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The role of Big Data in the business challenge of Covid-19: a systematic literature review in managerial studies

Michela Piccarozzi^{a*}, Barbara Aquilani^a

^a*Department of Economics, Engineering, Society and Business Organization, University of Tuscia, Via del Paradiso 47, 01100, Viterbo, Italy*

Abstract

2020 was globally greatly affected by the Covid-19 pandemic caused by SARS-CoV-2, which is still today impacting and profoundly changing life globally for people but also for firms. In this context, the need for timely and accurate information has become vital in every area of business management. The spread of the Covid-19 global pandemic has generated an exponential increase and extraordinary volume of data. In this domain, Big Data is one of the digital innovation technologies that can support business organizations during these complex times. Based on these considerations, the aim of this paper is to analyze the managerial literature concerning the issue of Big Data in the management of the Covid-19 pandemic through a systematic literature review. The results show a fundamental role of Big Data in pandemic management for businesses. The paper also provides managerial and theoretical implications.

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1. Introduction

2020 was globally greatly affected by the Covid-19 pandemic caused by SARS-CoV-2, which is still today impacting and profoundly changing life all over the world.

The pandemic has inevitably had consequences at a global economic level, with particular impact on international market and trade [1]. Firms are having a hard time and continue to face the dramatic consequences and business

* Corresponding author. Tel.: +39 0761352706

E-mail address: piccarozzi@unitus.it

challenges that Covid-19 is constantly creating. Firms have had to immediately rethink business models, strategies and forecasting tools to adapt their behavior and activities to the new scenario that has emerged [2].

In this context, the need for timely and accurate information has become vital in every area of business management, from strategic planning, to production dynamics, to relationships with customers [3].

The digital transformation process, which began some years ago [4], has seen a need to accelerate, to face and to satisfy this new emerging scenario [5].

Furthermore, the spread of the Covid-19 global pandemic has generated an exponential increase and extraordinary volume of data [6] and created the need to manage and monitor these data in order to obtain relevant information and benefits for management [7].

Big Data is one of the digital innovation technologies that can support business organizations during these complex times [8].

Even though widely investigated within literature, Big Data still remains an uncertain and abstract topic from various points of view [9]. The definition of Big Data, for example, is still today a controversial concept for scholars [10–13] although its characteristics have evolved and expanded over the years, these are issues that certainly require further study [14,15].

An interesting definition of Big Data is provided by Buhl et al. [16] (p. 68) who consider Big Data “a multidisciplinary and evolutionary fusion of new technologies in combination with new dimensions in data storage and processing (volume and velocity), a new era of data source variety (variety) and the challenge of managing data quality adequately (veracity)”. The authors also highlight the multidisciplinary aspect of Big Data which, like the other enabling technologies of Industry 4.0 [17–19], are tools formed within the engineering domain that have rapidly expanded to the managerial field, from production techniques to strategies, without neglecting their social impact [20–22].

The multidisciplinary nature of Big Data verifies its versatility and ability to support numerous decision-making processes, not only related to the managerial sphere [23,24]. The earliest uses and applications of Big Data in the context of the Covid-19 pandemic were certainly in the medical and biological fields. Indeed, Bragazzi et al. [25] (p. 3176) state that “Big Data can help handle the huge, unprecedented amount of data derived from public health surveillance, real-time epidemic outbreak monitoring, trend now-casting/forecasting, regular situation briefing and updating from governmental institutions and organisms, and health resources utilization information”.

Looking at the managerial use of Big Data in Covid-19, there are as yet a limited number of studies, also due to the recent emergence of the topic. In particular, there is no precise systematic analysis of the literature that organizes contributions published to date. Only one paper [6] initiates a first joint analysis of the two topics in the managerial field by examining methodological analysis innovations in studying Big Data and how they can be better used to examine contemporary organizational issues.

This allows us to highlight a gap in the existing literature and the need for some clarification.

Therefore, the aim of this paper is to analyze the early research of managerial literature concerning the issue of Big Data in the management of the Covid-19 pandemic.

To achieve this objective, this paper focuses on three research questions:

1. What are the main issues analyzed by researchers in the study of Big Data and Covid-19?
2. What is the use and/or application of Big Data described by researchers?
3. What is the contribution of Big Data to the management of the pandemic from a managerial point of view?

In relation to the third research question, if the contribution of Big Data is highlighted and discussed in the selected papers, it will be classified as positive, negative or nil, depending on its content.

