial Internet platform built by General Electric (GE).

Predix (Mino, 2016) is an interesting case study for researchers and practitioners, chosen because of the perceived relevance of the company (General Electric) to the object of study (a market leading company which is a first mover in the IoT).

3.2 Data Collection

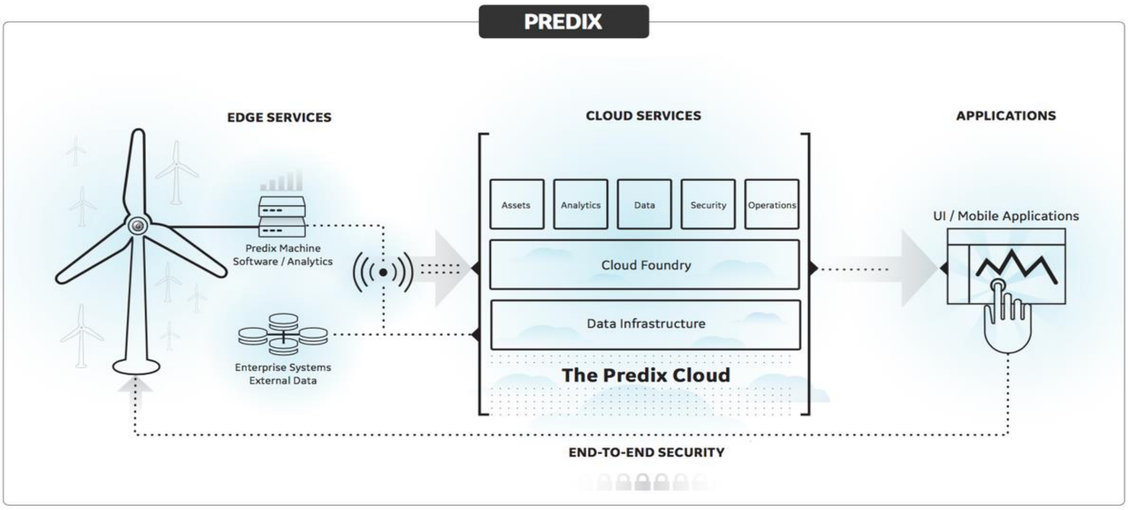
Data were collected preliminary through the website and company supporting materials. Furthermore, the direct involvement of a GE engineer (who co-authored this paper as well) allowed to obtain focused information about the investigated topic. The collection of data followed the guide of the Lusch and Nambisan's framework focusing on i) service ecosystem; ii) service platform and iii) value co-creation.

The activity of data analysis was supported by research notes and remarks, and by internal documents' analysis. In depth documents analysis allowed to obtain two significant advantages, the first of which is associated with the possibility of examining non-reactive data, that is to say not dependent on the researcher/person observed relationship; the second is linked to the fact that through such documents it has been possible to study and reconstruct the history and development of the project.

3.3. The study context: Predix

Predix is the Industrial Internet platform built by General Electric (GE) by packaging its own capabilities and transformation experience, to guide industrial companies through the complex technology and business transition. By using this comprehensive platform, businesses can create innovative apps on Predix that turn real-time operational data into actionable insights. Predix equips them with everything they need to rapidly build, securely deploy, and effectively operate industrial apps; it can securely connect with machines-old and new, GE and non-GE. Once connected, data is captured, stored, analyzed and made available to the right people at the right time to enable the right decisions (Figure 1).

Fig. 1: Predix: the GE Industrial Internet of Things Platform



Source: Predix- the Industrial Platform for The Industrial Internet, GE (2016).

Specifically, Predix is a machine-centric platform that supports heterogeneous data acquisition, storage, management, integration and access providing advanced predictive analytics by ensuring the end-to-end security (in the cloud and at the edge). Predix allows to deploy and operate industrial apps connecting machines, data and analytics to people.

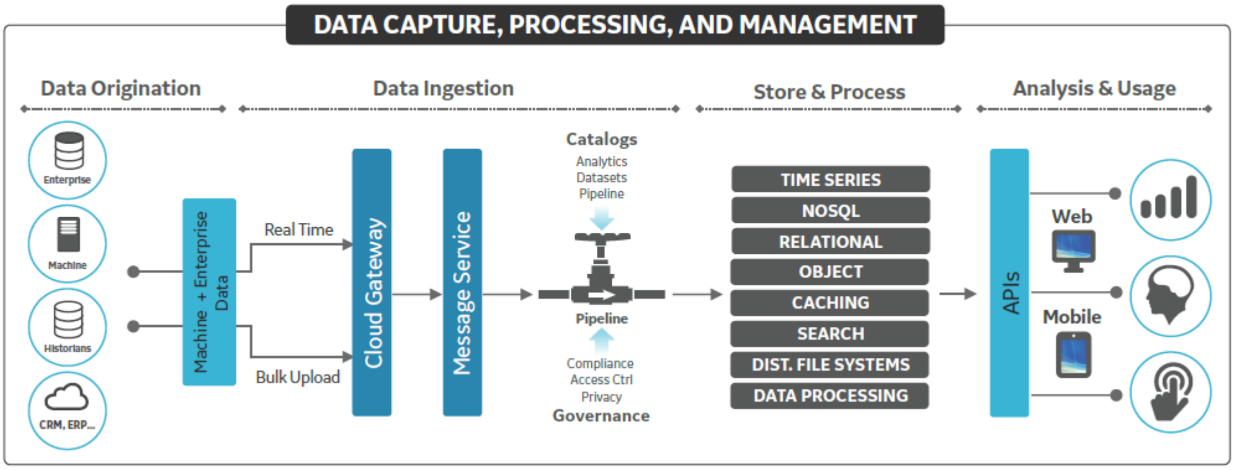
Predix is built on Pivotal's Cloud Foundry, an open source Platform-as-a-Service (PaaS). By using Cloud Foundry's unique microservices architecture, app developers can quickly build, test, deploy, and - most importantly - scale applications in hours or days instead of weeks or months. A comprehensive security strategy - that combines security certifications, hardware, software, expertise, and best practices to create an environment of trust for industrial companies - has been developed.

