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Understanding business model in the Internet of Things industry

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A R T I C L E I N F O

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A B S T R A C T

This research presents the results of an exploratory study of how organisations operating in the Internet of Things (IoT) industry are building and innovating their business model (BM). Using an explorative sequential approach through the multiple-case study method, we apply the "Canvas BM" framework to explore the BM of three companies operating in IoT industry, namely Intel, Solair, and Apio. The paper finds the most important building blocks - key activities, key resources, and value proposition - and most critical related factors enabling IoT-oriented organisations to create and capture value. Furthermore, our results also suggest that the main difference in the processes of BM building and innovation depend on the different capabilities and competencies possessed by organisations. This study therefore advances the theoretical understanding of the critical factors for the value creation process in the IoT industry's organisations and offers interesting implications for management theory and practice.

1. Introduction

Over the last two decades, the Internet of Things (henceforth: IoT) has been in a constant state of evolution. Some of the most prestigious management-consulting firms, such as Gartner, McKinsey analysis, and ABI Research, forecast that IoT devices would grow from about 5 billion in 2014 to as many as 20 billion devices by 2020. In terms of hardware spending, consumer applications will amount to $1534 billion by 2020, while the use of connected things in the enterprise will rise to $1477 billion in 2020 (Gartner, 2015). Therefore, IoT is included by the US National Intelligence Council in the list of six "Disruptive Civil Technologies" with potential impacts on US national power (NIC, 2008).

IoT represents a novel paradigm that is rapidly gaining ground in the modern economics, with a high impact on several aspects of the everyday-life of both private and business users (Atzori et al., 2010). IoT describes "the interconnection of objects or 'things' for various purposes including identification, communication, sensing, and data collection" (Oriwoh et al., 2013, p. 122). In particular, it consists of an infrastructure that is able to measure, identify, track, and monitor objects for connecting things, sensors, actuators, and other smart technologies (Uckelmann et al., 2011) as well as simplifying people's lives through tasks automation (Espada et al., 2011). There are several fields of application for IoT technologies, such as the smart industry (or Industry 4.0), transportation and logistics, healthcare, personal life domain and smart cities, emergency management (Atzori et al., 2010; Yang et al., 2013; Kim and Kim, 2016; Suwon and Seongcheol, 2016).

Considering the growing importance of the IoT industry in the global economy, academics are also increasing focusing their attention on several issues within a range of research fields. However, prior literature is concentrated mainly on technological aspects, meaning that managerial issues have been lacking compared to technical research (Kiel et al., 2016). According to the traditional technical approach, IoT technologies and overall digital technologies are studied in terms of technical infrastructure or platform (e.g., Eisenmann et al., 2006; Tiwana et al., 2010; Tiwana, 2014; Eaton et al., 2015; Spagnoletti et al., 2015). Thus, IoT technologies are considered as software-based platforms that that provides core functionality shared by software subsystems that connect to the platform and add functionality to it (Tiwana et al., 2010). This IoT technologies' view emphasises features such as interoperability or complementarity for showing these platforms seldom operate in isolation from other technologies, but generally offer functionality for other platforms or complementary technologies (Eisenmann et al., 2006; Eisenmann et al., 2011; Baden-Fuller and Haefliger, 2013; Tiwana, 2014).

At the same time, there is emerging a managerial research field for exploring how IoT is changing the way of interpreting the business

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process management inside and outside of firms (Del Giudice, 2016a). Managerial literature has pointed out that understanding the main mechanisms to create value from IoT technology is still a critical issue. Overall, the benefits of IoT technologies (e.g., RFID, cloud computing, sensors and many more) for companies are several and can refer to both internal operations and final products for end users (Chui et al., 2010). Through a rapid access to data and information about objects, IoT enables highly innovative and efficient services (Monino, 2016). For example, IoT technologies have a great potential in terms of business value through real-world visibility and business processes, allowing the business process decomposition where each steps can be carried out in a distributed manner (Haller et al., 2008). Leminen et al. (2012) showed that through IoT technologies, all devices would function as a web service, and by adapting manufacturing processes, it is possible to customise products during the production phases.

The managerial literature looks at IoT as the source of the next technological and industrial revolution (e.g., Chui et al., 2010; Trappeniers et al., 2013). In fact, Cheng et al. (2017) showed that disruptive technology, such as IoT, possesses the ability of initiating new markets and changes firms' technological competition status. Such revolution brings about profound organisational and managerial implications at both business-to-business (B2B) and business-to-consumer (B2C) levels. Recently various scholars in technology management analysed and illustrated how IoT can affect the business model (henceforth: BM) (Hui, 2014; Turber et al., 2014; Westerlund et al., 2014). In general, BM refers to "how a business creates and delivers value to customers" (Teece, 2010, p. 173). Many different elements shape organisations' BMs by which they gain profits and value: customer needs, value proposition, key processes, key activities, resources and many others (e.g., Johnson et al., 2008; Shafer et al., 2005; Zott et al., 2011).

Research has reported on the potential influences of IoT applications on existing value chains and opportunities for new BMs (e.g., Solima et al., 2016), offering some systematic literature reviews on links of IoT and BM (e.g. Kiel et al., 2016; Wnuk and Murari, 2016). In particular, Dijkman et al. (2015) by presenting a BM framework for IoT applications showed that BMs has ways to create value for IoT technology that are needed.