The paper is structured as follows: Section 2 sets out the methodology adopted, Section 3 presents the main findings of the analysis, Section 4 provides a discussion of the three research questions in light of the findings, and finally Section 5 sets out the conclusions, managerial and theoretical implications as well as limitations and future steps of the research.

2. Methodology

This extended abstract is based on a systematic literature review.

Following the consideration of different authors like De Mauro et al. [15], Merli [26] and Sassanelli et al. [27] the Elsevier's Scopus and Web of Science (WoS) databases have been selected for the research.

This systematic literature review was carried out from the 13th of January to the 4th of February 2021. Figure 1 shows the rational scheme of the systematic review conducted, highlighting the steps and their rationale in order to present a reasoned and replicable process.

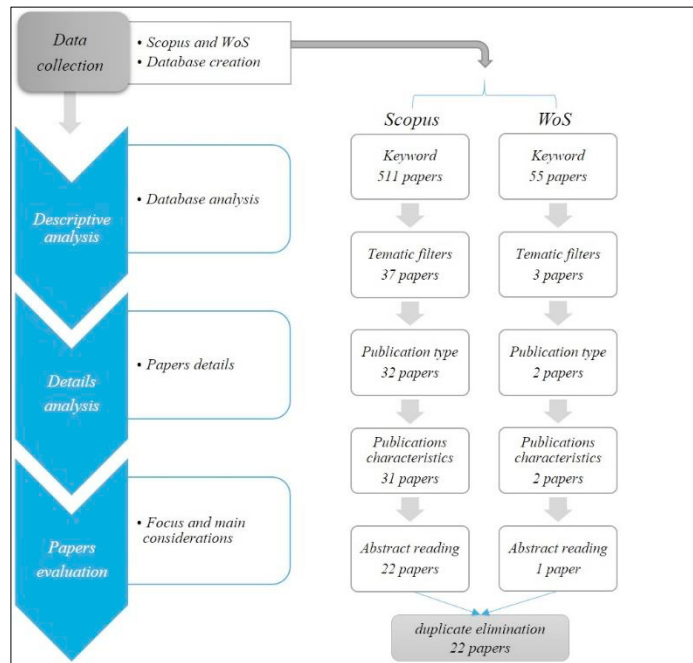


Fig 1. Systematic review process scheme

The research process begins with data collection through the selection of keywords.

To define the analysis and have a first selection of papers closely connected to the topic studied, the keywords "Big Data" and "Covid-19" were selected. There were 511 papers resulting from the research in Scopus and 55 papers in WoS. The results were further filtered to delineate a number of papers falling within the management domain. In particular, the thematic filter made available by the Scopus database relating to "Management, Accounting and Business research" was applied with 37 resulting papers. In WoS, the filters of "Business" and "Management" were applied with the result of 3 papers.

To select only papers of proven scientific reliability, only those published in Journals were chosen: 32 papers in Scopus and 2 papers in WoS. Then, only papers in English were selected and the results gave 31 papers in Scopus and 2 papers in WoS. Moreover, reading the abstract of the 33 selected papers, established their concrete relevance to the topic studied and their belonging to the managerial field. 22 papers were found central to the research in Scopus and 1 paper in WoS.

In the last step of the selection, the results of the two databases were compared to identify any duplicate papers.

The only paper selected in WoS was already present in Scopus and was therefore discarded.

The final number of papers, following this systematic literature review, was 22. The selected papers were downloaded and a database was created to support subsequent analyses.

The database contains: authors, title, publication details, year, geographical origin of the first author, research methodology, main topic, use of Big Data and contribution to pandemic management.

3. Results

Following the review process (please see Figure 1), the research was divided into three sections. In the first section, the descriptive analysis of the selected papers was to understand the main aspects, such as origin of authors and publication journals.

The second section provides the detailed analysis of the methodological approaches of scholars in this domain of research.

Finally, the third section, focuses on paper evaluation. The content of individual papers was analyzed in detail to extract information useful to provide an answer to the research questions formulated in the objectives section: topics, use of Big Data and contribution of Big Data to the management of the pandemic.

In the first section of the analysis, the year of publication was considered. Obviously, the papers were mainly published in 2020 (19 papers, 86% of the sample) while 3 papers were published in 2021 (14% of the sample). This clearly depends on both the extraction of the data and the increase of the pandemic in 2020.

