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Internet of Things and Big Data as enablers for business digitalization strategies

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ABSTRACT

Digitization blurs the lines between technology and management, facilitating new business models built upon the concepts, methods and tools of the digital environment. The purpose of this study is to investigate the role of the Internet of Things (IoT) and Big Data in terms of how businesses manage their digital transformation. The paper argues that the outbreak of IoT and Big Data has resulted in a mass of disorganized knowledge. In order to make sense of the noise, a literature review was carried out to examine the studies, published in the last decade (2008–2019), that analyzed both the Internet of Things and Big Data. The results show that IoT and Big Data are predominantly reengineering factors for business processes, products and services; however, a lack of widespread knowledge and adoption has led research to evolve into multiple, yet inconsistent paths. The study offers interesting implications for managers and marketers, highlighting how the digital transformation enabled by IoT and Big Data can positively impact many facets of business. By treating IoT and Big Data as faces of the same coin, this study also sheds light on current challenges and opportunities, with the hope of informing future research and practice.

1. Introduction

Internet of Things (IoT) applications have radically changed our lives, bringing immense value to the activities of both individuals and companies. Nowadays, billions of everyday objects are equipped with advanced sensors, wireless networks, and innovative computing capabilities. This profusion has given rise to wearables, smart home applications, advanced health care systems, “smart cities” and industrial automation (Chen and Ji, 2016; Marjani et al., 2017). After years of uncertainty, IoT seems poised to cross over into mainstream business use: The number of businesses adopting IoT technologies is on the rise, with the worldwide number of IoT-connected devices projected to reach 43 billion by 2023 (Gupta et al., 2017). IoT reflects this mounting trend toward physical devices that possess the computing and communication capabilities to collectively gather information on a real-time basis (Guo et al., 2013).

These technologies might help increase companies’ competitiveness by transforming their products and services into digital business opportunities. IoT features tools for studying consumer behavior, attitudes, consumption, and choices, which have relevant implications for

marketing studies. Likewise, the proliferation of such high-tech products and services has implications for innovation and digital management studies (Del Giudice, 2016; Meyer et al., 2013). Indeed, IoT might be a key enabler of business digitalization, thereby improving existing processes and daily routines (Krotov, 2017). Secondly, IoT allows different physical devices to connect to the Internet and engage in continuous data exchange. By collecting and analyzing such vast amounts of data, scholars can bolster their efforts to understand and predict consumer behavior (Lo and Campos, 2018; Pigni et al., 2016). These datasets—too large to be analyzed with traditional data-processing application software—have entered the common language with the term Big Data. The literature provides some definitions of Big Data (De Mauro et al., 2015; McAfee and Brynjolfsson, 2012; Popović et al., 2018; Provost and Fawcett, 2013): They can be defined as structured data such as organizational databases, and unstructured data generated by new communication technologies such as the IoT, as well as images, videos, audio (Lansley and Longley, 2016). These IoT devices and services – whether they be mobile phones, online purchases, social networks, electronic communications, GPS, or machinery – generate torrents of data by connecting and monitoring people. In other words,

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Big Data is just the recognition that consumers are now generators of both traditional and unstructured behavioral data (Erevelles et al., 2016). By leveraging the data generated by IoT and Big Data, businesses can make more effective decisions (McAfee and Brynjolfsson, 2012). However, firms have yet to truly capitalize on IoT data: E.g., McKinsey (2015), reported the example of one company's industrial application with 30,000 sensors, where only 1 percent of the data was event utilized, and even then, mainly for anomaly detection and control.

While the literature has illustrated the business potential of Big Data, IoT research is still at an early stage of evolution, at least outside of the engineering sciences. Relevant studies (Nord et al., 2019) have mainly focused on IoT-related concepts while neglecting applications, opportunities and reviews of the literature; thus, there is a theoretical gap in terms of the technology's adoption and use. To compound the matter, the prolific outbreak of IoT and Big Data has led to a mass of disorganized knowledge. To help address this gap, this paper presents the results of a systematic literature review covering an entire decade (2008–2019) of contributions related to exploiting IoT and Big Data for the sake of business digitalization strategies. Specifically, we investigated the impact of using IoT and Big Data for technological and strategic revitalization within industrial firms. To this end, we adhered to two main research objectives: The first was to identify studies related to IoT and its impact (deriving from Big Data) on businesses. The second was to synthesize insights from the literature in order to glean possible future research directions. As a result, our research makes four contributions to the literature. First, it advances our understanding of how Big Data and IoT technologies could facilitate business digitalization for management and marketing purposes. Second, we propose that Big Data and IoT are two faces of the same coin and should thus be factored into a precise strategic framework—not based purely on technological addition, but also on a deep process of culture diffusion among organizations. Third, for managers and marketers, we draw on extant research to propose precise technological strategies for revitalizing a business that are coherent with typical managerial functions. Lastly, we shed light on the current challenges and issues surrounding these disruptive technologies.