This article contributes to the extant literature about IoT-oriented BM by investigating how organisations operating in the IoT industry are building their BMs. In particular, the research question of the study is: how do IoT-oriented companies shape the critical factors of their BMs in order to create and capture value.

Using an explorative sequential approach through multiple-case study method, we apply the 'Canvas BM' (henceforth: CBM) framework (Osterwalder and Pigneur, 2010) to explore the BM of three companies operating in the IoT industry: Intel, a well-established firm in which IoT is an emerging area of business; Solaris, an small Italian company specialising in developing and selling IoT-based services and applications; Apio, a micro and emerging Italian start-up company specialising in developing highly customized IoT solutions for B2B markets.

The study seeks to make important contributions to the existing literature. Despite the debate on the consequences of the IoT revolution, such as a change of existing BM, new revenue opportunities from the existing product/services, or new business processes, until recently there has been very little empirical evidence which has tested these claims (e.g., Wnuk and Murari, 2016). Moreover, through the three firms selected, which have different entry modes into the IoT industry (well-established vs independent ventures), we contribute to the ongoing debate in the emerging research stream about incumbent/newcomer behavior with regards to responses to disruptive technology in terms of business model change (e.g., Christensen and Raynor, 2003). Thus, we deepen IoT-oriented BM with a managerial perspective, contributing further to the debate called for in Del Giudice (2016a, 2016b).

The article is organised as follows. Section 2 briefly reviews the main literature about IoT-oriented BM. Section 3 reports the research method used to investigate the three case studies selected, the data analysis, and the results of the study. Finally, Section 4 presents the discussion and conclusions, with particular reference to research and managerial implications, the limitations of the study and directions for future research.

2. Business model innovation in IoT industry

The notion of BM in management literature has emerged and become increasingly popular over the last 20 years (e.g., Chesbrough and Rosenbloom, 2002; Chesbrough, 2007a, 2007b, 2010; Zott et al., 2011; Trimi and Berbegal-Mirabent, 2012; Agrawal and Gugnani, 2014; Carayannis et al., 2015; Batocchio et al., 2016; Solima et al., 2016). Within organisations, BM plays a critical role because it enables entrepreneurs and managers to create and capture value through activities (Zott et al., 2011). As Chesbrough (2007a, b, p. 12) suggested, "Every company has a business model, whether they articulate it or not. At its heart, a business model performs two important functions: value creation and value capture". Value creation and value capture mechanisms have received increasing attention from management scholars who are interested in explaining firms' performance and competitive advantage (see Zott et al., 2011 for a review). Indeed, some literature on the business model tends to concentrate on value creation in networked markets, showing that organisations create value in concert with partners. In this regard, organisations should design and/or innovate their business models taking into account that value creation and value capture occur in a value network that includes suppliers, partners, distribution channels, and coalitions that extend the company's resources (e.g., Hamel, 2000; Zott et al., 2011).

Other scholars, have paid increasing attention to business models in the domains of innovation and technology management (e.g., Chesbrough, 2007a, 2007b, 2010; Chesbrough and Rosenbloom, 2002; Johnson and Suskewicz, 2009). Such a perspective views the BM as a mechanism to connect firm technology and customer needs, thus enabling organisations to exploit the value potential embedded in new technologies and converting it into market outcomes. Still others have focused on the interplay between mode of innovation, and 'open innovation' in particular, and BMs (e.g., Chesbrough, 2007a, 2007b, 2010; Miles et al., 2006; Mitchell and Coles, 2003). Open innovation provides new scenarios for organisations prompting them to look outside their boundaries in order to create value from the external activity of innovators who are sharing information and knowledge (Chesbrough, 2003). From this point of view, BM was recognised as a subject of innovation (well-known as the open business model or business model innovation), whose design and innovation must also take account of collaborative relationships between the company, the market, and communities (Chesbrough, 2007a, 2007b, 2010; Mitchell and Coles, 2003; Zott et al., 2011).

Academic literature has proposed a number of different frameworks for BM design and innovation (e.g., Bereznoy, 2015; Carayannis et al., 2014; Chesbrough, 2010; Osterwalder and Pigneur, 2010; Toro-Jarrin et al., 2016). Among them, the most frequently mentioned framework used for understanding BM's critical factors in creating and capturing value by organisations is the CBM (Osterwalder, 2004; Osterwalder and Pigneur, 2010). Osterwalder (2004), which compared the most mentioned BM frameworks and deduced nine critical elements (known as the business model building blocks) constituting a CBM, such as key partners, key resources, key activities, value proposition, customer segments, customer relationships, channels, costs structure, and revenues streams. Such elements are related to four areas (product; customer interface; infrastructure management; financial aspects) recognised as particularly suitable for understanding how an organization creates, delivers, and captures value (Osterwalder, 2004). Fig. 1 shows the Canvas BM's four pillars and the nine building blocks.