Examining the journals in detail to understand in which of them the papers had been published, some coherence emerged between the subject matter studied and its outlet. Notably, the Journal with the highest number of publications is "Technological Forecasting and Social Change" with 3 papers (14% of the sample). Indeed, this Journal is very pertinent to the topic analyzed and one of its main applications is the planning and analysis of forecasts (see below). Other journals that emerge are "IEEE Engineering Management Review" and "Journal of Small Business and Entrepreneurship" with 2 papers respectively (9% of the sample). The first Journal would indicate that Big Data is certainly a topic at the intersection between engineering and managerial studies, while the second Journal anticipates what will later emerge concerning small and medium-sized enterprises (SMEs) (please see below).

The last analysis of this first section focused on the geographical origin of the first author of the paper.

From this geographical analysis it is clear that European scholars more frequently propose studies in this field; in particular, UK (3 papers, 14% of the sample) France (2 papers, 9% of the sample) and Spain (2 papers, 9% of the sample).

Overall, the European continent contributes 12 papers (55% of the sample). The remaining contributions come from Asian countries (5 papers, 23% of the sample), the USA (2 papers, 9% of the sample), Africa (2 papers, 9% of the sample) and Australia (1 paper, 5% of the sample). The prevalence of studies in the European area can be partly justified by the dramatic impact of the pandemic at an economic level and the participation of management scholars to help firms in coping with this challenge. Indeed, China, where Covid-19 initially appeared, has seen its GDP grow at 2.3% on the 2020 annual basis with a growth of 6.5% in the last trimester 2020 [28].

In the second section authors attention was shifted to more detailed aspects of the papers and in particular to the methodology used. The analysis of the papers shows a slight prevalence for empirical studies (13 papers, 59% of the sample) compared to conceptual ones (9 papers, 41% of the sample). The papers based on an empirical study are almost all quantitative (8 papers, 62% of the sample); they use surveys (5 papers) and mathematical models (3 papers) for their research method. The qualitative papers on the other hand (5 papers, 38% of the sample) use research methods such as: case study (2 paper), content analysis (2 paper) and interviews (1 paper). Given that the study of these two topics is still in its early stages, it is therefore impossible to affirm the prevalence of one methodology or research design over another to better study the topic. It is only possible to hypothesize that the slight prevalence of empirical and quantitative research based on surveys may be linked to the need to empirically evaluate what is happening directly within firms in the pandemic context and then proceed to formulate hypotheses of conceptual models or reference frameworks. Fortunately, these types of shocks are quite rare and even if firms can learn from the past, the economic and business context is really different; direct study of what happens in firms can help understanding the long-term outfalls of the pandemic [29].

Conceptual studies, on the other hand, are related to literature reviews; they support the formulation of propositions to be further explored on behaviors and implications for businesses.

The third part of the analysis encompasses, above all, the topic on which the research is focused (please see Table 1).

Table 1. Topic details.

Topic	n.	%
Small Medium Enterprises (SMEs)	3	14%
Supply Chain	3	14%
Sustainability	3	14%
Tourism	3	14%
Digitalization	2	9%
Human resources	2	9%
Consumers	1	5%
Knowledge Management	1	5%
Marketing	1	5%
Open Innovation	1	5%
Quality	1	5%
Research methodology	1	5%
Total	22	100%

SMEs, Supply Chain, Sustainability and Tourism (12 papers, 55% of the sample) are the topics most analyzed in papers and clearly refer to businesses most affected by the pandemic [30] (Nicola et al., 2020). From the analysis of the papers (please see Table 2) it emerges that Big Data are usually used in the planning phase of business activities (11 papers, 50% of the sample). At the same time, it appeared clear that Big Data are also useful in other business activities, like consumer behavior analysis (4 papers, 18% of the sample) or strategy formulation to enable businesses to survive (3 papers, 14% of the sample).

Table 2. Use/Application of Big Data details.

Use/Application	n.	%
Planning	11	50%
Consumer behavior analysis	4	18%
Survival analysis of business	3	14%
General analysis of business	2	9%
Collaboration decision	1	5%
Service quality check	1	5%
Total	22	100%

Finally, the last level of analysis made it possible to focus on the contribution of Big Data on the management of the pandemic. In this regard, 95% of the retrieved papers (21 papers) highlight a positive contribution of Big Data to the management of the pandemic; only one paper does not identify the type of contribution made by Big Data to the management of the pandemic.