The remainder of the study is structured as follows: In the theoretical framework section, we analyze the main definitions of IoT, with a focus on the relationship between Big Data and IoT. Next, we explore how these two phenomena have driven the digital transformation of businesses. In the third part, we explain the methodology used for the literature review and systematically present the most relevant insights about the impact of IoT and Big Data on managerial functions (Koontz and Weihrich, 2015). In the last section, we offer some conclusions and discuss the limitations of this research.

2. Theoretical framework

2.1. IoT: definitions

The literature provides several definitions of IoT (Dorsemaine et al., 2015; Govinda and Saravanaguru, 2016; Madakam et al., 2015; Miorandi et al., 2012) (Table 1), which reflects debates stemming from its etymology. Whereas the term “Internet” refers to a virtual network-oriented vision of technology, the term “Things” emphasizes the objects that can be integrated into a technological framework. A new vision of IoT should transcend a simple technology-based approach, instead seeing IoT as a global infrastructure that connects physical and virtual objects. This “net” creates a world in which things can automatically communicate with other things, providing services for the benefit of mankind.

In the management field, the benefits of IoT extend to both consumers and companies (Perera et al., 2015): for the former, by supporting their consumption choices and use of products and services; for the latter, by regulating and monitoring industrial systems in an integrated framework also known as Industrial IoT (IIoT) (Boyes et al., 2018;

Table 1

Main definitions of Internet of Things (IoT).

Authors	Definitions
Van Kranenburg, 2008,(p. 414)	Dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual ‘Things’ have identities, physical attributes, and virtual personalities, use intelligent interfaces, and are seamlessly integrated into the information network.
Miorandi et al., 2012 (pp. 1497–1516)	An umbrella keyword for covering various aspects related to the extension of the Internet and the Web into the physical realm, by means of the widespread deployment of spatially distributed devices with embedded identification, sensing and/or actuation capabilities.
Gubbi et al., 2013 (p. 4)	Interconnection of sensing and actuating devices that provide the ability to share information across platforms through a unified framework, thereby developing a common operating picture for enabling innovative applications.
Perera et al., 2015 (p. 1)	IoT allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service.
Dorsemaine et al., 2015(p. 73)	Group of infrastructures that connect objects and allow for data to be accessed, managed, and mined.
Madakam et al., 2015(p. 250)	An open and comprehensive network of intelligent objects that have the capacity to auto-organize; share information, data, and resources, as well as act and react in the face of situations and changes in the environment.
Govinda and Saravanaguru, 2016(p. 2848)	The use of standard Internet protocols for the human-to-thing or thing-to-thing communication in embedded networks.

Sisinni et al., 2018). IoT technologies might also be used to monitor any events or changes in structural conditions that could compromise safety and increase risk, thereby contributing to cost- and time-savings, improving quality and dematerialization, and positively affecting productivity (Dey et al., 2018).

2.2. Big Data and IoT

IoT and Big Data are united by their emphasis on information that is rich in volume, velocity and variety, and which requires innovative forms of processing (Lycett, 2013). Velocity indicates the speediness of data generation (Dubey et al., 2019) due to real-time and continuous connections. Volume indicates the size of the data flows (generally huge). Variety refers to the wide range of data sources (Cukier, 2010), such as photos, tweets, posts, and information from IoT devices. Other researchers have proposed some other characteristics, namely: veracity, which indicates data reliability and, thus, quality (Gandomi and Haider, 2015); value, which specifies the availability of hidden insights deriving from data analysis (Opresnik and Taisch, 2015; Fosso Wamba et al., 2015); and variability, which considers the context in which data are generated (Ebner et al., 2014). Notably, such data generation is not constant with social media or IoT devices but is instead subject to highs and lows based on the time of day. Ultimately, the proliferation of devices and ubiquitous networks is leading to wide IoT diffusion and, by extension, Big Data production (ur Rehman et al., 2019). Analyzing the Big Data derived by IoT represents a huge opportunity for businesses to develop new market and consumer insights, and thereby improve their strategy planning and implementation (Erevelles et al., 2016; Richards et al., 2019). Indeed, Big Data represents a disruptive revolution for decision-making processes, potentially increasing organizational performance and producing new competitive advantages (Davenport, 2014; Raguseo, 2018; Yaqoob et al., 2016). Hence, IoT and data analysis are part of the same phenomenon (Ahmed et al., 2017; Ranjan et al., 2018): Companies should be able to equip themselves with competitive infrastructures that can analyze the data derived from IoT.