The product refers to 'what' the business offering, in terms of the products and services that are of value to the customers (value proposition). Customer interface refers to 'who' the company's target

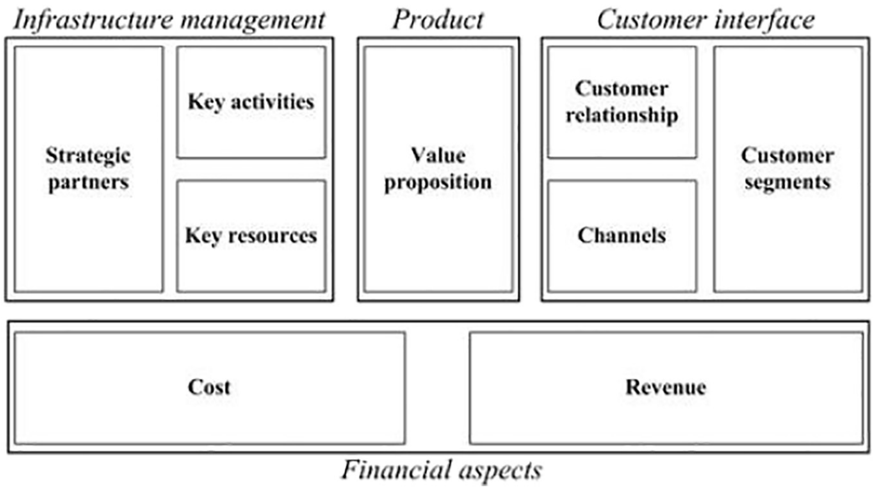


Fig. 1. The Osterwalder business model ontology.

customers are (customer segments), how it delivers them its products and services (channels), and how it builds strong relationships with these consumers (customer relationship). Moreover, infrastructure management focuses on 'how' the company efficiently performs its activities (key activities), with whom (key resources), and what kind of network enterprise it operates within (strategic partners). Finally, financial aspects concern the costs structure (cost) and the revenue model (revenue).

A rising trend in IoT-oriented BM research is the ecosystem perspective, which emphasises the complexity of the business environment for digital technologies, stressing the contextual issues such as interdependencies, interactions and partnerships that evolve in the same innovation ecosystem (Westerlund et al., 2014; Iivari et al., 2016; Oh et al., 2016). From a technical perspective, IoT technology is part of a more complex 'system of systems' (Tiwana, 2014) and it can be considered as a platform-based ecosystem (Tiwana et al., 2010). In many platform-based ecosystems, platform owners recognise the importance of supporting complementary services such as apps development to sustain the collective innovation dynamic. In this context, platforms clearly serve as mechanisms to facilitate access to certain external resources (Isckia, 2009). The platform's architecture and the governance structure selected by the focal firm directly influence the value that can be co-created within the ecosystem (Tiwana et al., 2010). From a managerial perspective, the ecosystem could be defined as a system of synergistic BMs rather than purely as a technology based set (Hui, 2014; Iivari et al., 2016; Westerlund et al., 2014). In this sense, the ecosystem is focused on the connections between the external environment and BM design choices of the firms, in order to support simultaneous value creation and capture (Jansson et al., 2014).

Westerlund et al. (2014) identified four key areas of value in BMs targeted for IoT ecosystems: drivers, nodes, exchanges and extraction dynamics. Value creation and value capture via an IoT ecosystem entails the design of innovative BMs, based on specific mindset and expressly tailored for this context, as reported in Table 1 (Hui, 2014).

The basic principles of such innovative mindset for designing IoT-oriented BM are the new nature of products, which should predict and anticipate user needs, the decline of the "one-and-done" assumption about products, and the wider space for product/service personalisation. Moreover, the IoT mindset stresses the role of the partner structure within BMs for IoT, showing that: "the concept of business model, which is traditionally associated with a single organization's business model, could be replaced with the term 'value design', which is better suited to ecosystems" (Westerlund et al., 2014, p. 11).

3. Research method

This study is based on an explorative sequential approach by using the multiple-case study method. Case study is one of the most used qualitative research methods in technology management and information systems studies (Benbasat et al., 1987; Myers, 1997). It is recommended over other methods to investigate a phenomenon when "research and theory are at their early, formative stages, and sticky, practice based problems where the experiences of the actors are important and the context of action is critical" (Benbasat et al., 1987, p. 369). An explorative sequential exploratory research approach is useful in research areas relatively unexplored, such as IoT-oriented BM where there has been very little empirical evidence (Dijkman et al., 2015).

We collected data from three companies operating in the same industry, but characterised by different size, markets and technological expertise. Sampling was performed by using the extreme or deviant cases technique (also known as Outlier Sampling) that enables the provision of interesting contrasts with other cases, thereby allowing comparability across those cases (Teddlie and Yu, 2007). The firms analysed are the Intel corporation, a large and established company

Table 1
Mindset for the IoT industry.
Source: Adapted from Hui (2014).

