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Creating and Capturing Value from Big Data: A Multiple-Case Study Analysis of Provider Companies

Abstract

Big Data has emerged recently as a new digital paradigm, one that companies adopts in order to both transform existing business models and nurture their innovation activity. The peculiarities of Big Data applications span different fields such as customer need identification, risk management and decision-making, data-driven knowledge, product and service design, quality management, and opportunity recognition and creation. However, while these have resulted in the emergence of a rich research domain focusing on the managerial and practical implications typically addressed from the user perspective, there is still a lack of complete understanding of how companies that provide Big Data solutions can create and capture value from them. This paper explores the question of how provider companies create and capture value from Big Data, drawing on a multiple-case study analysis of provider companies that offer solutions and services based on Big Data. The results illustrate a theoretical framework on value creation and capture by relying on Big Data and identify two main innovation service strategies based on Big Data used by provider companies. In addition, this paper provides valuable insights as to how the network of involved stakeholders influences the design and implementation of the innovation service strategy by the provider companies.

Keywords: big data, digital technologies, digital innovation, value creation, value capture, business model, service innovation, open innovation.

1. Introduction

This paper addresses the research question of how provider companies create and capture value from Big Data. Big Data has emerged recently as a new digital paradigm as companies have become overwhelmed with a flood of data that they have collected over the years through their information systems (Hopkins and Brynjolfsson, 2010; White, 2012; Johanson et al., 2014). In basic terms, Big Data refers to datasets that are large in volume, diverse in data sources and types, and created quickly, resulting in greater challenges to harvest, manage, and process them through traditional systems and capabilities (Chae, 2015; McAfee and Brynjolfsson, 2012; Chandy et al., 2017). Companies need tools to gain advantage from this amount of information (Erevelles et al., 2016; Dayal et al., 2014, Johanson et al., 2014; Storey and Song, 2017).

There is a significant difference between Big Data and traditional data, namely the shift from structured transactional data to unstructured behavioural data (Erevelles et al., 2016; Hird et al.,

2016). Indeed, individual consumers have become generators of both traditional data as well as more contemporary, unstructured data (Erevelles et al., 2016; Hopkins and Brynjolfsson, 2010).

To deal with Big Data, companies need to have the ability to access, diagnose, and integrate the necessary information gathered through various data sources and in various knowledge forms in order to identify and satisfy the existing and emerging needs of their target markets (Chen et al., 2012). This practice is known as Big Data management (Du et al., 2016; Xiaofeng and Xiang, 2013) and is more relevant today as companies are required to manage the transition towards digital transformation (Dodgson et al., 2006; Hopkins and Brynjolfsson, 2010, Hess et al., 2016), and as they increasingly rely on Big Data to support their business activities (O'Donovan et al., 2015; Wessel, 2016). Moreover, companies are using Big Data to design and offer better-tailored products, based on the data of their customers. Designers and engineers are now empowered by analytic tools that can identify relationships between users' purchasing behaviours and products' features, resulting in a more efficient and effective concept generation. The successful move towards a data-driven enterprise requires companies to apply effort in five distinctive areas that simultaneously embrace the use of Big Data: leadership, talent management, technology, decision-making, and company culture (McAfee and Brynjolfsson, 2012).

The above studies, though rich in terms of managerial implications, deal mainly with the user perspective and neglect the role that Big Data plays for provider companies. This issue is particularly timely because (i) the Big Data industry is still in its developmental stages, (ii) in the short term, it is believed that companies will rely on professional service providers to enable their applications, and (iii) professional service providers represent, today, the largest Big Data market segment worldwide (Finos, 2016a, 2016b).

From a theoretical perspective, a few over-arching directions are missing from the research domain of value creation and capture dealing with the management of Big Data in companies. On the one hand, Yoo (2010) and Yoo et al. (2010) highlight the lack of strategic frameworks that explain how value and competitive advantage are created in companies that rely on digital technologies, and mostly on Big Data (Troilo et al., 2017). On the other hand, existing research does not explain how Big Data is used in order to enable industrial innovation activities (Jin et al., 2016; Provost and Fawcett, 2013; Menor et al., 2002; Barrett et al., 2015; Witell et al., 2016), despite some interesting and recent contributions (see, for example, Urbinati et al., 2018; Teece, 2017).

The issue of how companies create and capture value from Big Data in their innovation activities is of huge interest to providers of services and solutions based on Big Data. In addition, the speed with which digital technologies develop and proliferate has left behind academic research in these fields (Svahn et al., 2017; Nambisan et al., 2017; Appio et al., 2018). This is even more so for Big Data,

one of the most analysed digital technologies in the literature (McAfee and Brynjolfsson, 2012; Mayer-Schönberger and Cukier, 2013), as it has been widely exploited in order to create product, process and business model innovations (Manyika et al., 2011; Jin et al., 2016; Erevelles et al., 2016).

The remainder of the paper is organized as follows. Section 2.1 provides a review of the existing literature on the role of Big Data for companies with regard to value creation and capture, whereas Section 2.2 deepens the conceptualisation of the research domain with regard to value creation and capture, as it is used as a theoretical guide along the whole paper. Section 3 provides details about the methodology and is followed by Section 4 that summarises the results of the multiple case study analysis. Section 5 then discusses the findings and suggests some relevant implications for theory and practice. Finally, Section 6 draws the conclusions, suggesting avenues for further research.

2. Background

2.1 The role of Big Data in a context of digital transformation

The aim of this section is to summarise the most relevant issues and challenges on the use of Big Data, and related data mining techniques, business intelligence tools, and advanced analytics in companies. Several scientific contributions shed light on the pivotal role that Big Data and digital transformation play for companies (see, e.g., Rindfleisch et al., 2017; Afshari and Peng, 2015; Erevelles et al., 2016; George et al., 2014, Hess et al., 2016). There now follows an overview of the most recent academic literature on the role of Big Data in companies with regard to value creation and capture in the context of digital transformation.

Customer needs identification

As proposed by several authors (see, e.g., Stockstrom et al., 2016; Arvanitis and Loukis, 2016), Big Data and advanced analytics (e.g., sentiment analysis) may reveal which users are best prepared to report on the origins of emerging trends and their implications for new designs. Big Data and related analytics can be also applied to validate the insights that companies gain from interviewing users (Stockstrom et al., 2016). For example, Su et al. (2016) explain how sentiment analysis is used to enable business innovation by identifying potential idea launchers, although the authors suggest that information overload could be a barrier for companies, operating in an open innovation context (see, e.g., Dodgson et al., 2006). Hopkins and Brynjolfsson (2010) suggest that a sense and respond strategy enabled by experiments can help companies learn what their customers' needs are and, hence, redesign their value proposition. Tresp et al. (2016) observe how major players in the pharma industry create value by discovering new drugs thanks to Big Data, as well as understand drug efficacy, and analytics can help in the identification of better and safer therapies, patient recruitment, improved

clinical trial designs, and personalised medicine (Groves et al., 2016; Raghupathi and Raghupathi, 2014). In addition, Big Data enables designers to obtain customer reviews, monitor trends of consumer interests and make comparisons with similar products, which allows them to improve their new products and respond to consumers accordingly (Jin et al., 2016; Lee et al., 2012). Higher customer satisfaction is achieved by association rules extracted using genetic algorithms that help designers understand more precisely what customers want and further change the product specifications (Yu and Wang, 2010; Liao et al., 2009a). Literature shows that realising customer's unspoken needs and requirements, by discovering patterns in their behaviors, can also help managers to design higher quality services (Markham et al., 2015; Karimi-Majd and Mahootchi, 2015), and academic stream suggests that customer requirements from an online customer centre could be transformed into new product concepts (Park and Lee, 2011; Liao et al., 2008, 2009b).

Risk management and decision-making

In today's business environment companies supported by business intelligence systems can apply the knowledge maturity models for effective decision-making in new value propositions (Yang, 2015; Maine et al., 2015; Ricondo et al., 2009). In particular, Yang (2015) suggests that Big Data aims at developing effective means in order to reduce uncertainty in comprehensive and real-time decision-making, whereas Maine et al. (2015) point to the need of enabling technologies for entrepreneurial decision-making in opportunity creation and recognition. Ricondo, et al. (2009) tackle risk management and decision-making in new product development (NPD). Specifically, their work shows how the implementation of analytics can increase product success by considering technical, market, commercial and organisational aspects. In addition, Relich and Bzdyra (2015) suggest using data mining, data selection, and pre-processing, as well as retrieving patterns for forecasting the success of a new product. However, from their work it emerges that difficulties in collecting enough data of past similar NPD projects can deter the methodology.