2.3. Digital transformation in businesses

IoT and Big Data are reshaping management and marketing strategies through digitalization (Muljani and Ellitan, 2019) which represents a new frontier in business competitiveness and is often understood as the 4.0 Industrial Revolution (Zhou et al., 2015). These new paradigms have radically changed not only human relationships and daily activities, but also companies' management methods and processes.

Businesses need to integrate 4.0 strategies into their activities in order to survive and compete (Agrawal et al., 2018), but to do so, they need to change their management, organization and production practices. The right approach to achieving this goal is "reengineering": First appearing in the field of IT, it has since evolved to reflect the broad process of redesigning core business procedures in order to increase organizational performance (Attaran, 2004). Reengineering approaches provide conceptual references aimed at rethinking and redesigning business processes through digitalization (Gutiérrez-Gutiérrez et al., 2018). Since its inception, the 4.0 Revolution has emphasized a joint relationship between business process digitalization and IT in order to create more flexible, group-oriented, coordinated, and real-time communication skills (Bhaskar, 2016). As a part of IT applications, IoT and digitalization are naturally related. IoT supports companies in: i) redesigning the production process of products and services; ii) providing new products and services with more advanced or efficient technologies; and, consequently, iii) capturing large amounts of generated data to predict behavior, choices, and consumptions, and thereby aid decision-making processes and strategic planning. On these bases, IoT is transforming the focus of business processes from physical products to data-based services (Ahmed et al., 2017).

In this scenario, IoT contributes to a wide range of industrial applications by connecting heterogeneous devices (Mehta and Kaur, 2018). It is extremely influential in the manufacturing industry, for instance, where it facilitates production strategies and communication among a large number of instruments and machines (Kiel et al., 2017). As a result, firms can develop intelligent machinery systems that use real-time connections to generate Big Data about each phase of different business processes. In the healthcare sector, IoT contributions can totally reshape core business processes (Saheb and Izadi, 2019): Healthcare services might be improved with telemedicine, while health data management can advance medical decisions and human health monitoring. In service industries, the use of connected devices, such as sensors and monitoring systems, can optimize intelligent transportation, traffic management, and security (Sun et al., 2018; Trilles et al., 2017). In short, the integration of IoT technologies and Big Data analysis might invoke a digital transformation that improves business' activities and processes (Meyer et al., 2013).

3. Methodology

For this review, we adopted a qualitative approach in order to understand how IoT and Big Data, as complex phenomena, work to enable business digitalization strategies. We first assembled a review panel featuring four experts in the areas of methodology and theory. In following the systematic process proposed by Tranfield et al. (2003), we considered four relevant phases: *Phase 1*: finding potential research gaps in the literature and identifying a specific research issue, which entailed uncovering a need for a review, preparing a proposal for a review, and developing a review protocol. *Phase 2*: providing an analysis of the existing literature using a qualitative approach to IoT, Big Data and business management. *Phase 3*: performing the extrapolation of data from the selected documents, including the data extraction, and the data synthesis. *Phase 4*: describing the results obtained from the review process, including the report and dissemination (insight).

Following this scheme, we defined the problem and the operational strategy, which entailed collecting information on the specific questions addressed by the studies (business opportunities derived by IoT and Big