		Traditional product mindset	IoT mindset
Value creation	Customer needs	Solve for existing needs and lifestyle in a reactive manner	Address real-time and emergent needs in a predictive manner
	Offering	Standalone product that becomes obsolete over time	Product refreshes through over-the-air updates and has synergy value
	Role of data	Single point data is used for future product requirements	Information convergence creates the experience for current products and enables services
Value capture	Path to profit	Sell the next product or device	Enable recurring revenue
	Control points	Potentially includes commodity advantages, IP ownership, and brand	Adds personalisation and context; network effects between products
	Capability development	Leverage core competencies, existing resources and processes	Understand how other ecosystem partners make money

operating in the B2B and B2C markets (its business unit “Internet of Things Group” received great attention in our analysis), Solair, a small and emerging company operating in the B2B market, and Apio, a micro and emerging start-up company operating in the B2B market. We selected these companies because they provide an ideal institutional setting to analyse such phenomenon, offering the following advantages. First, as noted by Kiel et al. (2016), the investigation of IoT-triggered changes on established manufacturing BMs is of particular interest, thus we selected Intel, a well-established firm in which IoT is an emerging area of the business. Moreover, given the popularity and the high profile of the Intel, it is possible to access to a rich body of secondary data, which allows us an in-depth empirical analysis. Second, the investigation of IoT-triggered changes on two small/micro and emerging companies considered to be dynamic and innovative, such as Solair and Apio, allows us to better understand the BM critical elements of such novel market players in the IoT industry, because they are independent ventures established by individual entrepreneurs. Finally, understanding how organisations operating in the IoT industry and are building and innovating their BMs is necessary to deepen knowledge of the different challenges faced by each firm type as noted in traditional management literature (Shrader and Simon, 1997).

Data were collected from April 2015 to October 2015. In particular, building upon the Yin's (1994) research, primary and secondary data was gathered by using various techniques, such as interviews, document and text analysis, and questionnaires.

With reference to the data collection techniques, primary data was collected by in-depth interviews and questionnaires, while documents and text analysis from the company's websites, and sources available on the Internet were used to gather secondary data.

With reference to data collection moments, we firstly managed to establish a first contact with CEOs, CTOs and/or IoT solution experts of these three companies by using e-mail. Following this approach, a number of preliminary telephone interviews were conducted with the organisation's personnel. Then, we sent the organisations a semi-structured questionnaire via e-mail. The questionnaire was composed of a set of open-ended questions and some Likert response scale questions aimed at gathering data on the company's profiles (e.g., size, IoT products/services, and markets) and on the ‘building blocks’ of CBM. In compliance with Osterwalder and Pigneur's (2010, p. 19–42) research, CBM was composed of 9 building blocks, each consisting of several items -factors- (from 5 to 13), and measured by using a 7-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (7). For instance, an item relating to the newness (or performance, customisation, etc.) factor of value proposition block was, “IoT applications should be offering the following value propositions”. In addition, we also measured the relevance for each CBM building block by using a 7-point Likert scale ranging from ‘strongly disagree’ (1) to ‘strongly agree’ (7). For instance, an item relating to the relevance of CBM building blocks was, “Please indicate to what extent the following building blocks are critical for your business model”. Measurement variables used were derived from existing literature (Osterwalder and Pigneur, 2010; Sprenkels, 2014).

Finally, we also conducted several unstructured phone interviews with IoT solution experts of the three companies at different moments in order to better understand their IoT initiatives and business models (both before and after sending questionnaire).

In the following sections of the study, we firstly explore the case studies of the Intel Corporation, Solair and Apio, in order to provide an overview of the three companies. Then, we analyse the data collected from questionnaires and interviews and present the research results.

3.1. The case of Intel Corporation, Solair and Apio

The Intel Corporation is a multinational company founded by Robert Noyce and Gordon Moore in 1968. It is headquartered in Santa Clara, California. In respect of Silicon Valley's start-up companies, Intel opened its doors with $2.5 million in funding arranged by Arthur Rock, the American financier who coined the term venture capitalist (Hall, 2013). Intel began operating in the semiconductor industry in 1969 by developing computer circuits and then it expand their range of products by offering various popular models of memory devices and microprocessors until 2000, when their market demand decline occurred.

From 2005, the company management decided to refocus the business of core processors and chipsets on platforms (enterprise, digital home, digital health, and mobility). In particular, the company is responding by moving into new markets such as cloud computing, wearables, and IoT (Interbrand, 2014). Intel established a new business unit, named the Internet of Things Group (henceforth: IOTG), that offers platforms for customers to design products for the retail, transportation, industrial, and buildings and home market segments (Intel annual report, 2014). The IOTG's aim is to “create opportunities to transform businesses, people's lives, and the world in countless ways by enabling billions of systems across the globe to share and analyze data over the cloud” (Intel annual report, 2014, p. 1). Intel has also joined the Open Interconnect Consortium (OIC), an industry group whose members are some leading high-tech companies aimed at defining the connectivity requirements and ensuring interoperability of the billions of devices making up the emerging IoT (OIC website).

The IoT architecture of Intel is composed of four categories of interconnected systems: things, gateways, network and cloud, and services-creation and solutions layers (Intel white paper, 2014). It includes “end-to-end reference architectures model and family of products from Intel and its ecosystem that works with third-party solutions to provide a foundation for seamlessly and securely connecting devices, delivering trusted data to the cloud, and delivering value through analytics” (IOTG websites, 2015).

IOTG provides support for various industries, such as automotive, energy, healthcare, industrial, retails and smart buildings. Intel accounted for $2.142 billion in revenues just for IoT products, solutions and services in 2014, much more than the revenues from other corporate divisions.