Data-driven knowledge

Academic discussions concerning dynamic databases, which serve customers as a platform where they look for assistance, began more than a decade ago (Menon et al., 2005; Lee et al., 2015; Johanson et al., 2014). The knowledge collected in such databases helps companies understand better the problems faced by customers, thus improving their processes (Johanson et al., 2014). In their study, Menon et al. (2005) investigate a problem response system that tracks mainly design-related problems in the different stages of the product development cycle. Lee et al. (2015) and Larose (2014) study how analytics discover hidden relationships between product features and customer purchasing behaviour related to preferences and dislikes for particular aspects of a product. The advantages of

using data mining in fast and aggressive new product development processes can be seen in the vast amount of existing knowledge stored in knowledge bases, which can be quickly and concisely retrieved using data mining techniques (Han et al., 2011). Generation of knowledge due to the management of data can be found also in the automotive industry (Johanson et al., 2014; Schulze et al., 2015), where connected vehicles generate data that helps establish preventive maintenance services, active safety and support of autonomous vehicles. However, a potential barrier companies could face is the scalability issue due to the high number of vehicles from which data is gathered (Johanson et al., 2014).

Product and service design

Today, companies focus on efficiency and cost-cutting strategies (Hausman and Wesley, 2014). For example, those involving customer requirements in the design process of new products and services, and making a quick analysis and decision, become an important issue for companies (Lin et al., 2013). To face this issue, the company is asked to enhance an efficient collaboration design. According to Lin et al. (2013), in collaborative design, in order to help reducing the loss in sales of a developed new product that may be incurred from communication obstacles between designers and customers, an efficient design assistance system is required in the design process. New operational and strategic issues related to the role of Big Data in product and service design are also documented by Bharadway and Noble (2016). In addition, Liao and Wen (2009) suggest how the contribution of customers' knowledge can differentiate the offering, thus increase profits. For example, an enabler for collaborative design could be crowd-sourcing (Chang and Chen, 2014). In their work, the authors discuss how to improve the efficiency of crowd-sourcing by identifying promising design candidates for further development, based on Big Data. Another enabler for collaborative design, suggested by Yan et al. (2009), is a data-mining approach for product conceptualisation in a web-based architecture. Byrum et al. (2016) argue how business intelligence and advanced analytics enable identification of a cost-effective soybean-variety development design in the agricultural industry. In another study, Afshari and Peng (2015) argue that if a company could identify future changes of a product in the design stage, a proper decision can be made to minimise cost and environmental impacts of the product.

Quality management

With regard to manufacturing, Mikawa (2015) suggests that data generated in plants can be integrated in a company's data centre and used as Big Data, regardless of its origin. In addition, the author explains that quality management can be facilitated thanks to the quality records collected from the manufacturing processes. The management and control of processes, however, can take into account

an entirely new set of factors such as news feeds, tweets and sensor data (Mikawa, 2015). In addition, process execution can be facilitated by identifying patterns in richer log data (vom Brocke et al., 2014), and the study of Mies et al. (2016) reveals how data is gained within the product lifecycle and examined to cut costs, decrease lead times, and increase efficiency.

Opportunity recognition and creation

Recognition and creation of opportunities for innovation activities and development of new business models are also central in the context of digital transformation, and an important area of investigation in connection with value creation and capture through the exploitation of emerging technologies (Garnsey and Hang, 2015; Maine et al., 2015). Indeed, several studies have highlighted how emerging technologies, such as Big Data, can support innovation activities and business models in order to discover or create opportunities for disruptive and discontinuous innovations (Wan et al., 2015), implying new competences, new capabilities and co-creation initiatives throughout all the phases of innovation processes within a set of sectors (Urbinati et al., 2018), or a re-engineering of them (Best, 2015). However, companies are required to pay attention to the collection and operationalisation of data constructs in order to identify the effective actions and strategies to pursue with the aim of recognizing and creating new business opportunities (Hang et al., 2015).

Following on from these premises, Table 1 summarises the objectives and benefits, as well as the barriers and challenges, in different domains of analysis as they arise from the review of the extant research on the role of Big Data in companies with regard to value creation and capture.

Table 1: The role of Big Data in a context of digital transformation.

Domain of analysis	**Objective and benefits**	**Barriers and problems**	**References**
Customer need identification	Identifying the origins of emerging trends and their implication for new value propositions, (i.e., product and service design). Improve current functionalities and attributes of existing products and services. Turning customer complaints and requirements into new products and services concepts.	Efficient discovery of changes in trends due to information overload. Lack of critical thinking capabilities to support decision-making, which is based on the data collected. Furthermore, it must be ensured the right data is gathered. Customer complaints alone cannot generate a new products and service concept.	Stockstrom et al., 2016 Jin et al., 2016 Arvanitis and Loukis, 2016 Tresp et al., 2016 Groves et al., 2016 Markham et al., 2015 Karimi-Majd and Mahootchi, 2015 Raghupathi and Raghupathi, 2014 Spiess et al., 2014 Lee et al., 2012 Park and Lee, 2011 Yu and Wang, 2010

			Hopkins and Brynjolfsson, 2010 Liao et al., 2008, 2009a, 2009b
Risk management and decision-making	Risk management, reduction of uncertainty in real-time decision-making, and forecast the success of development of new value propositions.	Reliability of data.	Yang, 2015 Maine et al., 2015 Relich and Bzdyra, 2015 Ricondo et al., 2009
Data-driven knowledge	Knowledge enabled by the analysis of databases (data-driven knowledge) allows a better understanding of problems faced by the customers.	Information overload, scalability.	Johanson et al., 2014 Lee et al., 2015 Schulze et al., 2015 Hashem et al., 2015 Larose, 2014 Han et al., 2011 Menon et al., 2005
Product and service design	Cost effectiveness gained in product design through business intelligence and advanced analytics. Collaborative design and crowd-sourcing in new product development (NPD).	Reliability of data. Communication obstacles between customers and designers.	Byrum et al., 2016 Afshari and Peng, 2015 Lin et al., 2013 Bharadway and Noble (2016) Chang and Chen, 2014 Yan et al., 2009 Liao and Wen, 2009
Quality management	Quality management of processes and of their outcomes.	Information overload.	Mies et al., 2016 Mikawa, 2015 vom Brocke et al., 2014
Opportunity recognition and creation	Recognition and creation of opportunities for innovation activities and development of new business models.	Collection and operationalisation of data constructs for the identification of effective actions and strategies.	Garnsey and Hang, 2015 Maine et al., 2015 Wan et al., 2015 Best, 2015 Urbinati et al., 2018 Hang et al., 2015

From the analysis of the theoretical background, there emerges a picture of how and why Big Data allows companies to create and capture value in different domains of analysis. Although rich in terms of managerial and practical implications, this literature deals mainly with the user perspective, neglecting the role that Big Data plays for provider companies. From a theoretical point of view, there is still a lack of strategic frameworks that can properly address how value and competitive advantage are created in companies offering services and solutions using emerging technologies (Yoo, 2010; Yoo et al., 2010) and, in particular, Big Data (Troilo et al., 2017). Some academics provide anecdotal evidence on the role that Big Data play for provider companies (Du et al., 2016; Erevelles et al., 2016; Groves et al., 2016; George et al., 2014), but this issue still remains under-researched and the speed

at which Big Data penetrates companies calls for further theoretical and empirical investigation in management and innovation research (Del Vecchio et al., 2016). And though several emerging studies emphasise the role of Big Data in the creation and capture of value, their focus is more on the role of Big Data as an enabling factor for a dual-side-market or is still on the user-side perspective (see, e.g., Trabucchi et al., 2017).

Therefore, the paper analyses and provides a structured direction on how provider companies support their customers when exploiting Big Data to co-create product, process, or business model innovations, and capture value from them.

2.2 Value creation and value capture

What is value?

Value may take the form of "perceived use" value or "exchange" value (Bowman and Ambrosini, 2000; Pagani, 2013; Sharma et al., 2001). Perceived use value is subjective and is defined by customers, based on their perceptions of the usefulness of the product on offer. Customers' perceptions of the value of a good are based on their beliefs about the goods, their needs, unique experiences, wants, wishes and expectations. Exchange value is realised when the product is sold. It is the amount paid by the buyer to the producer for the perceived use value (Bowman and Ambrosini, 2000).

