Towards a Systematic Review on Industry 4.0: Big data & Internet of things

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Abstract. Digital technologies are occupying more and more a very important place in the industry, and more precisely with the 4th industrial revolution or what is called industry 4.0. In addition, digital transformation requires the implementation of two tools: Big data and the Internet of Things as the two starting tools, which continue to evolve gradually.

Intending to explore on this area, this paper studies the literature to get a detailed understanding of Industry 4.0, as well as an overview of the two digitization tools namely big data and the Internet of Things used to improve the quality of processes in different areas. Through a systematic literature review (SLR), the study is an effort to provide an overview of existing big data and the Internet of Things in the literature and to study the existing studies to classify them by application domain and according to a developed architectural framework. The search identified 81 relevant articles. Analyses of the distribution of articles by publication year, domain, country, type, tool, and source are presented and discussed. A research agenda for future research are provided.

Keywords— Industry 4.0, Big data, Internet of things, Logistics, Systematic literature review.

1 Introduction

Industry 4.0 was first introduced in Germany in 2011 [1], and it is the result of the technological progress of the fourth industrial revolution. Industry 4.0 helps constant changes even within companies, these changes have introduced the concept of Company 5.0: this concept was introduced by the Japanese government in 2015, which bets on a future super-smart company. However, the concept of Industry 4.0, within companies, is nothing if it is not integrated with the concept of lean manufacturing [2,3,4]. The success of an Industry 4.0 system is highly correlated with the success of lean manufacturing, and the growth of the company's performance depends on both factors.

Many authors, including [5], have compared the different studies related to Industry 4.0 by analyzing the main technological developments, the most important innovations, trends, challenges, and the consequences of Industry 4.0 on economic, industrial, and social aspects. Others, [6], focused their studies on Industry 4.0. Trying to find out how smart production can increase the logistics of the company.

Currently, there is a large body of literature on this area of research but there is no overview. Based on this, this research will provide an overview by listing all relevant information available by conducting a systematic literature review (SLR). This article strives to expose and discuss big data and the Internet of Things.

In addition, it gives an overview of the current state of the art in this field concerning years, topics, sources, and domains.

The rest of the paper is structured as follows: In the first section, we review the literature on BD and IoT, and then present the research methodology. Then, we present a detailed result and discussion. The paper ends with a conclusion and future research directions.

2 Review of the literature: Big data & internet of things

2.1 Big data

The term 'Big data' refers to a growing mass of data whose size exceeds the normal capacity of software and tools to manage, store and analyze databases [7], with the rapidly increasing data, big data is occupying an important place in industries day by day, the total volume of data is estimated to be 1.8ZB according to the International Data Corporation (IDC) in 2011 [8].

Big data is considered to be a new digitalization technology that consists of obtaining and extracting intelligence from data and translating them into benefits for users and businesses [9].

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Some characteristics describe the term big data namely: volume, variety, velocity, veracity, and value [10].

- Volume refers according to [11] to the huge numbers of data measured in gigabytes and petabytes, as well as the large numbers of files, tables, and transactions. Furthermore, according to [12] volume refers to data that is constantly growing and exceeds terabytes.

- The variety concerns the fact that big data is generated from heterogeneous and structured sources such as databases, simulations, and medical records. [12]

- Velocity is related to the speed of processing and response to demand [13], the analysis of data and the rapid processing of large data promptly guarantees the value of this data, the more time passes, the more the data loses its relevance.

- Veracity requires studying and addressing the uncertainty of data, then we find that big data fails in most of the time in unusual circumstances [12], according to [14] it is necessary to avoid dirty data and keep the data with high quality.

-Value refers to the valuable economic and social benefits of the development of the big data process.

2.2 Internet of things

The Internet of Things is a network of physical objects that use sensors, software, and other intelligent devices to transfer and receive data from other systems via the Internet [15].

The IOT begins has played an important role in several areas, as examples transportation and logistics are the two sectors that are advanced in the adoption and application of IOT, according to [16] the internet of things refers to a network of elements consisting of embedded systems and sensors, allow companies and users to exchange data via the internet.

The Internet of Things is an architecture that facilitates the exchange of goods and services via the Internet [17], which includes risk [18] and uncertainty [19], to connect each object to a network.

3 Research methodology

To present and evaluate the current knowledge on big data and the Internet of Things as well as past research, provide avenues for future research, we opted for a systematic literature review by searching for all relevant articles on the two tools of Industry 4.0: big data and the Internet of Things which are considered the starting tools towards digital transformation.

The systematic literature review will allow us to identify, select and critically evaluate existing research to answer questions, going through a methodology and a very precise protocol schematized in the following figure:
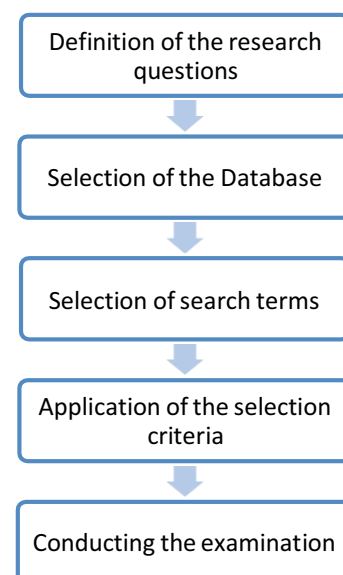

Fig 1. Research methodology

3.1 Definition of the research questions

For our study, the research questions aim to formulate the research problem, collect, evaluate data (studies/publications), analyze interpret and present the results of our research.