4. Findings

"Predix platform provides rapid access to data and timely analytics while minimizing storage and compute costs. It offers a secure model that includes network-level data isolation and encrypted key management capabilities. It also supports the ability to plug in analytic engines and languages to interact and process the data" (Predix – GE, 2016, p.13). Figure 2 shows the processes enhanced through the platform.

Predix develops and enable mechanisms of participation in which social and economic actors forge relationships for service exchange. Such mechanisms facilitate interaction among the actors through the reduction of time and of distortion and asymmetry in communication as enhances the transparency of communication.

Figure 2: Value co-creation and resource integration in IoT



Source: Predix- the Industrial Platform for The Industrial Internet, GE (2016, p.13)

Indeed the platform offers a standardized way to enable the entire business to quickly take advantage of operational and business innovations. By interacting within the platform that is designed around a reusable building block approach, industrial actors can: build apps quickly; leverage work elsewhere; reduce sources of error; develop and share best practices; lower risk of cost and time. Independent actors can also build apps and services on the platform, allowing industrial actors to extend their capabilities easily by tapping into the industrial app ecosystem. The platform is machine-centric and support heterogeneous data acquisition, storage, management, integration, access; it provides advanced predictive analytics; guides personnel with intuitive user experiences on the device of choice and delivers securely in the cloud and at the edge.

Predix boasts an extensible architecture that enables processes to develop and maintain a shared worldview among a set of actors, managing the conflicts among the actors in service ecosystem. Indeed, it works as a comprehensive, purpose-built industrial platform that can be deployed from the edge to the cloud. Edge and cloud deployment models are complementary and typical industrial applications need both. Specifically, the cloud model allows businesses advantages including lower costs based on the economics of a centrally managed and shared infrastructure in a *pay-as- you-go* subscription model; scale to meet different business and application workloads by easily adjusting capacity on-demand; generation of actionable insights with assets that can be modeled across the business; deliver insights from analytics that can be developed and run at all levels of the organization. With respect to the architecture of participation, Predix is based on a multi-tenant “gated community” model to ensure that tenants belong to the industrial ecosystem. This reduces the risk of bad actors entering the community, and enables GE to account for stringent regulatory requirements in ways that IT-focused public clouds cannot.

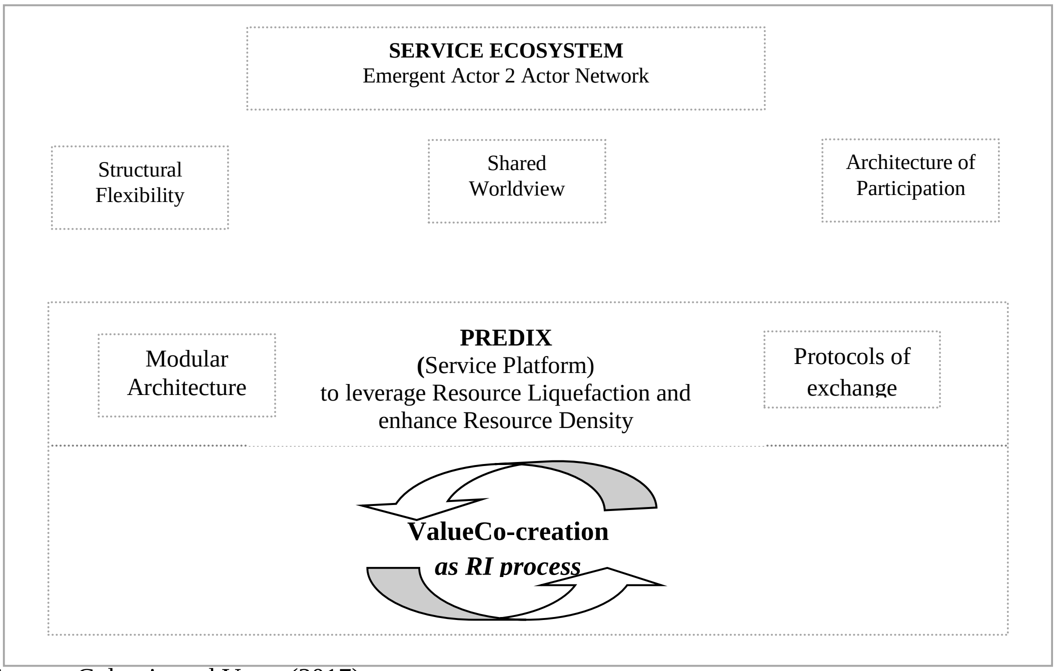
5. The IoT as enabler of value co-creation in Predix