4. Discussion

RQ 1. What are the main issues analyzed by the researchers in the study of Big Data and Covid-19?

From the analysis of the results, it emerges that the field of application of Big Data in business management is very extensive. Indeed, the areas of application that have emerged are numerous (12 different topics in 22 papers analyzed). From the results it is possible to state that there is a prevalence of SMEs, Supply Chain, Sustainability and Tourism for example, in these first published contributions.

SMEs are an area of considerable interest and importance. The use of Big Data in SMEs appears to be closely linked to the survival of these firms. In particular, Akpan et al. [31,32] argue that the knowledge and correct application of Big Data and other innovative technologies are fundamental for the survival of SMEs in the current pandemic context, not only for management but also for maintaining a competitive advantage. The authors also focus on the possibility of the pandemic breaking down entrepreneurial resistance to the use of new technologies and Big Data, moving business management towards innovation. Moreover, Akpan et al. [31,32] underline that the adoption of innovations such as Big Data does not always involve huge financial investment, given that nowadays there are also low-cost technologies including Big Data.

In our opinion, the Big Data support of SMEs is not only the main issue studied so far, but is one of the major potentials that emerged from the literature review. Indeed, SMEs were the firms most affected by the pandemic [33] and Big Data represented one of the few technological tools (especially among the enabling technologies of Industry 4.0 [34]) able to be readily understood and used in such a context. The ease of the use of this enabling technology is linked not only to its cost-effectiveness, but also to the possibility of management to read and interpret them, even without particular skills [35].

Another emerging issue is related to the Supply Chain that has been hit hard by the advent of the pandemic [36]. In this context, the authors underline the support of Big Data in defining a new structural definition of the supply chain [37] and in looking for a marked orientation towards flexibility [38,39]. Belhadi et al. [40] also state that Big Data can help identify risks along the supply chain. In this context Big Data will continue to make an important contribution to the restructuring of supply chains, especially at the global level where the effects of the pandemic have been felt most [41]. In our view, the role of Big Data in this context must be closely linked to the next topic that emerged from the literature, the sustainability issue. Big Data will be truly useful in defining a new supply chain that respects not only the new scenarios and needs of businesses, but above all the three pillars of sustainability - environmental, economic and social. Indeed, the crisis that the pandemic has created in supply chains, especially at a global level, is now pushing companies to increase, and in some cases recover, the credibility of their businesses by focusing on sustainability. Therefore, in the post-pandemic era, increasingly complex and transversal data will be needed to build and monitor supply chains in order to link technical requirements with brand image and reputation.

In this context, the analysis of Big Data simultaneously permits consideration of technical data of supply as well as the more qualitative data related to sustainability issues (such as consumer preferences and their orientation towards environmental sustainability or social issues), emerging as a key tool to face the hardest challenges of firms nowadays.

Within the topic of Sustainability, authors underline the use of Big Data in a planning perspective. In planning and entrepreneurial choices, the orientation towards sustainability can be validly supported by the use of Big Data. In particular, according to Chaves-Maza and Fedriani Martel [42], the use of Big Data is strategic in order to support firms in the pursuit of economic and social sustainability, which has become critically significant and more acute with the advent of the pandemic. In particular, the Covid-19 pandemic will continue to provide instruction at health, environmental and human levels toward more fairness, human cohesion and environmental attention, and in this context Big Data can play an important role in guiding firms not only in planning activities that respect these principles but also in verifying the achievement of goals in these domains. Therefore, in our opinion, the use of Big Data can be pivotal in both planning and implementing sustainability.

Finally, in the domain of Tourism, Big Data can be of considerable support for the management of risky situations and can allow better organization of tourist activities, as well as for the study and forecast of the resumption of post pandemic activities [43]. Park et al. [44] and Falk et al. [45] also underline the fundamental contribution of Big Data in the analysis of consumer preferences and orientation in the current context of the health emergency. Such data can provide advance information regarding customer needs and expected behavior. Therefore, in the tourism sector, but also at a more general level and in all sectors more or less affected by the pandemic, it appears essential to use Big Data to enhance all decision-making processes, starting from strategic ones. To do so, it is necessary to invest in data, analyses and also alliances so that the use of Big Data be both effective and useful in all these firm activities.