The Solair corporation (henceforth: Solair) is an IoT software company founded by Tom Davis in 2011. It is headquartered in Casalecchio di Reno, a little village in the Province of Bologna, Italy. With over 18 years of experience in various enterprise software companies, such as think3, PTC e MRO - now IBM - and European and Asian countries, Tom Davis, who is now based in Italy and acts as the Solair CEO, founded the company on the belief that the “benefits of technology should be affordable and beautifully simple, all things that traditional enterprise software are not” (Davis, n.d.). The business idea is helping companies to reach and/or expand their business through IoT applications.

Solair is also an IoT application platform designed in collaboration with the Department of Engineering of the Bologna University for companies - no matter where they are - that want better products and improved competitive services. It offers a complete end-to-end solution that makes it quick and easy to connect and manage devices through a powerful cloud-based service. As Tom Davis stated, “We not only help make products “intelligent” but we create value with the data collected that would not be much use on its own” (ibid).

The IoT architecture of Solair is composed of different hardware, software, and data brokerage infrastructures for data management and devices communication. Based on two pillars within a .NET framework, Microsoft SQL Server, and Microsoft Azure, “the Solair platform acts as a unique environment for both the front-end development and the back-end management of IoT applications” (Solair website, 2015).

Solair has 25 employees and operates exclusively in the IoT sector and the B2B markets of various industries, such as energy, transportation, healthcare, industrial machinery, retail, and smart buildings. The Solair Corporation earned more than 2 million Euros in revenues for IoT services in 2014. This result makes Solair one of the six Italian innovative start-up companies able to exceed such a threshold and the first IoT company to be taken over by Microsoft in April 2016 (IlSole24Ore, 2016).

Apio is an innovative Italian start-up founded by Alex Benfaremo, Matteo Di Sabatino, Alessandro Chelli, and Lorenzo Di Berardino in 2014. It is an IoT company aimed at providing people with ad-hoc solutions for creating connected objects able to interact each other. The company is headquartered in Ancona, Italy. As suggested by the co-founder Alessandro Chelli (CEO and CTO), Apio was created thanks to the close collaboration of four University students who invested in the business project, and developed an integrated platform controlled by users via a Web App with a switch connected to Arduino (Apio website, 2016). This idea was much appreciated by some investors who decided to finance the project, allowing the four young entrepreneurs to realise the first prototype: the Apio Board (which in Latin means, "to connect"). It is a hardware and software platform for creating and managing connected objects. Thanks to the Apio Board, the company was awarded with the prize of "Maker of Merit" at the Rome Market Faire in 2014. Apio has also obtained also other awards. For instance, thanks to a partnership with the start-up Circle Garage, Apio developed "Hiris", an armlet that controls all connected home devices by a simple wrist movement. This application enabled Apio to win the "Smart Home Hackathon" organised by the Energy@Home Association in 2014.

The first version of the Apio Board has been improved in both its hardware and software sides. Nowadays, the IoT solution of Apio is an open source system composed of two parts: Apio OS, the cloud platform, and Apio Mesh, the hardware platform. Apio OS is a content management system enabling people to manage, monitor and index any objects with a network connection (Wi-Fi; 3G; Ethernet; GSM; etc.). On the contrary, Apio Mesh is a platform enabling people to create a modular and flexible personal wireless area network. Generally, the IoT architecture of Apio is composed of a software and data brokerage infrastructures for data management to devices connection. As suggested by Alessandro Chelli, the Apio platform is highly customisable, modular and expandable. In this way, people can easily integrate it with existing solutions and use it for their specific needs (Apio website, 2016).

Apio is a small IoT company with just 7 employees, of which 4 are the co-founders and 3 are collaborators, and it operates in B2B market by offering products and services highly customized for companies.

3.2. Data analysis and results

This section provides a comparative analysis of the IoT-oriented BM of Intel, Solair, and Apio. Building upon the data collected from questionnaires and interviews, we developed the CBM for three IoT companies with particular reference to (a) the most critical building block factors (Fig. 2); (b) the most important CBM building blocks (Fig. 3); (c) the main existing differences among building block factors in their IoT initiatives (see Table 2).

Building block factors were ordered according to the score that they received from the respondents. Among these, those with a score higher than the average score of the building block were considered as more important than other factors, and thus they were included in the grey area. On the contrary, factors with a score lower than the average score of the building block were considered as less important and thus they were reported below the grey area. Fig. 3, highlights the most important CBM building blocks for the three companies.

The most important building blocks were measured by the survey respondents. Finally, Table 2 shows the main existing differences in the Intel, Solair, and Apio CBM building block factors.

With the aim of highlighting the main differences of the building block factors, we created three different ranges (high relevance; medium relevance; low relevance). In particular, the first range (high relevance) was based a set of values from the 5-point to 7-point Likert scale. The second range (medium relevance) refers to the 4-point Likert scale. Finally, the last range (low relevance) consists of a set of values ranking from 1-point to 3-point Likert scale. Then, the main differences among building block factors of three companies' business models were reported in Table 2.

3.2.1. Infrastructure management

The results of data analysis show that the infrastructure management is the most critical CBM area for three companies. As is apparent in Fig. 3 above, key activities (m = 6.67; SD = 0.31) and key resources (m = 6.06; SD = 0.63) are two of the most important CBM building blocks. Key partners (m = 5.58; SD = 0.60) is also critical because it is the fifth out of the nine CBM building blocks.