Value creation and capture

Value creation is the contribution to the utility of the final good or service to end users (Pagani, 2013). It coincides with perceived use value and is created when companies produce products, though this does not mean that perceived use value necessarily creates exchange value (Bowman and Ambrosini, 2000). The purpose of any business enterprise is value creation or value addition for all its stakeholders and it is possible to say that, for a company, value is created anytime an action is taken where the benefits exceed the costs, or anytime an action is avoided where the costs exceed the benefits (Sharma, et al., 2001; Porter, 1985). Bowman and Ambrosini (2000) argue that new perceived use value is created by the actions of organisational members and that each stage of the value chain contributes a proportion of the overall value created, whereas exchange value is realised at the time of sale. According to Porter (1985), new value can be created when companies develop or invent new ways of doing things using new methods and new technologies. Other scholars suggest that new value is created when an incremental innovation appears, improving upon something that already exists or reconfiguring an existing form or technology in order to serve some other purposes (Pagani, 2013). In a context of digital transformation, where information becomes more widely

available, companies are asked to expand their domains of competence by creating new digitally enabled products and services (Pigni et al., 2016; Eaton et al., 2015; Tambe, 2014; Parmar et al., 2014).

An isolating mechanism is any knowledge, physical, or legal barrier that may prevent replication of the value-creating new task, product, or service by a competitor. In essence, isolating mechanisms limit value slippage, thus enabling the sources of value creation to capture most of the value created (Lepak et al., 2007). While Lepak et al. (2007) argue that the existence of an isolating mechanism raises the potential bargaining power of the creator of value to retain this value, other scholars highlight two main mechanisms defining a company's ability to capture value from innovation, i.e., uniqueness and complementary assets (Barney, 1991; Teece, 1986, Rothaermel, 2001; Tripsas, 1997; Arora and Ceccagnoli, 2006). However, in the context of digital transformation, due to the ubiquitous and social nature of digital technologies, digitally enabled innovations require (almost) no complementary assets in order to diffuse within the market, such as: a brand name, manufacturing capacity, access to distribution channels, marketing investments (Downes and Nunes, 2013). This requires a transition from "Creating Value + Capturing Value As Long As Possible" to "Creating Value + Capturing Value for a Short Time + Create Value by Innovating Again".

3. Methodology

A multiple-case study methodology was used in this paper. Case study research allows investigation of phenomena in their general complexity and within their natural environment (Yin, 2003). Such a feature makes the methodology effective for a paper on an unexplored topic where the main aim is to answer to ''how'' research questions (Yin, 2003, Siggelkow, 2007). Multiple-case study methodology is regarded as more robust than single case study, since cross-case comparisons allow a more vigorous explanation building process and understanding of contextual variables' effects (Chiesa, et al., 2007). These properties of the multiple-case study methodology made it particularly appropriate for the aim of the present paper.

3.1. Sample of companies

The selection process of provider companies targeted ones that are well-respected, highly innovative, and that have successfully maintained their competitive advantage in the digital era. Information concerning such companies was collected after several meetings with project managers and researchers of the Big Data Analytics and Business Intelligence Group of the Digital Innovation Observatories, Politecnico di Milano. In the end, two Big Data reports were provided by the experts, on which the final selection of companies is grounded. The first report (Finos, 2016a) is a detailed

research on the Big Data industry, while the second report (Finos, 2016b) is a Big Data market share forecast.

After an analysis of the secondary sources provided by the experts, it was agreed that companies in the Big Data industry can be placed into one of four distinctive categories:

1. Traditional database and analytic services and software companies that provide databases, data management tools, core Big Data software (Hadoop, Spark, Streaming), and applications, analytics and related tools (such as visualisation and query);
2. Big Data professional service provider companies that help customers realise business value by implementing Big Data solutions (such as insight-driven operations, data warehouse optimization, cyber security, business data lake);
3. Traditional infrastructure hardware provider companies which develop tools and platforms that support big data applications with different workloads and data types. Additionally, companies from this segment create a converged infrastructure which packages their offering to specific categories of customers, including Big Data, private Cloud and Internet of Things (IoT);
4. Rapidly growing pure Big Data software companies that offer solutions to bridge the many gaps in the current Big Data software ecosystem. Often these are privately, or venture capital funded.

After much discussion with the same experts mentioned above, in order to find criteria for choosing the appropriate category, the selection fell into the second cluster, i.e., the professional service provider companies of Big Data solutions, as being most suitable for the analysis and for the scope of the present paper, due to a set of reasons that are given below.

First, the Big Data industry is still in developmental stages. There are many less-than-optimal solutions forming an uncertain environment for providers and end users. For example, to deliver Big Data solutions that provide significant business impact, end-users need to count on specialised tools from specialised providers, employees with diverse knowledge of tool and analytic competence, and vendor partners that do not always share each other's aims.

Second, in the short term, it was thought that companies will be relying on professional service providers to enable their applications, though the experts predicted that the Big Data software ecosystem will start to solidify in the next decade, thus enabling end-users to overcome and solve more Big Data-related business issues themselves.

Third, professional service providers represent the biggest segment of the Big Data market today, with a share of around 40%, which gives it a value of around $ 3,680 billion on a total of $ 9,115 billion, and it is expected to remain quite stable until 2021 (Finos, 2016b).

In particular, five types of sub-categories compose the market of professional service providers, where different companies operate:

1. 1st tier general Information Technologies (IT) services providers with the widest scope and scale, as well as profound vertical expertise where Big Data can be implemented;
2. Big Data specialists;
3. 2nd tier IT services providers with less breadth compared to the above mentioned 1st tier;
4. Specialists in adjacent domains that are moving towards Big Data;
5. Small professional services companies.

Based on these preliminary analyses, an initial sample of 11 companies was identified. However, companies without Italian subsidiaries (which account for an 8% of the market share) were excluded for convinient sampling criteria (Etikan et al., 2016) to give a final sample of 9 companies. Accordingly, Table 2 provides the list of the final sample, with a brief description of the companies, their turnover, R&D expenses and market share.

Given that data on turnover and R&D expenses were provided as aggregates in the 2016 consolidated financial statements, key data on this initial sample of provider companies are provided at a global level.

Table 2: Sample of companies.

Company	**Brief Profile**	**Turnover**	**R&D expenses**	**Market share**
Company A	The company provides information technology (IT) products and services worldwide. Its Cognitive Solutions segment includes a cognitive computing platform that interacts in natural language, processes Big Data, and learns from interactions with people and computers. The company's Cognitive Solutions segment also offers data and analytic solutions, including analytics and data management platforms, cloud data services, enterprise social software, talent management solutions, and solutions tailored by industry; and transaction processing software that runs mission-critical systems in banking, airlines, and retail industries. The company's Global Business Services segment offers business-consulting services; delivers system integration, application management, maintenance, and support services for packaged software applications; and business process outsourcing services.	79.9 bn	5.7 bn	13%
Company B	The company provides consulting, technology, and outsourcing services worldwide. It offers modernising integrated data warehouses and information management to enable movement, management and consumption of large volumes of fast moving	34.7 bn	0.6 bn	5%

	structured and unstructured data. The company implements data security measures to protect unauthorised access, viewing, modifications or deletions, whether accidental or malicious. Its data discovery methodology results in advantages on a variety of Big Data technologies and visualisation tools to facilitate rapid discovery and outcomes delivery-enabling enterprises to reach meaningful conclusions and innovate quickly.			
Company C	The company provides analytic data solutions and related services in North America, Latin America, Europe, the Middle East, Africa, the Asia Pacific, and Japan. The company operates through American Data and Analytics, and International Data and Analytics segments. Its analytic data solutions comprise software, hardware, and related business consulting and support services for data warehousing, Big Data, and tools for data integration, data discovery, and business intelligence. The company offers hybrid cloud solutions that deliver an end-to-end analytical ecosystem across hybrid cloud architecture, as well as to enable, manage and access data across various deployment options, including software on public cloud, managed cloud, and hybrid cloud solutions. It also provides analytic business consulting, and IP capture and management services. In addition, the company offers ecosystem architecture consulting services that enable customers to build an optimised analytical ecosystem independent of technology, leveraging the company, open source, and other commercial solutions; and customer support services such as installation, maintenance, monitoring, back-up, and recovery services. It serves various industries comprising banking/financial services, communications, energy, government, insurance and healthcare, manufacturing, oil and gas, retail, travel and transportation logistics, and utilities.	2.3 bn	0.2 bn	3%
Company D	The company, together with its subsidiaries, provides information technology services and solutions primarily in North America, Europe, Asia, and Australia. It operates through two segments, Global Business Services (GBS) and Global Infrastructure Services (GIS). The GBS segment offers technology solutions comprising consulting, applications services, and software. This segment also provides applications services that optimise and modernise customers' business and technical environments, enabling customers to capitalise on emerging services such as cloud, mobility, and Big Data within new commercial models, including the "as a Service" and digital economies. It provides consulting services that help	7.1 bn	0.76 bn	2%