Data, and the most promising research trends that require further investigation), as well as delineating the search strategy and inclusion/exclusion criteria for the relevant studies (Davies and Crombie, 1998). We defined a list of four keywords referring to the application of IoT and Big Data for business management. In the most important economic journals, the relevant scholarly articles commonly employ words such as "IoT", "Big Data", "business management", "marketing", and their combinations. To provide a critical review of academic studies (both experimental and review studies), we only examined scholarly articles in the marketing field published in international, peer-reviewed journals from January 1st, 2008 to December 31st, 2019. We searched for articles using the Scopus services, an abstract and indexing database with full-text links that is overseen by the Elsevier Co., because such online services, such as Google Scholar, contain a wider universe of articles (Franceschet, 2010). Indeed, Scopus provides significant insights and a greater possibility of analysis and filtering. In particular, an example of the proposed query is "Term_1" AND "Term_2" AND "Term_3" AND "Term_4" AND "Term_5" AND "PUBYEAR > year_min" AND "PUBYEAR < year_max" AND "Subject Area = SA1". Thus, the obtained result from a query would be: "Internet" AND "of" AND "things" AND "business" AND "management" AND "PUBYEAR >2007" AND "PUBYEAR <2020" AND "Subject Area = Business, Management and Accounting". In the second phase, we selected the articles or conference papers that would generate the most human-comprehensive conceptual structure for this subject to develop our proposition (Tranfield et al., 2003). From these, we chose only those that specifically adhered to the use of IoT and Big Data in business. In the third phase, we conducted the data analysis through a process of data extrapolation, following an accurate and thorough reading of the studies. We used a structured research framework based on an analysis of specific elements, such as the research theme (akin to the research question), the methodology of data collection and analysis, and the type of research (qualitative, quantitative, or review). Following the proposed methodology, our first analysis produced 1428 total documents from 2008 until 2019, derived from different combinations of our keywords. Notably, the amount of research has grown steadily since 2008, with a sudden increase beginning in 2014. After analyzing the results and considering the overlaps, our purification process narrowed the list to 560 unique publications. Moreover, after identifying the target articles, we thoroughly read each one to verify its consistency with the research objectives, as well as manually reviewed their bibliographies to find other relevant articles. We then excluded another 356 articles that did not meet the content criteria. Next, we reviewed and synthesized each article's results in a coherent and integrated manner (Bal and Nijkamp, 2001) in order to highlight the impact of business digitalization on the management functions most suitable for our scope (Koontz and Weihrich, 2015): planning, organizing, staffing, leading, and controlling. Fig. 1 provides a flow chart depicting the four phases (and their related sub-phases) followed in the literature review.

Ultimately, the process shed light on the opportunities and issues inherent to digitalization strategies, namely: Improving Business Processes; Business Management Innovation; Business models and organizational culture; Privacy and ethics; and Marketing strategies (Table 2).

4. General discussion

4.1. Improvement of Business Processes

Smart IoT devices allow managers and researchers to overcome old ways of doing business, thereby ensuring autonomous operation, sustainable values and self-optimization (Qu et al., 2018). As a result, production systems that incorporate IoT technologies become more effective and efficient, thanks to the self-nurturing potential of accurate knowledge and more informed decisions. When oriented toward business process management, IoT efforts support the implementation of machinery aimed at reshaping production processes or providing services according to IIoT approaches. Managers can then leverage the