However, it is important to remember that Big Data cannot be considered a stand-alone tool. It is necessary to purposely integrate it into businesses and organizational structures, adapting it to the values and needs that arise from time to time. Indeed, the long-term application and usefulness of this data, not only in the event of an emergency such as the one firms have experienced, requires a profound revision of firm business models, organizational structures and, last but not least, corporate values [46].

RQ 2. What is the use and/or application of Big Data described by the researchers?

The topics analyzed have partly highlighted some details relating to the use and/or application of Big Data in the new needs dictated by Covid-19. In particular, many of the Big Data applications that emerged are linked to the business planning process (11 papers). This result underlines the wide information range of Big Data, which starting from planning, are able to support other even more specific decisions related to the consumer, relationships and quality management. In particular, managing the situation related to Covid-19, Almeida et al. [47] (p. 100) argue that “an exponential growth in the use of big data is expected to forecast sales of products or services, to predict customer behavior, to analyze consumer trajectory in physical and virtual spaces”. This statement heralds an even more consistent use of Big Data, not only in this core phase of the pandemic, but certainly also in the coming years to cope with the emerging and ever-changing needs of the consumer. In our view, independently of the present adoption and/or application of Big Data in businesses, its integration with existing tools and processes remains a key issue. In particular, Big Data will more and more be able to provide useful data for management, in its various fields, both by supporting already existing processes and by giving input to new management models and innovative processes. At the same time, the full potential of such a tool can only be achieved by combining Big Data with new enabling technologies (i.e., artificial intelligence, machine learning or virtual reality); Big Data, in this way, will be able to both express its full potential and push towards a more pervasive business digitization.

RQ 3. What is the contribution of Big Data to the management of the pandemic from a managerial point of view?

Finally, the analysis clearly shows that in most papers (95% of the retrieved papers), the authors underline a positive contribution of Big Data to overcome the challenges imposed by Covid-19. It is interesting to underline that Akpan et al. [31] affirm the positive contribution of Big Data in creating an “open” firm able to dialogue and understand the economic context in which it operates. Moreover, Akpan et al. [32] affirm that Big Data also contribute to the reduction of management costs being, among the various enabling technologies of Industry 4.0, certainly the least expensive. The positive contribution of Big Data described in the analyzed papers focuses mainly on its application in the business environment. Some papers study specific sectors such as hospital management, transport or even goods and services. In the hospital sector, in particular, Big Data is being applied in the analysis of data generated by sensors and health databases to produce statistics on Covid-19 outbreaks and other reports to limit the effect of the pandemic worldwide. Data was also used to improve operation flexibility in hospital supply chains. No unambiguous criterion or application for the use of Big Data exists and this highlights the practical knowledge still being developed by firms in the application of this innovative tool. It seems clear that Big Data is not consolidated in business processes but has responded to an emergency situation by becoming the simplest tool to face the challenges brought about by the pandemic.

Therefore, there is often no maturity and no integration or integrated use of Big Data in business management. The positive contribution of it largely refers to its use in a single process and/or activity within firms, but there is a lack of systematic and integrated use in overall business management.

Moreover, it is clear that none of the papers provide a method for analytically assessing the contribution that Big Data has made to businesses in tackling the pandemic. Therefore, there is no criterion for measuring the benefits of such data in terms, for example, of savings in management costs. This aspect could be extremely interesting and useful in future research developments.

In an overall view, Figure 2 graphically summarizes the use/application of Big Data in pandemic management for businesses, as well as the main topics of study emerging from the literature.