	organisations innovate, transform, and create sustainable competitive advantage; and vertically aligned software solutions and process-based intellectual property transaction engines in insurance, banking, healthcare and life sciences, manufacturing, and other diversified industries. The GIS segment offers managed and virtual desktop, unified communications and collaboration; data centre management, cyber security, and compute and managed storage solutions to commercial clients.			
Company E	The company provides consulting, technology, and outsourcing services. It operates through consulting services, technology and engineering services, application services, and other managed services segments. The company offers consulting services in the areas of digital transformation, strategy and transformation, supply chain management, finance transformation, people and performance, CIO strategy and transformation, accelerated solutions environment, and Big Data and analytics, as well as marketing, sales, and services. It also designs, develops, and implements technology projects; and provides system integration and IT application development and maintenance services. In addition, the company integrates, manages, and/or develops customers' IT infrastructure systems, transaction services, on-demand services, and/or business process outsourcing services; and offers professional technology services for applications, engineering, testing, and operations. It serves aerospace and defence, consumer products and retail, high tech, life sciences, automotive, distribution and transportation, industrial products, manufacturing, telecom, media and entertainment, banking and capital markets, healthcare and insurance, utilities, and oil and gas sectors, as well as the public sector.	12.5 bn	1.1 bn	2%
Company F	The company is one of the world's largest professional services networks. It is a network of companies in 157 countries and has 756 locations, with more than 223,000 people. As of 2015, 22% of the workforce worked in Asia, 26% in North America and Caribbean and 32% in Western Europe. The company is organised into the following three service lines: (i) Assurance (43%), (ii) Advisory (32%), and (iii) Tax (25%).	35.9 bn	0.1 bn	2%
Company G	The company, with over 150 years of hard work and commitment, has grown in scale and diversity; approximately 245,000 people in 150 countries and territories, providing audit, tax, legal, financial advisory, risk advisory, and consulting services. That said, its shared culture remains the same.	36.8 bn	0.11	2%

Company H	The company provides technology solutions to business and public-sector enterprises. It operates through an enterprise group, software, enterprise services, and financial services segments. The enterprise group segment offers industry standard servers and mission-critical servers to address the array of its customers' computing needs; converged storage solutions, including 3PAR StoreServ, StoreOnce, all-flash arrays, and software defined and StoreVirtual products; wireless local area network equipment, mobility and security software, switches, routers, and network management products; and support and technology consulting services. The software segment offers software to capture, store, explore, analyse, protect, and share information and insights within and outside organisations; This segment also provides application delivery management, enterprise security, and IT operations management software products. The enterprise services segment offers technology consulting, outsourcing, and support services in infrastructure, applications, and business process domains within traditional and strategic enterprise service (SES) offerings that include analytics and data management, security, and cloud services. The financial services segment provides leasing, financing, IT consumption and utility programmes, and asset management services. The company markets and sells its products through resellers, distribution partners, original equipment manufacturers, independent software vendors, systems integrators, and advisory companies.	50.1 bn	2.3 bn	2%
Company I	The company is situated in Silicon Valley and offers the following Big Data solutions: fraud detection, customer segmentation, customer churn, predictive maintenance, sentiment analysis, cybersecurity, recommendation engine, demand forecasting. Its team of data scientists works with customers across industries to solve their most pressing business challenges, allowing them to take advantage of timely market opportunities. The company helps its customers to assess existing analytic capabilities and data sources, determine an executable use case with high business value, iteratively develop, evolve, and refine analytic models, and operationalise by embedding predictive insights into business logic and smart applications.	0.27 bn	0.04 bn	1%

Note: The real names of the companies are withheld for confidentiality reasons.

3.2. Data collection and analysis

Emails were sent to the 9 companies listed in Table 2 in order to establish an initial contact. To this purpose, the digital managers of each company were selected as recipients.

Meanwhile, an initial set of questions was assembled with the objective to gather information on the potential of the Big Data analytic software provided by the companies. The background of the academic literature enabled the creation of specific questions for the key respondents to answer the research question highlighted in the Introduction in relation to value creation and capture. The interview protocol was then written and used as a reference template during interviews (see Appendix I, "Interview Protocol").

After the initial emails and subsequent calls, 6 companies (companies A, B, D, E, G, and H) were involved in the multi-case study analysis. The digital managers of these companies were contacted by phone in order to give them a brief presentation of the proposed study and to arrange the dates for an interview. In total, 20 managers were involved in direct interviews, either by phone call or face-to-face meetings. At least two managers for each company were involved and all were interviewed separately in order to prevent the answers of each manager from influencing the answers of his or her colleagues. The average time for each interview was around one hour and each interview was recorded and transcribed. A traditional coding process was performed in order to examine and organise any important information received by the key respondents (Strauss and Corbin, 1998; Hsieh and Shannon, 2005). Each manager was interviewed at least twice in order to obtain complete answers, reaching in total around 40 hours of interviews (see Appendix II, "Final sample of companies and key respondents involved").

The results of the empirical analysis were continuously compared with information from the theoretical background and secondary sources of information in order to refine, enrich and modify the theoretical setting.

4. Results

The multiple-case study analysis shows how provider companies create and capture value from Big Data by innovating their services and solutions. Indeed, they innovate in a different way their value proposition towards customers through Big Data. The results allow identifying two innovation strategies through Big Data that provider companies pursue in order to innovate their value propositions, allowing the creation of a favourable environment for themselves and user companies for an effective implementation of Big Data. These two strategies – which can be used to cluster the sample of provider companies – were called (i) use case-driven, and (ii) process-driven. Companies A, D and H pursue a use case-driven strategy. In this case, the innovation of the value proposition

happens through the direct interaction with customers along all the phases of the project and the creation of a tangible component in their offer (i.e., the Big Data analytic software). Here, the customers own the data that are managed by the provider. Companies B, E and G pursue a process-driven strategy. In this case, the focus is on the internal use of Big Data and the interaction with customers is limited to the initial request and in the final phases of the project. In this case, the providers own the base of knowledge (data). In addition, in a use case-driven strategy, the interaction with customers is usually realized through individual business cases (or use cases) that answer to customers' requests for a specific analytic software solution. Occasionally, companies replicate an existing offer, whereas in other cases, they develop a new analytic software solution. The implementation of these use cases enables the development of best practices that can be used by the provider company for future customers' requests. Finally, with regard to the triggering of a virtuous circle of continuous improvement of the company's best practices and service innovation towards customers, in a process-driven strategy, Big Data enables the hosting and managing of large amounts of information with respect to the past, thus provider companies can leverage on a much broader knowledge base and elaborate this into their internal processes related to pricing, marketing, pushing innovation, and knowledge-driven decisions. The Big Data supports *ex-ante* the internal activities of the provider company and, through their improvement, it leads *ex-post* to a better service innovation, where the customer is mostly involved in the final phases of the project (after the initial request). With regard to the first innovation strategy, provider companies offer both the analytic software (mostly developed internally and with the support of external vendors) in combination with their skills and expertise (both technical and industry-specific) in advance of the customer's request. This is in line with recent research on service innovation, which emphasizes the central role played by IT in combination with other intangible assets such as information, skills and knowledge, in order to create value for the actors engaged in the service ecosystem (see, e.g., Barrett et al., 2015; Lusch and Nambisan, 2015). Companies using this strategy already have the industry-specific skills that allow for the implementation of the use cases jointly with their customers. With regard to the second innovation strategy, provider companies mainly take advantage of, in advance of the customer's request, their skills and expertise (mostly technical), as the analytic software (mostly developed externally) is used for elaborating their existing body of knowledge. Therefore, technology does not play a central role in influencing the value proposition towards customers. This appears to be more in line with consolidated research on service innovation. For example, Vargo et al. (2008) argue that the skills and expertise of companies represent the essential source of value creation, rather than the outcome. Companies using this strategy mostly take advantage of technical skills to use Big Data internally, whereas they leverage on industry experts in case they need industry-specific skills.

From the empirical analysis, there emerges how the impact of both strategies, in terms of innovation of the value proposition towards customers, can be influenced by the entire network of their stakeholders, both key partners and customers (see, e.g., Barrett et al., 2015; Smedlund, 2012). Indeed, whether more or less developed, the network of stakeholders influences to a different extent the effectiveness with which companies offer their service or innovate their value proposition for value creation and capture (Bowman and Ambrosini, 2000). Figure 1, below, maps the sampled companies in relation to their different offers. As for the y-axis, the analytic software can be (i) developed internally, (ii) developed by external vendors, or (iii) developed internally and with the support of external vendors. And as for the x-axis, skills and expertise can be (i) pure technical, (ii) industry-specific, or (iii) both technical and industry-specific. In addition, Appendix III ("The business model of the sampled companies") shows the business model of the sampled companies in along the key dimensions of (i) the value network and (ii) the value proposition, which respectively reflect the value creation and value capture dimensions (see, e.g., Foss and Saebi, 2017; Zott et al., 2011; Osterwalder and Pigneur, 2013).