With reference to the main CBM building block factors differences, the results presented in Table 2 confirm that Solair and Apio pay more attention than Intel to service partners (IOTG = low; Solair = high; Apio = high) in key partners. On the contrary, physical resources (IOTG = high; Solair = high; Apio = low) and intellectual property (IOTG = high; Solair = high; Apio = low) are more critical resources in IOTG's and Solair's BMs.

3.2.2. Product

Our results also show that the product is the second most critical CBM area for the three companies. In particular, as Figs. 2 and 3 indicate, value proposition (m = 6.54; SD = 0.42) is the second most important CBM building block and many of these factors were recognised as critical. With reference to the CBM value propositions factors, Table 2 shows that a relevant difference concerns the brand/status, which is recognised as very critical for IOTG (IOTG = high; Solair = medium; Apio = low).

3.2.3. Customer interface

Data analysis results also confirm that although the customer interface is a less critical CBM area than other ones, even though it is characterised by a large number of existing communalities and differences among building block factors. In particular, as Fig. 3 shows, customer relationships (m = 5.33; SD = 1.33) and customer segments (m = 5.40; SD = 1.11) are the most important building blocks of this area, while channels (m = 4.00; SD = 1.4) have lower values. In addition, Fig. 2 shows that the most critical building block factors are personal assistance and dedicated personal assistance in customer relationships, niche and segmented markets in customer segments, and sales force and wholesaler in channels.

With reference to customer segments, Table 2 shows that the Solair corporation is more oriented towards the mass market than Intel IOTG and Apio (IOTG = low; Solair = high; Apio = medium).

With reference to other channels, web sales' factor is used more by Intel IOTG and Solair (IOTG = high; Solair = high; Apio = low). Moreover, Intel IOTG is also more inclined to reach customers by using its own (IOTG = high; Solair = low; Apio = low) and partner stores (IOTG = high; Solair = low; Apio = low) channels.

Some relevant differences also existed in customer relationship management. In particular, Intel IOTG and Solair are more inclined than Apio to use self-service's (IOTG = high; Solair = high; Apio = low), automated service's (IOTG = high; Solair = low; Apio = high), communities (IOTG = high; Solair = medium; Apio = low) and co-creation (IOTG = high; Solair = high; Apio = low) factors.

3.2.4. Financial aspects

Data analysis also shows that the financial aspects are not a very crucial area, although it is characterised by a large number of most critical building block factors. For example, Fig. 3 indicates that three companies pay more attention to cost structure (m = 5.67; SD = 0.44) than revenue streams (m = 5.11; SD = 0.89) building block. Instead, the main factor differences are in the building block revenue streams where lending/renting/leasing (IOTG = high; Solair = low; Apio = high) are more critical in the IOTG and Apio business models than in Solair's.