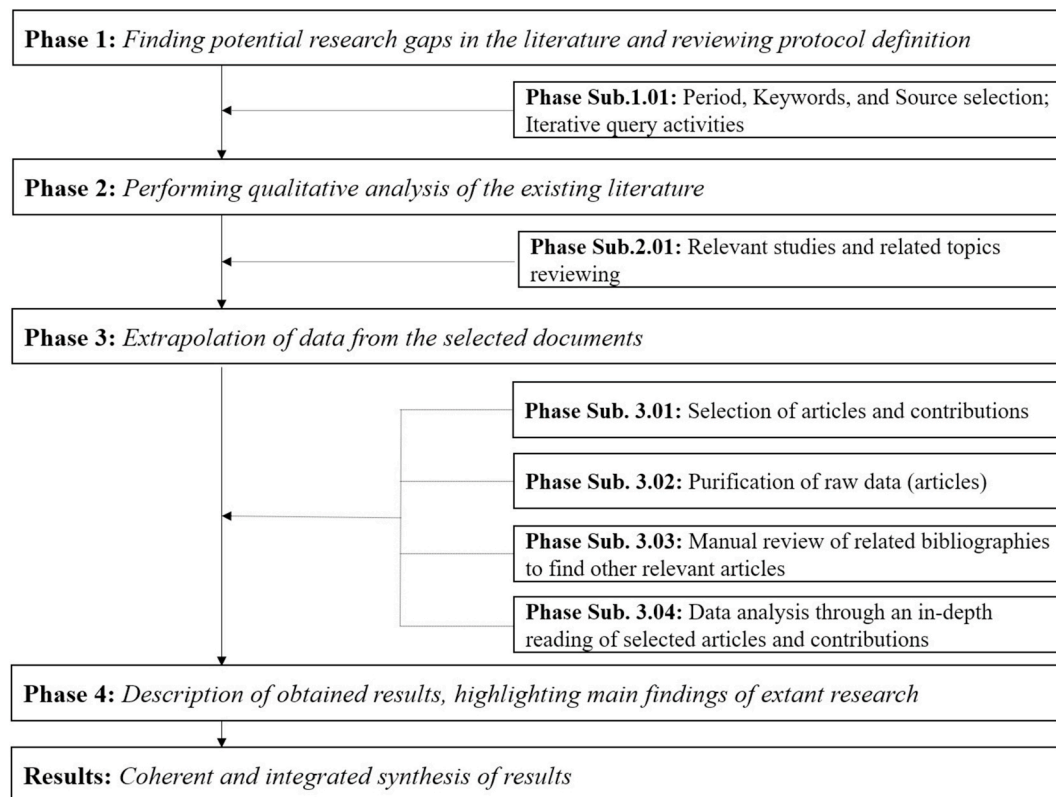


Fig. 1. Flow Chart of the literature review process.

resulting Big Data to perform valuable analyses that support strategic planning. Unlike traditional data sources (i.e., non-IoT computers, machinery), IoT devices produce large amounts of data in real-time, which allows managers to make rapid changes to production processes or services based on market loads or expectations. Furthermore, the greater speed, abundance, and heterogeneity of Big Data can improve the efficacy of qualitative data analysis (Dwivedi et al., 2019). Indeed, the knowledge derived from connected “things” can illuminate relationships and intuitions hidden in the data (Chui et al., 2010). IoT can be used to monitor production, intervene on stops, or quickly change production methods, all of which can have positive effects on production (Liu et al., 2017). Thus, the incorporation of such devices into daily functions could reveal operational inefficiencies in technical production or the organization of human work, which might then lead to cost reductions.

There are other interesting ways that IoT might transform traditional services. With such wide data availability about employees’ activities, firms might be able to better direct or empower their staff. In the service field, IoT devices such as Voice Assistant – “software agents that run on purpose-built speaker devices or smartphones” (Hoy, 2018, p. 82) – can be integrated into traditional services (i.e., hotel rooms, workplaces) in order to improve their planning and provision. IoT devices and data analysis could also strengthen security management services (Liu and Yang, 2011). Moreover, they could be integrated into production machinery to monitor the loading and unloading of goods, prevent production stops, reduce defects, or enable servitizing business models (Suppatvech et al., 2019). In the healthcare sector, patients could wear IoT devices that connect them to control platforms (i.e., software) monitored by doctors, who can promptly intervene in the event of abnormal health events or states, such as in telemedicine (Akhlaghi and Asadi, 2002) or Ambient Assisted Living systems (Dohr et al., 2010). Local governments could also use these devices to protect healthcare workers and curb dissemination in the event of an epidemic, such as with COVID-19 (McCall, 2020). Importantly, Big Data and IoT may inspire companies to rethink their Human Resources requirements in

terms of staff skills and capabilities (De Mauro et al., 2018; Gatouillat et al., 2018): In order to support traditional managerial functions and roles, companies may need to invest in data scientists, who are essential for extracting, manipulating, and managing the precious value derived from collected data.

IoT devices could also strengthen traditional digital platforms (i.e., customer experience platforms, information systems platforms, ERP, data analysis platforms) by facilitating greater monitoring, optimization, control, and performance evaluation. By strategically collecting and interpreting Big Data in the context of existing businesses systems, companies can achieve a more realistic and useful vision in the decision-making process. The resulting data flows can be collected and delivered to interested parties in order to manage processes, even remotely, or quickly change production plans, even in real-time. These changes could hasten prototyping cycles and accelerate the adoption of new products and services. Data can also be stored and analyzed in order to create intelligent objects (smart objects) whose programmed responses can deliver valuable knowledge and optimize business processes. In these ways, companies can build a product-centric organizational model capable of identifying objectives associated with product leadership, i. e., developing products and technological services, improving customer involvement, and enhancing competitive advantages.

4.2. Business Management Innovation

The diffusion of IoT guarantees the spread of “intelligent spaces”: physical and digital environments in which people and technological systems interact in a coordinated and networked manner (Korzun et al., 2013). These elements refer to spaces, processes, services, and things that create engaging, interactive and automated activities. However, in order to really exploit the advantages of IoT, firms need to go beyond mere integration and develop strategies for analyzing the resulting reams of data. In this sense, technology can simplify operations by offering management a more holistic view of the business and its various

Table 2
Summarized main topics related to IoT and Big Data according the Systems Approach to Management.