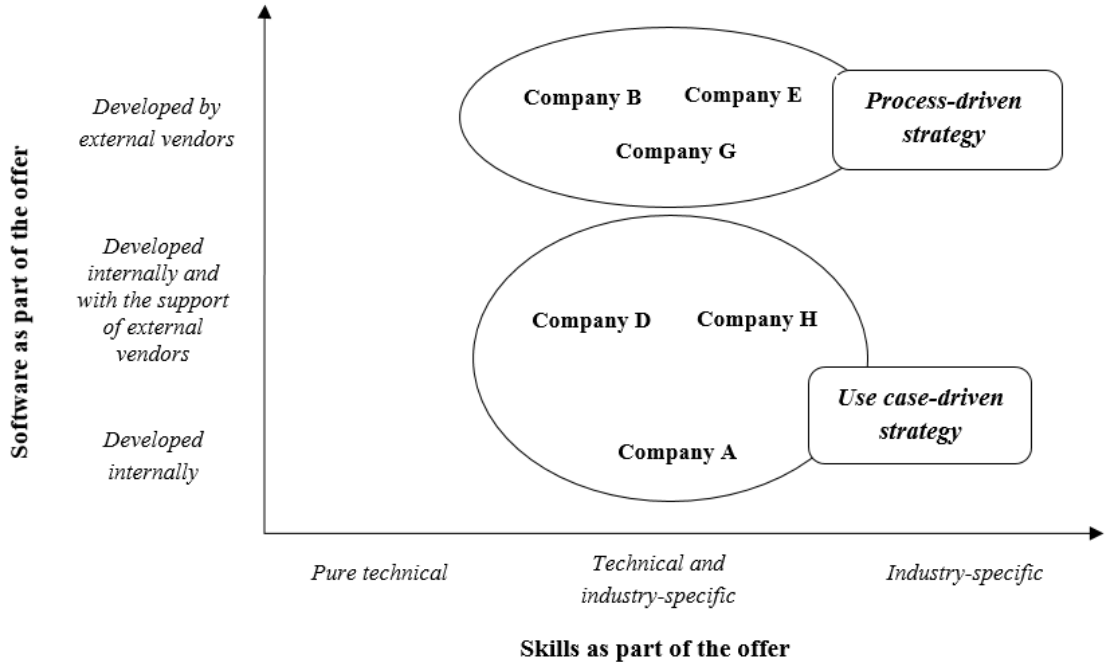

Figure 1: Sampled companies in relation to the offer's characteristics**.**

The following section discusses the innovation service strategies of the sampled companies and how they create and capture value through Big Data by providing service innovation. Then, in a separate paragraph, attention is paid to the role played by the network of the stakeholders, both key partners and customers, in influencing the effectiveness with which companies innovate their value proposition in order to create and capture value for their customers and themselves.

5. Discussion & Implications

5.1 Use case-driven strategy

Value creation

Big Data enables the implementation of new key activities. Indeed, as argued by a manager in company H, *"We use Big Data in order to change the product, change the way we support the internal activities, and change the customer-related processes"*. This happens especially for company A, where, as argued by a manager, *"Besides the co-creation activities with the customer, we use Big Data also internally. Indeed, we actually use our cognitive abilities to reinvent each of our different products. For example, we put intelligence within our systems to do predictive maintenance. It is actually a core part of our business – being cognitive not only for the customers but also being cognitive within our specific portfolio of products"*. Company D typically provides architecture design and implementation, data acquisition and analytic services. Once the data is gathered, it is reconverted in practical solutions for customers, *"For example, a customer operating in the Telco industry asked us to implement a Big Data analytics in a customer journey project. In particular, it*

was about face detection at the entrance and at the exit of the shop. Such "mood" analysis helped in understanding its customer satisfaction level", argued a manager of company D. The pivotal role played by Big Data in enabling a shift towards realizing new activities has previously been highlighted in the background of this paper (see, e.g., Afshari and Peng, 2015; Erevelles et al., 2016; George et al., 2014, Hess et al., 2016).

With regard to key resources, a manager of company H argued, *"The most critical resources required, in order to manage Big Data, are skills and expertise; in particular, the most important for us are the technical ones"*. In the same way, a manager of company A highlighted, *"We leverage particularly on technical skills for artificial intelligence*". The critical role played by Big Data and by other digital technologies in requiring new key resources is well known in academic literature (see, e.g., Erevelles et al., 2016; Anaya et al., 2015).

In addition, Big Data represents an enabler of the service offer. In the case of company H, it allows understanding customers' need and finding out new insights for the offer, *"We use predictive analytics to understand up-sell solutions on the software side, by looking at the customers' historical purchases"*. However, company A takes advantage from a new combination of IT-resources with the existing know-how to deliver its service offering. Indeed, as reported by a manager of company A, *"We put together our Big Data analytics, our own cognitive computing, and our artificial intelligence platform and thus, we empower the creation and implementation of our offer to the customer"*. The idea of combining existing knowledge with new digitally enabled resources is consistent with findings from existing research in the fields of service innovation and open innovation through digital technologies (Witell et al., 2016; Downes and Nunes, 2013; Urbinati et al., 2018).

Value capture

Company H offers an analytical platform, the aim of which is to drive very complex analytics on large data sets with high speed and very low cost with respect to traditional data warehouse (DW) solutions. As reported by a manager of company H, *"Our offer is built on the following pillars: sales pace, lower costs of development, lower cost of maintenance, lower cost of installation, very high scalability, and very high performance in terms of query. We also developed the product in terms of supporting open source innovation"*. Company D offers a hybrid architecture platform, which aims at embedding Big Data analytic intelligence in the operational processes of the customer (i.e., operational intelligence) and, thus, application maintenance and operation enhancement are part of the value proposition. Accordingly, as argued by a manager of company D, *"We leverage on Big Data technology Hadoop and a columnar data structure that enables a high-performance analytics database; we strive to modernize legacy enterprise data warehouse and business intelligence architecture, in order to help customers to increase their analytics individual qualification (IQ) in*

digital transformation for a better business outcome. Finally, we offer a hybrid architecture platform, by leveraging on previous experience and expertise in enterprise data warehouse and business intelligence."

Company A offers different kinds of Big Data analytical platforms that are complemented by data gathering tools and tools for data analysis (predictive and prescriptive maintenance). As a manager of company A reported, *"We have: (i) products that help identifying opportunities from all kind of data and from different sources, within and outside the organisation; (ii) cloud data services, a hybrid approach to our customers, especially to open source developers; (iii) products that can manage data and content, both on cloud and hybrid environments; (iv) enterprise content management, a product that helps managing and transforming different contents of business; and (v) integration tools".* In addition, *"Big Data helps our company to change the whole core system around the selling processes, the reporting, and the marketing that leads to a change of the value proposition of our different solutions. For example, there are business units that used to offer products only for monitoring purpose, but. now the same business units embed Big Data technology in their software, and thus, totally change the product offer"*. The hybrid nature of Big Data and, more generally, the inter-dependency (or cross-fertilisation) between IT (and digital technologies) within existing body of technological knowledge of companies (and customers) to create and capture value in a new business model dimension is of a huge interest in existing research (see, e.g., Björkdahl, 2009).

As for the value absorbed by the customers, as argued by a manager of company H, *"Predictive analytics helps our customers to understand whether their customers are more or less predisposed to buy different components of their core product"*. Therefore, customers of company H are able to improve their marketing activities through Big Data. The concept of how Big Data supports marketing initiatives is covered also in the academic literature (see, e.g., Erevelles et al., 2016, Jin et al., 2016). Similarly, this happens for company D, as argued by a manager, *"We offer a solution to one of our customers that enables the post-launch phase. More precisely, it is predictive marketing aimed at retaining customers when a warranty expires and attracting other in order to gain a new business. Therefore, the marketing activities of the customer turned totally into being event-driven that doubled the return on the marketing investment (ROMI)"*. Finally, in company A, Big Data enables a new way through which customers establish their value proposition. As argued by a manager within the same company, *"We collaborate with agricultural machine producers by putting sensors in the machines. Then, leveraging on a platform to elaborate all data collected by the sensors. In such a way, we are able to understand the, predictive maintenance of these machines, and the different aspects of the ground (e.g., chemical characteristics). Therefore, the agricultural machine producers can sell information about the different grounds (i.e., what can be obtained, harvested, the optimal*

use of their agricultural machines, and the annual amount of yield). This is all information that they offer to the farmers, their customers". What it emerges here is the indirect effect that Big Data has, not only in enabling a new value proposition for the provider, but also for the user towards its customers.