The analysis of the case study showed that with Predix, GE is transforming the industry according a vision that is bigger than just one company. GE has joined forces with other industry leaders and innovators to build a powerful ecosystem of companies committed to advancing the new digital industrial era. Through partnerships with other technology companies, academia, consultants, and systems integrators, GE is sharing its expertise and knowhow and co-innovating to drive important advances in functionality (Chesbrough, 2006; Chen et al., 2011) - harnessing the potential of the Industrial Internet to deliver powerful customer outcomes (Predix, GE 2016). Indeed, Predix delivers actionable insight into assets and operations, revealing new business opportunities (www.ge.com/digital/predix).

The result of such a transformation process is a reconfiguration of activities of GE according a view of multiple actors collaborating by means of integrating and reconfiguring resources. Such an open view, based on the mechanisms of RI, overcomes the firm/output-centric view of innovation (Koskela-Houtari et al., 2016) toward a broader service-based view of innovation (Ostrom et al.,

2015) in which technology plays a relevant role (Bitner et al., 2010; Arthur, 2009).
Adapting the framework of Lusch and Nambisan (2015), we can represent Predix as showed in Figure 3. Predix is a service platform that operates according the PaaS-Platform-as-a-Service- open source model and consists of both tangible (i.e. machines and devices) and intangible components (information, processes, experience). In this case the IoT, that is the technology resource, works both as operand and operant resource (Akaka and Vargo, 2014). It runs as operand resource as it is the outcome of human action sand is functional to the strategic attribute of the business relationship such as transparency, speed, common and shared code. It represents a means, a sort of operational mechanism that facilitates the interactions among diverse actors and improves the transparency of actions and information among the diverse actors. However, the IoT works also as operant resource because of it is capable of acting on other resources to contribute to value creation as showed in Figure 2 (Constantin and Lusch 1994; Vargo and Lusch 2004). Specifically, the IoT acts on the *resource liquefaction* as Predix allows actors to create innovative apps that turn real-time operational data into actionable insights and offers a secure and reliable connectivity and communication over various access networks, including fixed line, cellular and satellite communication. Furthermore, Predix acts on *resource density* as customers can connect existing infrastructure and new deployments to the cloud for data ingestion, analytics, remote device management, and monitoring.

Figure 3: Services of the Predix IoT Platform



Source: Colurcio and Verre (2017)

Acting on *resource liquefaction* and on *resource density* Predix sets up as an engagement platform that is more than a set of multiple touch-points and consists of "multisided intermediaries that actors leverage to engage with other actors to integrate resources" (Storbacka et al., 2016, p. 3011).

6. Discussions

The study aimed to explore the IoT according the marketing perspective of value co-creation. Specifically, the analysis focused on the "Internet of Thing" (IoT) scenario illustrating the strong implications of the development interconnected and interoperable communications protocols in a context of resource integration where the ambition is value co-creation.
We argue that the IoT may plays a crucial role for the integration of resource and information in business relationship as continuous data acquisition, coupled with timely response demands robust and scalable technologies at the edge and onward to the cloud. Predix is purpose-built to offer software services that deliver actionable intelligence, transformative insights, and effective control—

from the edge, to the data center, and back (Predix, 2016). Therefore "from a system-level perspective, the Internet-of-Things can be looked at as a highly dynamic and radically distributed networked system, composed of a very large number of smart objects producing and consuming information. The ability to interface with the physical realm is achieved through the presence of devices able to sense physical phenomena and translate them into a stream of information data (thereby providing information on the current context and/or environment), as well as through the presence of devices able to trigger actions having an impact on the physical realm (through suitable actuators)" (Miorandi et al., 2012, p.1498).
The case study hints that the IoT could stand for a practice of resource integration that goes beyond the simple digital environment and offers opportunity for the improvement of both social and business life. Indeed, practices are "more or less routinized actions, which are orchestrated by tools, know-how, images, physical space and as subject who is carrying out the practice" (Korkman, 2006, p. 27) that can be developed by actors and/or by active resources, such as interactive and smart technologies (Caridà, Colurcio, Melia 2014).
The platform offers the space and the resources for the interaction of actors and, due to the technological infrastructure and its potential (Protocols and Technical Architecture), sets up the pre-conditions for triggering value co-creation process;"It is more than mere combinations of physical equipment and technology, it is, according to a system approach, a configuration of resources that includes people, information, and technology and that generates value in use through resource integration and thus through the collaborative process of co-creation between parties" (Vargo and Lusch 2008, p. 256)
Our study is of course limited in its scope and concerns a very peculiar industry: further research is needed to shed more light on how IoT work in different contexts and on IoT affect value co-creation.

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