	Improvement of Business Process	Business Management Innovation	Business models and organizational culture	Privacy and ethics	Marketing strategies
Planning “Selecting missions and objectives as well as the action to achieve them, which require decision-making”	<ul style="list-style-type: none"> – IoT and Big Data might help to design products and services, on the basis of consumers’ <i>consumption experiences</i> (Bojanowska, 2019; Chang et al., 2014; Erevelles et al., 2016; Gao and Bai, 2014) – Business Process Reengineering based on <i>revitalization of technological contents in products or services</i> (Lee et al., 2018; Lu and Weng, 2018) 	<ul style="list-style-type: none"> – Constant interconnection bolsters the analysis of qualitative data producing a faster, more abundant, <i>heterogeneous and multi-source</i> generation (Dwivedi et al., 2019) 	<ul style="list-style-type: none"> – Technological environment is driving companies to adopt <i>hybrid business models</i> (Gupta et al., 2019; Hodapp et al., 2019) 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – IoT helps to collect a series of consumption data that marketing managers can use to identify new gaps, trends or variables in understanding consumer behavior; this involves examining attitudes and choices on a large scale (Boulos et al., 2015; Dekimpe, 2019; Tao et al., 2016) – Features integrated into IoT devices, such as voice commands and voice recognition, stimulate interaction in consumers who begin to think of their IoT device as a friend rather than as a technological tool (Hsiao and Chen, 2018) – None: Lack of research
Organizing “Establishing an intentional structure of roles to fill an organization”	<ul style="list-style-type: none"> – IoT and Big Data could help companies adopt mobile, <i>flexible, team-oriented, and non-routine working methods</i>, which would enable the creation of <i>digital workplaces</i> (Dubey et al., 2019; Rialti et al., 2020; Yildirim and Ali-Eldin, 2019) – Employees equipped with IoT devices can support the service <i>delivery processes</i> in an innovative way or improve the product <i>consumption experience</i> (Al-Halalmeh, 2018; Strohmeier, 2018) 	<ul style="list-style-type: none"> – R&D efforts might be oriented toward the integration of IoT in plants and machinery (process innovation) or in existing products (product innovation) (Frank et al., 2019) – IoT devices can strengthen traditional digital platforms (i.e., customer experience platforms, information systems platforms, ERP, data analysis platforms), as well as connect physical resources for the purposes of monitoring, optimizing, controlling, and evaluating performance (Bojanowska, 2019; Castro et al., 2012; Hodapp et al., 2019; Yerpude and Tarun Kumar Singhal, 2018) 	<ul style="list-style-type: none"> – Communication and dissemination of corporate strategies; creating innovative workplaces (Koren and Klamma, 2018) 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – None: Lack of research
Staffing “Filling and keeping filled identifying requirements, placing, promoting, appraising, career planning”	<ul style="list-style-type: none"> – IoT and Big Data activate <i>collaborative practices</i>, aligning the process of selecting technologies for redesigning internal processes with the new desired ways of working, involving staff at all levels (Donalek et al., 2014; Peng et al., 2018) 	<ul style="list-style-type: none"> – None: Research required 	<ul style="list-style-type: none"> – Big Data Analytics and integration require business to rethink their Human resources and new <i>skills</i> needs (De Mauro et al., 2018; Gardiner et al., 2018) 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – None: Lack of research
Leading “Influencing people so that they will contribute to organizational and group goals”	<ul style="list-style-type: none"> – Technology simplifies operations by offering management a more <i>holistic view</i> of the business and its various activities (Kip and van Gemert-Pijnen, 2018) 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – None: Lack of research 	<ul style="list-style-type: none"> – None: Lack of research
Controlling “Measuring and correcting individual and organizational performance to	<ul style="list-style-type: none"> – IoT guarantees reductions in time and costs, positively affecting efficiency or service levels, thereby impacting effectiveness (Manavalan and Jayakrishna, 2019) 	<ul style="list-style-type: none"> – IoT devices could be <i>integrated into production</i> machinery to monitor the loading and unloading of goods (Frank et al., 2019; Suppatvech et al., 2019; Tao et al., 2016) 	<ul style="list-style-type: none"> – Real-time data production allows managers to make <i>real-time decisions</i> and modify production processes or services based on market loads or expectations (Yerpude and 	<ul style="list-style-type: none"> – IoT and Big Data diffusion facilitates <i>preventive analysis and evaluation of the risks</i> related to privacy through the introduction of new 	<ul style="list-style-type: none"> – None: Lack of research

(continued on next page)

Table 2 (continued)