Table 3 summarises the main components of value creation and capture through Big Data of the provider companies A, D, and H, which allow innovating their value proposition towards customers.

Table 3: Creation and capture of value in companies A, D and H.

	Company A	**Company D**	**Company H**
Value creation	• Technical skills in combination with industry-specific skills • In particular, technical skills for artificial intelligence • Combination of IT-resources with existing know-how • Co-creation activities with customers	• Technical skills in combination with industry-specific skills • In particular, technical skills for machine learning, data engineering and mining • Combination of IT-resources with existing know-how • Co-creation activities with customers	• Technical skills in combination with industry-specific skills • In particular, technical skills for data gathering from multiple sources and technical skills for architecture with advanced analytics • Combination of IT-resources with existing know-how • Co-creation activities with customers
Value capture	• Technical expertise and Big Data analytic software as main constituents of the offer • Compatibility in hybrid environments of the technological solutions (cross-fertilisation) • Support the predictive maintenance of technological assets (through IoT)	• Technical expertise and Big Data analytic software as main constituents of the offer • Compatibility in hybrid environments of the technological solutions (cross-fertilisation) • Through Big Data solution customers are able to improve their marketing activities	• Technical expertise and Big Data analytic software as main constituents of the offer • Through Big Data solution customers are able to improve their marketing activities

5.2 Process-driven strategy

Value creation

With regard to key activities, a manager of company E outlined the definition of specific Key Performance Indicators (KPIs) in order to assess the accuracy of the results provided to customers and the continuous optimisation of algorithms and measures, or even the identification of new

measures (see, e.g., Yin et al., 2014). As for the key resources, a manager of company B pointed out the importance of technical skills, *"We started employing people with very vertical analytical skills, and we even recently developed a new analytics business unit that is focused on the development of new offers"*. However, a manager of company E highlighted four different type of key resources that are crucial for the Big Data offer, i.e. data scientists, data engineers, Big Data architects, and business analysts. In particular, he argued, *"Our company is starting to invest to what is known as data scientists – people who are able to understand how to manage data and to capture value from their elaboration. That is to say, people with a statistical background or with specific expertise in specific areas rather than pure IT expertise. This is a revolution in terms of skills, because these are completely new skills compared with the traditional IT skills we used to employ"*. The importance, today, of combining technical skills with industry-specific ones, as well as the employment of data scientists in validating and interpreting data, is well established in existing research (see, e.g., White, 2012). Finally, a manager of company G added that, for them, it is also important to have people with industry-specific skills, e.g. people who are experts in the insurance industry, as company G has customers working in this industry.

As for the enablement of the offer through Big Data, a manager of company E argued, *"As an IT consultant and system integrator, there is a strong thinking of how Big Data and Digital transformation affects our own business model. The way we manage the relations with our customers and the way we traditionally focused on IT are changing dramatically. Our customers are asking us to support actively their business processes, and thus, we have to build ourselves in a position to propose innovation and value creation for them. In this context, Big Data is one of the key enablers on which we can define our proposition, and then push it to the market in order to capture value. This is a very" hot" topic and Big Data is one of the technologies on which we can and have to leverage to be able to actively push innovation to the market"*.

Similarly, a manager of company G stated, *"We use our Big Data related skills and competences internally for improving our processes, resulting in a better value proposition to customers"* (see, e.g., Lusch and Nambisan, 2015).

Value capture

Company B offers data analysis skills and the opportunity for its customers to develop analytical models, as argued by a manager, *"We offer, to our customer, data analytics empowered by advanced technologies, as well as the opportunity to develop analytical models that improve the more traditional propensity models. The latter can enrich the information analysis by putting together different factors: for example, mix purchasing and demographical information, in order to*

understand the life cycle of customers. In another case, when customers are not mature, we help them to identify the more critical and interesting sectors that could be relevant for addressing more effort".
In the case of company E, a manager argued, *"The company offer to big retailers is mainly that of forecasting, and thus, optimising the stock level and inventory. The forecast is based not only on the data of the history of sales, but it is also enhanced with data regarding external conditions. In addition, the company offers predictive maintenance services to the Industrial and Equipment Manufacturing sector. Predictive maintenance for big plants and machines owners is based on the link between Big Data and Internet of Things (IoT) (sensors or interconnected devices) and aims at decreasing their downtimes (periods in which machinery is not working due to breakage)"*.
The focus on data analysis skills is also central in company G. Indeed, a manager stated, *"The value proposition to our customers consists of analytics solutions that empower the offer to their final customers. For example, for Media industry customers, we analyse data of TV audiences in order to segment customers, and thus, to understand what customers like in order to address more specific offers with customised advertising. In the Telco industry, we analyse customer data in order to improve customer service activities as well as for marketing analysis and up-selling or cross-selling possibilities"*.
With regard to value absorbed by the customers, company B offers its customers the possibility to propose a new value proposition. As in the case of data monetisation (see, e.g., Najjar and Kettinger, 2013; Woerner and Wixom, 2015), a manager reported, *"We offer a solution which enables our customers to the sale of information. Therefore, our customers develop new products and innovate based on this data monetisation concept, enabled by our Big Data solution"*.
In the case of company E, a manager highlighted, "*The predictive maintenance offered to our producers of big plants and machines allow them to sell the machines to their customers by offering support in terms of servitisation. Therefore, data coming from the sensors can sustain the existing or enable new business opportunities"*. The concept of servitisation as a new business strategy, through Big Data, is becoming a largely discussed topic in existing research (see, e.g., Opresnik and Taisch, 2015).
Finally, a manager of company G argued, *"In the travel industry, we offer our customers Big Data services that allow them to analyse the subscription of their customer, customer satisfaction, and gain insights for the most appealing proposition to each customer segment"*.

Table 4 summarises the main components of value creation and capture through Big Data of the provider companies B, E, and G, which allow innovating their value proposition towards customers.

Table 4: Creation and capture of value in companies B, E and G.

	Company B	**Company E**	**Company G**
Value creation	• Employing industry-specific skills in combination with technical skills • Data scientists expertise (statistical or interpretative knowledge)	• Employing industry-specific skills in combination with technical skills • Data scientists expertise (statistical or interpretative knowledge)	• Employing industry-specific skills in combination with technical skills • Data scientists expertise (statistical or interpretative knowledge)
Value capture	• Support the choice of right sectors by segmenting customers • Through Big Data solution customers are able to change their value proposition: (i.e., data monetisation)	• Support the predictive maintenance of technological assets (through IoT) • Through Big Data solution customers are able to change their value proposition (i.e., servitisation)	• Support the development of use cases although it is not an activity that drives the company's strategy • Through Big Data solution customers are able to propose new appeal value propositions to each of their served segments

5.3 The role of the involved stakeholders

As mentioned above, the entire network of stakeholders, among which technology vendors, system integrators, strategy advisors, and customers plays a critical role in the development of the strategy of the provider companies. This is consistent with existing research on service innovation, which emphasizes how service innovation always involves a network of different actors (Barrett et al., 2015), including also customers (Smedlund, 2012), in order to co-create differential value. More generally, the involvement of third parties is critical in the value creation process, as the value network creates a cluster of economic actors who collaborate with each other in order to deliver value (Bowman and Ambrosini, 2000).

The main similarity of companies A, D, and H, belonging to the first cluster, concerns the lack of involvement of internal business units and the co-operation with technological stakeholders (and industry experts, although to a lesser extent). However, the main difference comes from the selection of partners in order to put together all the components needed to build the solution for the customers. Companies D and H collaborate with infrastructure providers, platform providers, analytics services vendors, applications vendors, specific system integrators, and strategy advisors. This does not happen in company A, which mainly developed solutions internally, and the involvement of customers with vertical know-how in specific fields guarantees company A the co-creation of differential value.

The main similarity among companies B, E and G, belonging to the second cluster, concerns the involvement of customers in the last phases of the project. In addition, companies G and B co-operate with their internal business units while company E does not. However, company G does not engage industry experts, whilst companies B and E interact with third parties who provide industry-specific know-how for their value proposition. As for the technological vendors, only companies E and G involve them.