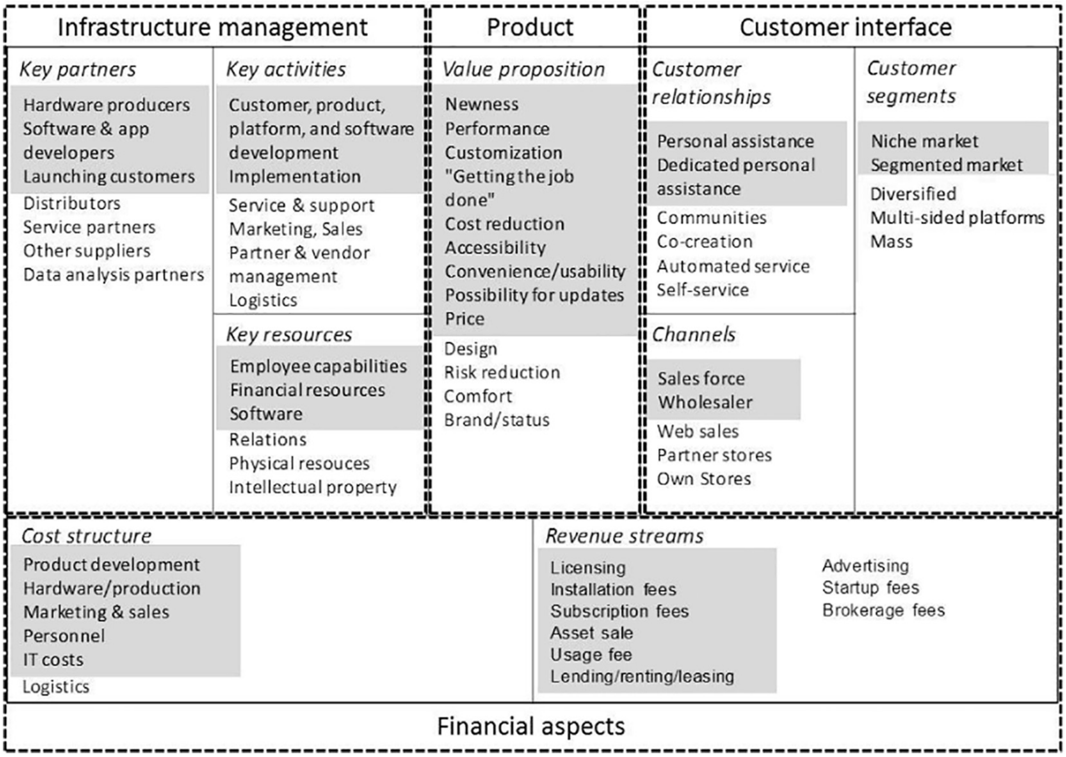


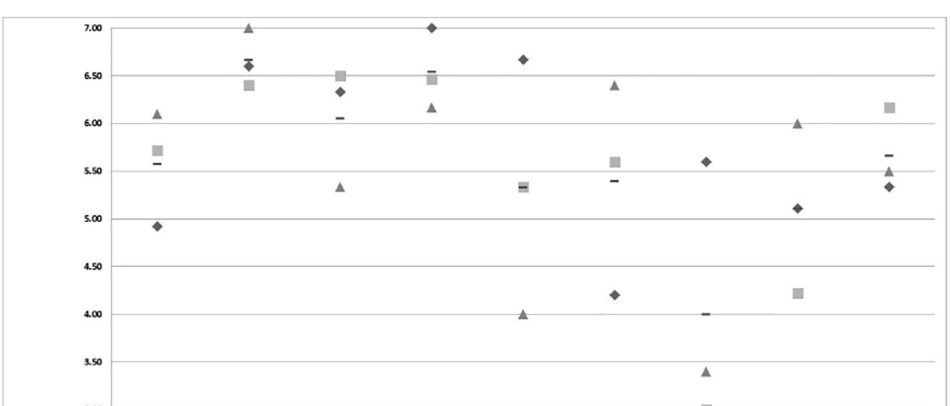
Fig. 2. The CBM and the most critical building block factors.

4. Discussion and conclusions

The findings showed that infrastructure management and product are the most important CBM areas, while customer interface and financial aspects were recognised as less critical. More specifically, they also indicated that key activities and resources, and value proposition were commonly recognised as the most important building blocks for their BM, while significant differences emerged within other building blocks and factors.

With reference to infrastructure management area, our results suggest that activities and resources are recognised as the most important building blocks. Customer, product, platform and software development, as well as the implementation, were commonly recognised as the main critical activities needed to create and deliver value for companies. Such activity configuration looks mainly at in-house resources and human resources in particular for value creation, rather than out-house resources from partner networks. However, Apio is more inclined to use networks, rather than in-house resources, for acquiring the knowledge and competencies needed for completing activities. Such result could be justified by the fact that Apio is a micro and emerging start-up company operating only in B2B market.

Young and small firms normally endure a scarcity of financial, human, and tangible resources that results in a reduced set of competitive options (Knight and Cavusgil, 2004). Older firms typically rely on their internal resources to compete more intensively in the market. Moreover, larger and older companies, already holding a large set of technological capabilities and for which IoT is just an emerging area of business, tend to focus extensively for value creation and value capture on their key resources, much more than is the case with small specialised companies. For instance, Intel can be considered a "multi-technology firm" that tries to exploit new opportunities emerging from more technological fields through a process of "creative accumulation"



	Key partners	Key activities	Key resources	Value propositions	Customer relationships	Customer segments	Channels	Revenue streams	Cost structure
	Infrastructure management			Procuct	Customer interface			Financial aspects	
◆Intel corporation	4.92	6.60	6.33	7.00	6.67	4.20	5.60	5.11	5.33
■Solair Srl	5.72	6.40	6.50	6.46	5.33	5.60	3.00	4.22	6.17
▲Apio srl	6.10	7.00	5.33	6.17	4.00	6.40	3.40	6.00	5.50
−mean	5.58	6.67	6.06	6.54	5.33	5.40	4.00	5.11	5.67

Fig. 3. The most important CBM building blocks.

Table 2
Main differences between the IOTG, Solair and Apio CBMs.

CBM areas	CBM building blocks	Relevance		
Infrastructure management	***Key partners***	**High**	**Medium**	**Low**
	Service partners	Solair-Apio		Intel
	Key resources	**High**	**Medium**	**Low**
	Physical resources	Intel-Solair		Apio
	Intellectual property	Intel-Solair		Apio
Product	***Value propositions***	**High**	**Medium**	**Low**
	Brand/status	Intel	Solair	Apio
Customer interface	***Customer relationships***	**High**	**Medium**	**Low**
	Self-service	Intel-Solair		Apio
	Automated service	Intel	Solair	Apio
	Communities	Intel-Solair		Apio
	Co-creation	Intel-Solair		Apio
	Customer segments	**High**	**Medium**	**Low**
	Mass	Solair	Apio	Intel
	Channels	**High**	**Medium**	**Low**
	Web sales	Intel-Solair		Apio
	Own Stores	Intel		Solair-Apio
	Partner stores	Intel		Solair-Apio
Financial aspects	***Revenue streams***	**High**	**Medium**	**Low**
	Lending/renting/leasing	Intel-Apio		Solair

Negligible value differences are not displayed.
High: from 5-point to 7-point Likert scale. Medium: 4-point Likert scale. Low: from 1-point to 3-point Likert scale.

and "competence enhancement" (Granstrand et al., 1997; Patel and Pavitt, 1997). These companies create corporate competencies in new fields through a dynamic process of learning, combining external technology acquisition and internal technological competencies (Granstrand et al., 1997), which results in "multi-field competencies" (Patel and Pavitt, 1997).