	Improvement of Business Process	Business Management Innovation	Business models and organizational culture	Privacy and ethics	Marketing strategies
ensure conformity to plans"	– IoT is often used to monitor production, intervene on stops, or quickly change production methods with <i>positive effects on TQM</i> (Liu et al., 2017)	– IoT and related Big Data could help to prevent production stops, reduce defects, or enable <i>servitizing business models</i> (Metallo et al., 2018; Suppatvech et al., 2019) – The set of collected data, when properly studied, provides the foundations for the <i>technical construction of new product components</i> (Lu and Weng, 2018)	Tarun Kumar Singhal, 2018	professional roles. Furthermore, it is mandatory to adopt adequate measures for the <i>protection of personal data</i> , by safeguarding systems for both consumers and employees (Ogriseg, 2016; Rahim et al., 2017; Vermanen et al., 2019)	

activities. Managers can use data about past events to identify current trends and simulate future scenarios. For example, future research should focus on the introduction of advanced technologies, such as machine learning, and how the information they provide can automate production and accounting processes, validate proposed strategies and actions, and facilitate predictive analyses and automation tools (De Mauro et al., 2019). Additionally, IoT might be valuable for spreading innovative workspaces and communicating corporate strategies (Koren and Klamma, 2018). Because data can come from distant geographical locations, IoT allows management to compare results and better tailor their production and decision-making processes. Furthermore, intelligent products can provide information on how consumers use them, thus empowering firms to adapt quickly to the real needs of the market, increase productivity, and achieve high returns on expected investments.

4.3. Business models and organizational culture

As the Digital Revolution pushes companies to adopt hybrid business models (Gupta et al., 2019), it is important to remember that such transformations must be supported by adequate investments in people skills and corporate culture. Culture can be a strong determinant of how quickly companies embrace a digital transformation and should thus be the basis for any technological choices (Acar and Acar, 2012; Hock-Doepgen et al., 2020). When selecting technologies to redesign their internal processes, companies should involve staff at all levels and focus on new ways of working (Donalek et al., 2014; Peng et al., 2018). In this vein, companies could create digital workplaces structured around mobile, flexible, team-oriented and non-routine working methods. However, to capitalize on the technology and process innovations, firms should consider individuals' psychological needs and attitudes toward change in order to mitigate job insecurity (Nam, 2019). Indeed, some employees could be reluctant to move away from the established organizational culture and thus experience feelings of uncertainty (Cullen et al., 2014).

4.4. Privacy and ethics

With IoT, it is essential that technological progress be accompanied by considerations about ethical, social, and data security. Companies must work to protect consumers from the loss of data or privacy, or else risk damaging their own trustworthiness (Guo et al., 2013; Lohachab and Jangra, 2019). Despite the profuse impact of IoT on daily life, consumers might lose their willingness to engage with online platforms and mobile devices if their privacy concerns become too great (Kreuter et al., 2018; Taylor et al., 2018). Thus, companies are challenged to balance their own interests against users' privacy concerns (Khan et al., 2018; Rastogi and Nath, 2010). Profiling consumers can be useful for optimizing internal processes or analyzing consumers' interests, but the compilation of individual data and correlation with other profiles

creates a swath of security concerns (Ziegedorf et al., 2014). Privacy protection is further complicated when discussing tools such as location and geo-referencing (Compagno et al., 2015; Jung and Park, 2018). As the volume of data grows, companies should implement an ethical system that can address these emerging needs. People are increasingly concerned about how companies use their personal data, and it falls on companies to take actions that stimulate the kind of trust that fosters loyalty. For this reason, decision-makers need to involve users when developing digital ethics practices. Notably, some concerns over privacy may be abating: As one recent study (Gutierrez et al., 2019) found, individuals are gradually becoming amendable to the sharing of personal data and the related benefits.