Most of the companies work with technological stakeholders in order to receive technical support, as reported by a key informant of company H, *"There are customers that extend their core offer with IoT – information coming from sensors on the product, and thus, they are able to know what their customers are doing. Therefore, they are able to mine more data they were able before. Here, in our work, we interact with technology vendors, software vendors, specific system integrators, and strategy advisors"*.

In company E, the partners involved are both technological, such as vendors or open source developers, and industry-specific, such as industry experts. Indeed, as argued by a manager of company E, *"We are a system integrator and we partner with leading Big Data vendors. Our offer is constituted by a technological part that affects the implementation of the technological infrastructure. In this case, as I said, we work together with technological vendors who provide support in defining the setup and the overall configuration of the technological infrastructure. In other cases, we involve actors with specific technological knowledge, for example, small companies specialised in advance analytics. However, we aim also to develop many different open-source projects, as today there is good momentum for them, and that require working with open source developers in order to build new solution for our customers. Additionally, we sometime involve third parties with industry-specific know-how".* Therefore, company E leverages on both technical and industry-specific skills provided by these typologies of external partners.

The same happens for company B, which also takes advantage of teams comprising people coming from different business units, *"We work in the following ecosystem: we provide experts from our company's analytical division in order to define analytical models that are the basis of propensity analysis, and then we provide people from our company's technology division who work on the development of the front end together with people coming from our company's interactive division. We involve also, industry specific experts"*, argued a manager of company B.

Although in different way, all the sampled companies interact with technological stakeholders or industry experts in order to enhance their value proposition. A manager of company A argued that the main external actor involved is the customer, as it enables a process of value co-creation, *"The main external actor involved in the process is the customer, as the process consists in a co-creation*

of differential value. The latter has control over the data and we can provide all tools in order to gather the data, analyse them, and produce predictive and prescriptive analysis. In addition, the specific knowledge of the customers on the market where they operate helps us to understand how to analyse their data and the best output". Additionally, a manager of company G recognised the importance of customers, although their role is relegated to the final phases of the project, coherently with what with argued above. *"We are positioned in the middle of an ecosystem as a strategy advisor between technology vendors and customers. With regard to the customers, they can be a pure system integrator with specific skills, as well as another business unit of the company that address the needs of final customers".*

Once again, though with more or less involvement in the project, all the sampled companies work in a collaboration with their direct or indirect customers.

Table 5 summarises the role played by each typology of stakeholder, whether involved, for the sampled companies.

Table 5: The role of the stakeholders' network for each sampled company.

	Company A	**Company D**	**company H**	**Company B**	**Company E**	**Company G**
	Use case-driven companies			**Process-driven companies**		
Internal business units	No co-operation	No co-operation	No co-operation	Co-operation	No co-operation	Co-operation
Technology vendors	No involvement	Involvement enables the building of Big Data software as a main offer	Involvement enables the construction of technological infrastructure	Involvement enables the construction of technological infrastructure	Involvement enables the construction of technological infrastructure	Involvement enables the construction of technological infrastructure
Industry experts	No involvement	No involvement	No involvement	Improve the offer	Improve the offer	No involvement
Customers	Involvement in all phases of the project enables the co-creation of use cases	Involvement in all phases of the project enables the co-creation of use cases	Involvement in all phases of the project enables the co-creation of use cases	Involvement in the last phases of the project	Involvement in the last phases of the project	Involvement in the last phases of the project

5.4 Theoretical Implications

The multiple-case study analysis designed to illuminate how provider companies create and capture value from Big Data. The perspective of provider companies has been neglected in existing

management research, the primary focus being on users (see, e.g., McAfee and Brynjolfsson, 2012), though their role is predicted to assume more relevance in the future (see, e.g., Finos, 2016a, 2016b). In addition, existing research (see, e.g., Yoo, 2010; Yoo et al., 2010) has called for further effort to propose conceptual frameworks in data-driven environments (see, e.g., Troilo et al., 2017) for the creation and capture of value (Trabucchi et al., 2017). Building on these research gaps, this paper advances existing knowledge in a number of ways.

A first contribution is link to the fact that this paper focuses provider companies. Traditional research has focused on how and why companies implement and use emerging technologies, such as Big Data, arguing that evaluating how companies implement and use technology is a complex phenomenon that depends on the interaction between the company and the technology in a specific context (e.g., Jiang et al., 2002). Despite this, the present paper suggests that is necessary to examine multi-dimensional forms of interaction throughout the process of creating and capturing value from a specific emerging technology. In this case, the focus on Big Data extends from only involving user companies and technologies in specific environments to also considering several actors that span from provider companies, technology vendors, and industry vendors. Accordingly, this paper argues that multi-dimensional interactions between several stakeholders, with different backgrounds and from different contexts, can improve the relationship between provider companies and user companies when creating and capturing value from Big Data. It also proposes a strategic framework that maps two main innovation service strategies. The framework highlights that it is not sufficient to explain how to implement emerging technologies, as most recent contributions still call for (e.g., Appio et al., 2018; Urbinati et al., 2018), but it is also necessary to understand the pre-conditions, as the actions pursued by provider companies, in order to create a favourable environment for an effective implementation of emerging technologies, such as Big Data.

Second, the present paper adds to the literature on open innovation, especially from the point of view of highlighting value creation and capture mechanisms (West and Bogers, 2014) and by extending it toward a systems perspective, by emphasizing both the role of users and providers (Bogers et al., 2017). For example, there is a need to consider multi-dimensional interactions that are required by companies in order to cooperate with a set of stakeholders throughout the innovation process in the adoption of open innovation (Chesbrough, 2003; Chesbrough and Bogers, 2014) and changing business models (Foss and Saebi, 2017; Massa et al., 2017; Zott et al., 2011). In a context of digital transformation and data-driven environments, multi-dimensional interactions are even more necessary in order to create and capture value from emerging technologies as Big Data (Troilo et al., 2017).

Moreover, this paper adds to the literature on (digital) platforms (e.g., Parker et al., 2016). On the one hand, these authors define a pipeline as "the structure of a traditional (non-platform) business, in which a firm first designs a product or service, then manufacturers the product and offers it for sale or puts in place a system to deliver the service. This step-by-step arrangement for creating and transferring value can be viewed as a kind of pipeline, with producers at one hand and consumers at the other. Also known as *linear value chain*". On the other hand, these authors define a platform as "a business based on enabling value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants". Accordingly, the use case-driven strategy seems to have properties like a pipeline, whereas the process-driven strategy may turn into activities like a platform. In the former case, provider and user companies co-operate throughout all the phases of the project development to share risks, costs and the benefits ensuing from the project implementation. In the same way of a pipeline business, provider and user companies are engaged in a step-by-step arrangement or in a sort of linear value chain, as they share every detail of design, development, implementation and delivery of the Big Data analytic software. In the latter case, provider and user companies interact when necessary throughout the phases of the project development in order to enhance value-added interactions and at a specific minimum rate of frequency they consider appropriate. In the same way as a platform business, value is created for all the participants in the project development in an open and participative infrastructure of interactions, and also influenced by the involvement of more internal and external stakeholders.

5.5 Managerial implications

There are main two practical implications suggested by this paper. First, it maps the domains within which user companies can obtain benefits from the application of Big Data and through which they can set up the adoption of Big Data. In particular, the present paper maps the domains of: (i) customer need identification, (ii) risk management and decision-making, (iii) data-driven knowledge, (iv) product and service design, (v) quality management and (vi) opportunity recognition and creation. These are the areas from which user companies willing to adopt Big Data can derive benefits and that could be considered, for instance, in the evaluation process leading to the decision to adopt or not Big Data solutions.

Second, it highlights for provider companies a set of actions they can potentially adopt in order to enable the creation and capture of value for their customers and themselves. In particular, this paper suggests that some provider companies, such as companies A, D, and H, (i) leverage technical skills

and expertise, (ii) conduct co-creation activities with customers, (iii) develop digital capabilities, i.e. through a combination of IT resources with non-IT resources, and (iv) cross-fertilise technological know-how, i.e. combine the functionalities of several technological solutions that could derive from the Big Data implementation. In addition, it suggests that provider companies, such as companies B, E, and G, (i) leverage technical, industry-specific skills, and technical experts, and (ii) support their customers in the last phase of a project development, in order to enhance their marketing activities or servitisation strategies.

6. Conclusions and limitations

This paper draws on a multiple case study analysis of provider companies that take advantage from Big Data in order to improve their value proposition towards customers. The results of the multi-case study analysis are twofold and may be of particular interest for scholars working in the fields of technology and of innovation management.