With reference to product area, our results have also shown that value proposition is the most important CBM's building block after key activities. Moreover, findings confirmed that newness, performance, and customisation were recognised as common critical factors for creating new and more efficient opportunities for value creation, even before the price and cost reduction. Several studies have already shown that the value proposition has a central role in IoT-oriented BMs (see Kiel et al., 2016 for a review). For instance, Hwang and Christensen (2008) pointed that with the advent of disruptive innovations, the value proposition is critical for a successful BM. IoT gives rise to new ways to create/capture/deliver value, through customised and individualised value propositions, as well as smart products and services. In line with such research, our results also considered innovation through new, complementary or customised offerings, as a way to value creation for customers by a range of capabilities that underpin the proposed value (Osterwalder and Pigneur, 2002).

Furthermore, consistent with the previous research, which has focused on how value and competencies -or capabilities- are interconnected (e.g., Carayannis et al., 2016; Del Giudice et al., 2013; Osterwalder and Pigneur, 2002), our findings also lead us to believe that there are links between infrastructure management and product areas that could be explained by the different ways the three companies create and provide value for customers. Usually, smaller and younger companies are mainly focused on a specific technological area (such as IoT) and these firms put more emphasis on developing partnerships, rather than building internal capabilities (Hui, 2014). For young technology-based firms, partnerships are seen as the main vehicle to gain access to resources or knowledge (Del Giudice et al., 2013; Yli-Renko et al., 2001). In fact, young firms are resource constrained (McDougall et al., 1994) and depend upon knowledge rejuvenation to survive and grow (Autio et al., 2000). Solair and Apio are young venture firms, defined as companies six years old or younger (Brush, 1995), and the accumulation of knowledge through collaborations constitutes a driving force in their development and growth (Carayannis et al., 2016). Such orientation towards growing partnerships might lead, for instance, to value capture processes based on the continuous appropriation and exploitation of knowledge, information, resources, and capabilities from the ecosystem partners.

4.1. Research and managerial implications

This research has contributed to the managerial literature on IoT-oriented BMs, and it also advances the theoretical understanding of critical factors for value creation processes in IoT industry organisations (e.g., Del Giudice, 2016a, 2016b). Building upon the CBM's framework, the study has examined the BM architecture in order to explore what factors are more critical for value creation and capture. The findings indicate that firstly, for organisations operating in the IoT industry, value proposition and key activities are the most important building blocks in BMs. Moreover, in the IoT industry, it is possible to distinguish BMs and the way these models generate and capture value in relation to the type of firm (well-established vs independent ventures). In fact, the findings have shown that the main differences concern the infrastructure management and product areas, with particular reference to key activities and resources, and value proposition that emerge as the most critical building blocks in creating and capturing value. This issue has gained increasing importance in management literature in terms of incumbent/newcomer behavior responses to disruptive technology, particularly in terms of BM change (e.g., Christensen and Raynor, 2003; Del Giudice, 2016a).

From a practical point of view, the research contributes to clarifying the critical factors in successful BM of organisations operating in the IoT industry, supporting managers on how to construct IoT-oriented BMs. In this way, our findings can enable managers to focus on value opportunities in the emerging IoT industry by understanding key challenges of BM design. Moreover, our study advises that practitioners of IoT industry, mainly within of smaller and younger companies, need to look externally when accessing the critical resources needed for creating and capturing business value, especially if they do not have internal competencies. In this regards, IoT-oriented organisations can capture value based on the continuous appropriation and exploitation of knowledge, resources, capabilities available from the creation and maintenance of partnerships. On the contrary, larger and older firms, having a broader range of technological competencies that support extensive diversification processes, are able to exploit more intra-group synergies and complementarities for creating value from the IoT revolution.

4.2. Limitations and opportunities for future research

This study has a number of limitations that should be addressed. Firstly, the research was based on a case study method to explore IoT-oriented BMs. Although the case study research method is considered particularly useful for explorative analysis in managerial literature, it can make no claim to being typical because the sample was small and idiosyncratic. Thus, the findings are not generalizable in the conventional sense to the IoT industry and to other industries, because it is difficult to establish the probability that the data findings are representative of a larger population. However, this is a common limitation of the qualitative studies based on such research technique, rather than a specific weakness of this paper. Moreover, the use of questionnaire for data collection enabled us to reduce the predominantly non-numerical outcome of data that is usual in qualitative research. Furthermore, another limitation is that some variables, such as human, technological and economic resources, were not measured, although they were later recognised as important. Measuring such resources would have enabled us to get a clearer and deeper understanding of BM's critical factors in creating and capturing value by organisations.

Further research should focus on a deeper exploration of the building blocks and related critical factors, as well as the interplay among them, which enable IoT-oriented organisations to create and capture value. In order to better understand the underlying dynamics of IoT-oriented organisations business models, further research should also deepen the contribution of knowledge, resources and competences exploration and then exploitation of the processes of value creation and capture.

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