4.4. Marketing strategies

Thanks to the accessibility of new tools, marketing managers can collect large-scale consumption data in order to identify new gaps or emerging trends on consumer behavior. The papers we reviewed highlighted that IoT's main marketing advantage is in supporting decisions and campaigns with real-time data (Hofacker et al., 2016). However, IoT diffusion also presents a major opportunity to create stronger bonds with consumers: The movement toward multichannel, multimodal and omnichannel experiences will increase users' immersion, which may then increase customer retention and data accessibility. On this point, IoT raises new opportunities for improving consumption experiences. New payment instruments enable consumers to order products and services directly through a device without ever visiting an online store. Moreover, IoT contributes to post-purchase phases by stimulating reviews, website visits, product research, and word-of-mouth. Furthermore, as online connection becomes the norm, people will expect more speed and personalization. Features integrated into IoT devices, such as voice commands and voice recognition, may satisfy these desires, while simultaneously encouraging consumers to think of their devices (e.g., smart watch, smartphone, home kit) as friends rather than mere tools (Hsiao and Chen, 2018). Companies can also use digital marketing tools to refine and emphasize the customer journey (Bijmolt et al., 2019). For instance: Thanks to IoT devices, consumers now have a direct line with companies. Vice versa, companies can leverage consumers' real-time data flows to continually improve their products and marketing campaigns. Moreover, smart objects (those imbued with IoT) are becoming prominent in the shopping environment and retail sector in general (Novak and Hoffman, 2019), thereby contributing to omnichannel experiences that blend online and offline channels (Verhoef et al., 2015). Consumers use their smartphone during their pre- and post-purchase activities, comparing prices, checking product availability, looking for information on features or reading online reviews (Erevelles et al., 2016). This volume of data increases dramatically when considering all the *touchpoints* that today's stores are equipped with (e.g., interactive totems, voice assistants, displays). Retailers could additionally collect

their customers' transaction data and provide offers based on highly personalized marketing strategies. These opportunities widen further when considering the explosion of data generated by emerging technologies, such as Artificial Intelligence (Dwivedi et al., 2019). For instance, companies could adopt smart solutions – such as Virtual Customer Assistant (VCA), chat box or Virtual Personal Assistant (VPA) – in order to guide customers through their journey and suggest the most appropriate actions. Furthermore, IoT-related tools (beacons, NFC, apps, interactive *touchpoints*) can encourage geo-marketing and geolocation strategies. Meanwhile, purchasing behaviors and interactions can be analyzed to derive more customer-friendly promotions, announcements, or email marketing.

5. Conclusions

For businesses, the evolution of digital technologies is marked by both great opportunities and complex challenges. Given the rising interest in IoT and Big Data, this study sought to outline the state-of-the-art in business digitalization and enrich current theorizing. The growing popularity of IoT and Big Data has made them central to business digitalization strategies. However, the movement from IT and technical domains to applied engineering, management, marketing and social sciences has resulted in a mass of disorganized knowledge. Through a systematic literature review, this study analyzed IoT and Big Data adoption in the field of business management, with the goal of assessing how these phenomena can positively affect the digitalization of business strategies. In broad terms, managers and marketers can integrate new devices into traditional processes or equip products and services with greater technological content. In this way, companies can collect and analyze the feedback data in order to design appropriate business strategies. More specifically, there are a great deal of hidden opportunities in such expansive data flows, including human behavior studies, the redesign of business processes, and the expansion of service activities.

Regarding the first opportunity, our review could be useful to understand the positioning of future research, placing contributions in a precise theoretical background. Secondly, our study substantiates the multidisciplinary nature of IoT and Big Data by examining their evolution about the Improvement of Business Processes; Business Management Innovation; Business models and organizational culture. Thirdly, the present study also highlights the value of both digital business transformation – in terms of relevant changes to organizational processes, structures and system applied to develop organizational performance through increasing the use of digital media and technology platforms – and also change management – the management of process, structural, technical, staff and culture change within an organization. Specifically, our study makes clear that companies will need to assess the positives and negatives of adopting these technologies (in terms of improved performance or higher anxiety), as well as determine whether they will develop skill sets internally or seek external partners. In short, IoT and Big Data analysis have the potential to radically change the way businesses and people interact: The ability to electronically manage objects in the physical world makes it possible to exploit data-driven decision-making to optimize the performance of systems and processes. Ultimately, deeper digitalization may save time, improve people's quality of life, and revitalize businesses.

That said, our research could have some limitations. Firstly, our selection criteria may have excluded some research articles. Likewise, we only considered contributions written in English and thus may have overlooked relevant documents in different languages. Lastly, despite the strength inherent to a systematic approach, we ultimately relied on human discretion to accurately classify and synthesize the articles' results, which naturally carries some risk of oversight.

In conclusion, companies seeking to digitalize their business must learn how to listen to and interpret the great noise generated by IoT and Big Data. If they pursue a simple technological adoption without

considering a strategic framework, they may blunt – or even undermine – their effort to generate value. As part of a revitalization strategy, IoT and advanced analytical approaches might potentially create intelligent environments that can transform structures, processes and services. In short, companies should see IoT as not just a tech opportunity, but a business opportunity. To this end, they need to not only equip themselves with the best available technology on the market, but also develop strategies and practices for using it that will foster competitive advantages. At the same time, firms need to also mitigate potential issues related to data security and privacy, balancing their desire for innovation and advantage with consumers' expectations and ethical norms.

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