First, a theoretical framing on the role of Big Data for value creation and capture processes was proposed. In particular, the paper does so by highlighting the pivotal role of Big Data in different applicative domains, such as customer need identification, risk management and decision-making, data-driven knowledge, product and service design, quality management and opportunity recognition and creation. Second, the paper presents two main innovation service strategies based on Big Data as they emerge as findings from the empirical analysis. In particular, these strategies aim to represent a strategic framework that provider companies establish in order to innovate their value proposition towards their customers and to allow the creation and capture of value for customers and themselves. These two strategies were called (i) use case-driven, and (ii) process-driven.

The findings ensuing from the empirical analysis show how these two strategies differ from each other due to three main reasons: (i) the management of data (owned either by customers or by providers), (ii) the use of the technology to support directly or indirectly (improving *ex-ante* the internal processes) the customers, and (iii) the characteristics of the offer, in terms of analytic solution, skills and expertise.

Despite its contributions, this paper has some limitations that open up avenues for further research. Given the focus on value creation and capture for provider (and user) companies through Big Data, the paper avoided to put emphasis in the discussion on the problems and challenges in dealing with Big Data analytic software. And, though several main barriers were highlighted by the key respondents, such as: (i) the lack of talent on the job market (for company A), (ii) underestimation of the information governance by the customer (for company D), and (iii) low skills and organisational

issues on the customer side (for companies H, B, E, and G), the paper invites scholars to conduct ad hoc research on the managerial actions that can help overcome them.

From a theoretical perspective, the proposed framework could be also enriched, refined or modified in accordance with how service innovation will evolve in the future through digital technologies, in terms of new strategies, new actors, new competitive environments, and new contextual factors. In addition, the paper invites future research to expand the number of provider companies to be involved in order to improve the generalisability of the findings; this represents a typical limitation of qualitative research, as in the present case. In addition, the present paper invites scholars to study how managers, who adopt a process-driven strategy, can improve their service level by shifting to the use case-driven strategy; this strategy, indeed, conceives a high degree of involvement of customers throughout the all phases of the project, thus it can potentially avoid asymmetries – which may occur more likely through the process-driven strategy – between the initial request and the outcome. Finally, this paper purposefully focuses on value creation and capture through Big Data from the perspective of companies providing services and solutions that leverage Big Data. In doing so, it also discusses the role of customer involvement and interactions, as the end users represent a key stakeholder that shapes the development and implementation of the service innovations pursued by the provider companies. However, future research may be needed to further the understanding of the dynamic and co-creation processes that shapes the supply-demand interactions taking place in the value creation and capture processes enable by Big Data technologies.

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Appendix I: Interview protocol

Company background

- Type of company: market, size, competence, products
- Organizational structure and context
- Organization and innovation management activities

Value creation

- What are the characteristics of the Big Data analytics software?
- What is the offer to your customers?
- How does the Big Data analytics software empower the creation and implementation of your offer to customers?
- To what extent the use of the Big Data analytics software involves external actors (and at which level of the value network, i.e., suppliers, customers, other types of partners)?
- Which kind of activities do the external actors perform?
- Which kind of key activities do you perform with the Big Data analytics software?
- What core resources are required for managing the Big Data analytics software (i.e., skills, expertise, technology, etc.)?
- Does the Big Data analytics software support your innovation activity? In which phases of the innovation process it is implemented (i.e., idea generation, product development and commercialization)?

Value capturing

- What kind of products or services are you enabled to create for customers from the Big Data analytics software?
- Which revenue streams does the Big Data analytics software allow generating?
- How does the Big Data analytics software influence the innovation activity of the customer (i.e., increased speed, reducing costs, empowered launch and post-launch phase)?

Problems with Big Data

- Which problems and challenges were faced during the development of the Big Data analytics software?

Appendix II: Final sample of companies and key respondents involved

Company	Role
Company A	• Digital transformation account manager • Business development manager for digital innovation • Technical solution manager e IT architect
Company B	• Digital transformation and innovation manager • Digital manager • Senior manager • Application development, maintenance and operations innovation manager
Company D	• Italy delivery leader, analytics manager • Head of analytics and data scientist unit, account delivery manager • Solution principal, analytics and data management practice • Analytics director
Company E	• Digital project manager • Vice President • Head of Big Data and cloud • Managing Consultant
Company G	• Digital manager • Innovation manager • Senior manager
Company H	• Technical manager of innovation projects • Customer success manager data division

Note: The real names of the companies and the names of the key respondents are withheld for confidentiality reasons.

Appendix III: The business model of the sampled companies

Dimensions	Company A
Value proposition	It offers products that help **identifying opportunities from all kind of data** and different sources within and outside the organization, Cloud Data Services. A hybrid approach to their customers, then products that can **manage data and content both on cloud and hybrid environments**, enterprise content management, a product which **helps managing and transforming different contents of business**, **integration tools** which try to put all different sources of data, finally it also provides a **columnar data structure**. Data gathering tools, tools of analysis and produce predictive and prescriptive maintenance. **API Big Data services platform**, which works like a one-stop shop, enabling new, continuous, and stream of revenues.
Value network	**Technical skills for artificial intelligence**. The main external actor involved in the process is **the customer**, as the process is a co-creation with the customers.

Dimensions	Company B
Value proposition	**Data analytics empowered by advanced technologies**, as well as the **opportunity to develop analytical models**, which improve the more traditional propensity models. It offers the opportunity to **identify the more critical and interesting sectors**. **Value-based business model**, which **enables revenues coming from commissions based on outcomes** rather than products.
Value network	**Vertical analytical skills**. People coming from **other Company B' business units**, **industry specific experts.**

Dimensions	Company D
Value proposition	Big Data technology Hadoop and a columnar data structure that enables a **high-performance analytics database**, it **strives to modernize legacy enterprise Data Warehouse and Business Intelligence architecture**. It helps clients to **increase their analytics individual qualification (IQ)**. Further, **application maintenance and operation enhancement** are part of the value proposition, and it offers a **hybrid architecture platform**.
Value network	**Definition of the reference architecture models** before the start of each Big Data project: the definition of the components needed in each project, then the implementation of the project, then, from the project, the company develops the best practices, and from the best practices, company D refines the components of the architecture for future projects. **Skills and expertise**: statistics & machine learning, data engineering and mining, performance and scalability (platform, distributed computing), visualization and social media tools (information visualization and UX), and domain experts. **Infrastructure providers**, **platform providers**, **analytics services vendors**, **applications vendors**.

Dimensions	Company E
Value proposition	**Forecasting and optimizing the stock level** and inventory, **predictive maintenance services**. I**nsights** empowered by Big Data, **Customers analytics**, **Operations analytics**, **Risk analytics**, **Big Data and Fast Data** (management and parallel processing of data, management of unstructured data), **Machine learning**, **Self-analytics**, and **Data governance**.
Value network	The company **assesses the client's business, defines the KPIs and correct measures**. It also **evaluates** with the customer **the accuracy of the results** and then it **improves the real impact on the business.** **Training activities, seminars and conferences** are also provided internally, to ensure up-to-date awareness of the diverse Big Data solutions, available on the market. **Data scientists**, people from statistical background, or with specific expertise in specific areas, rather than IT expertise, **data engineers**, **Big Data architects**, and **business analysts**. Leading **BD technology vendors**, **open works**, a **company that is specialized in sensor devices**, **and vendors** who have specific technological skills. **Small partners with specific knowledge**, for example small vendors, specialized on advance analytics could possess a specific know-how, **third parties with specific industry-related know-how**.

Dimensions	Company G
Value proposition	An **analytics solution** that empower the offer to their final customers. It leverages on **use cases** that allow a new interaction with customers. For example, the pricing component is evaluated when developing the use case and a KPI is created and monitored. Thus, a certain portion (e.g., 10%) of the profit goes to the provider of the Big Data solution (i.e., Company G).
Value network	It develops **training programs**, which consist of an assessment of resources, a gap analysis, level of maturity of data and then, the estimation of the change line. **People with specific business skills**, (e.g., people experts in the insurance industry) or people **with technical skills** of different technologies. **Technology vendor** and **client**.

Dimensions	Company H
Value proposition	An analytical platform with very **high speed** and very low cost. Further, **sales pace**, **lower costs as development**, **lower cost of maintenance**, **lower cost of installation**, **very high scalability and very high performance in terms of query**.
Value network	**Change the product**, **change the support** and **change the customer-related processes.** **Skills** that tackle challenges of gaining the data from multiple sources, and expertise for the design of an architecture with advanced analytics. **Technology vendors**, **software vendors**, **specific system integrators**, and **strategy advisors**.