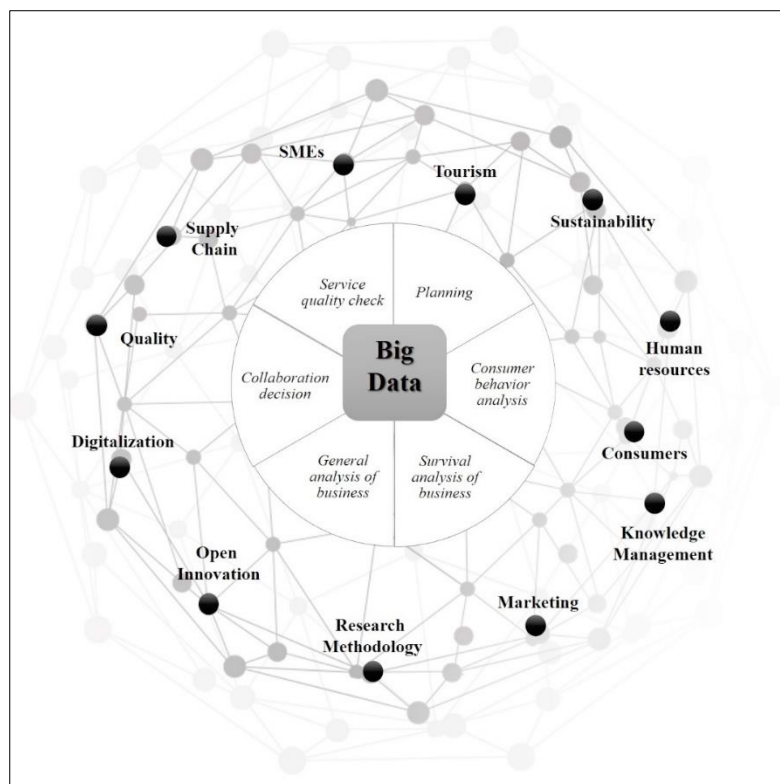


Fig. 2. Overview of the main findings of the literature review.

5. Conclusion

Analysis of the early management literature on the role of Big Data in pandemic management shows that it has had numerous applications. As the results of the systematics show, there are several topics related to enterprises, their management during the pandemic and the use of Big Data: from the management of SMEs, the new dynamics of the Supply Chain, the aspects of sustainability, up to issues related to quality and marketing. This underlines the wide versatility of Big Data in the managerial field and especially in a crisis management perspective. The versatility of this technology also emerges from the analysis of the second research question, which highlights the business process in which Big Data has been predominantly applied. The results show a prevalent use in planning, but at the same time, it is interesting to see how Big Data information has been useful in managing the new dynamics of the consumer as well as an analyses of business survival. What clearly emerges from this first analysis of recent literature is that all authors (95%) affirm that Big Data has made a positive contribution to firm management of the pandemic.

This enabling technology, among all those introduced with Industry 4.0, seems to be the most easily adaptable to the needs of businesses (even SMEs) and above all one of the least expensive in terms of acquisition and application.

It is therefore possible to assert a central role for Big Data from a managerial point of view in addressing the challenges and complexities posed by the pandemic. The use of Big Data, consolidated and integrated more and more into firm management, can lead to positive results in terms of accurate forecasts and stability of operations, both from a purely operational/productive point of view and also from a commercial point of view (think of the accurate analysis of consumer behavior and their sudden changes in view of the external environment).

In conclusion, it is necessary to point out some limitations of the paper, besides the theoretical and managerial contribution made. Indeed, the paper presents a series of limitations related to the methodology used. First of all, the choice of keywords. The limited number of keywords selected to implement the systematic review of the literature could lead to a limitation and determine a reduction in the number of papers extracted from the research. Although the choice of keywords was motivated (see methodology) and is the result of an evaluation and methodological choice

by the authors, this however represents a limitation that must be acknowledged. Furthermore, the paper has theoretical and managerial implications. From a theoretical point of view, the paper provides an initial approach to systematize what emerges in relation to Big Data and Covid-19 within managerial literature. The pandemic has led to the rapid growth of research and papers on these topics and it is therefore extremely important to order the contributions into different clusters. This systematization of the published literature can be a guide and a support as well as an inspiration for researchers and scholars who wish to further understand the possible and numerous implications of Big Data in the pandemic context. From a managerial point of view, the paper informs managers and entrepreneurs of the possible scope of Big Data in this pandemic context. The systematization of the papers and their topic organization provides a more organic understanding of the uses and usefulness of Big Data tested or hypothesized by researchers through their studies. Indeed, managers and entrepreneurs must understand that it is extremely necessary within this new Covid-19 reality to resort to the use and support of technologies, Big Data in particular, not only for large companies capable of huge investments, but also, and above all for SMEs.

Finally, future research steps should be considered. First of all, given the replicability of the review methodology used, this work could be further expanded and updated. By selecting additional databases and keywords, a much broader view of the topics covered could be provided. Moreover, through a set of ad hoc indicators, it could be interesting to define a precise measurement of the contribution of Big Data in economic-financial and/or qualitative terms. Indeed, in the analysis of the contribution that emerged from the papers, no author formulates a precise measurement of the value generated by Big Data. Moreover, a further future interesting topic to be analyzed, which has not yet been identified in published papers, is related to the possible problems or issues of security and privacy using Big Data.

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