To this end, three research questions (RQs) were raised as follows:

RQ1: What is the state of knowledge about big data and IOT?

RQ2: What is the current level of research on big data and IOT topics?

RQ3: What are the trends in domains, research methods, and which conferences, journals, and publishers have been active in the field of big data and the Internet of Things over the years?

3.2 Selection of the database

The documentary resources we used in our study include four scientific sites: Sciences direct, Springer, web of science, and Emerald.

Some of these resources belong to important journals related to our research area, such as Big data analytics, Journal of big data, Internet of things.

3.3 Selection of search terms

The study searched the database using the main keywords: 'Big data' 'Internet of Things', it identified and submitted a total of 11 search strings: ['Big Data', 'Big data analytics', 'Data Science', 'Data analytics', 'Internet of Processes' 'Machine Learning', 'Data Mining', 'Systematic Review', 'Literature Review', 'Systematic mapping review', 'Systematic mapping study'].

3.4 Application of the selection criteria

We used the previously constructed search chain, so we considered all research interests, and we limited the search to the period from 2015 to 2021.

3.5 Conducting the examination

The research was limited to the field of the abstract, a total of 163 articles were downloaded and studied, the objective was to collect the maximum number of articles on big data and IOT, as well as the different points of view, to be able to study the areas of application of the latter, A quality assessment was applied to remove the repetitive articles and those that did not answer our research questions, in the end 82, articles were taken into consideration to proceed to the establishment and analysis of the systematic literature review, a spreadsheet was built to collect and run the data of the selected articles.
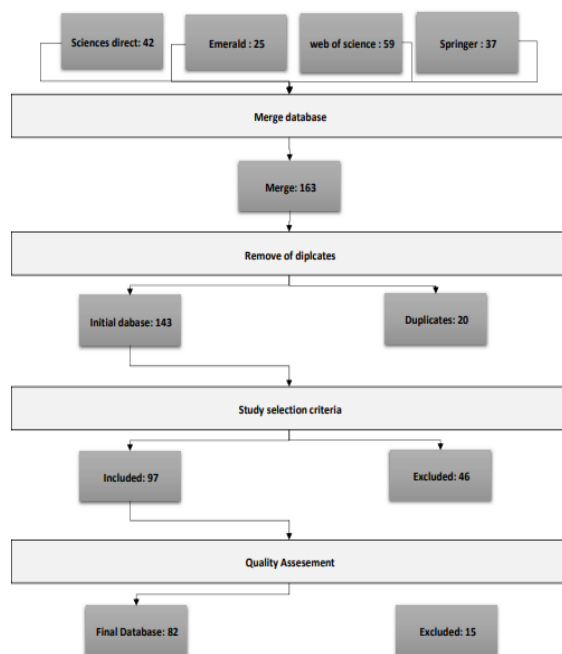

Fig 1. Steps of the systematic review

3.6 Synthesis of results

The goal of data synthesis is to combine the evidence from the selected articles to provide answers to the original research questions. The results are presented in this step of the SLR.

4 Results

In this section, we will present and discuss the key big data findings, and IoT-related topics identified by our research in our database.

4.1 Evolution of publications over time

Figure 2 shows the number of articles published and reviewed between 2015 and 2021. It can be seen that the pattern of selected articles on big data and the Internet

of Things has fluctuated steadily over this period. There is a steady fluctuation of articles published on the topic between 2015 and 2019. It is interesting to note that a dramatic increase in publications in this area can be observed in the last two years 2020 and 2021 (60% of the sample), This considerable increase in the last few years shows that Industry 4.0 tools are of great interest to researchers and industrialists, and confirm the relevance of a literature review too closely study these tools and propose the ideas has developed in-depth in this area of research.
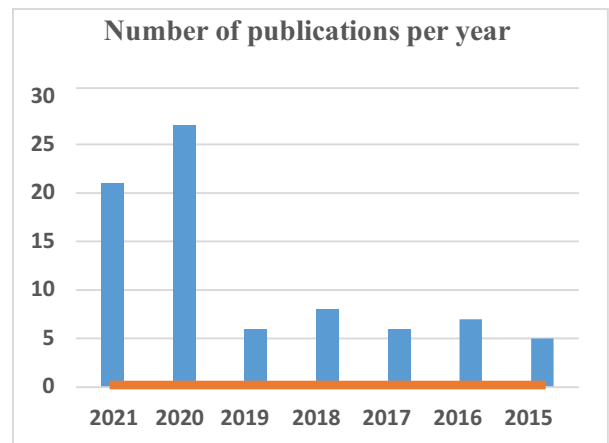

Fig 3. Number of publications per year

4.2 Distribution of publications by field

To understand the distribution of articles of Big data and the Internet of Things on the domain. Figure 3 presents the distribution of articles by domain, we can see that these two tools are used more in the supply chain and Smart cities with a rate of 35% and 23% of articles published. In addition, comes the production (17%) and transportation (15%), followed by Healthcare 4.0 (6%), security (4%), and towards the end the maintenance and finance with a rate of 1%.
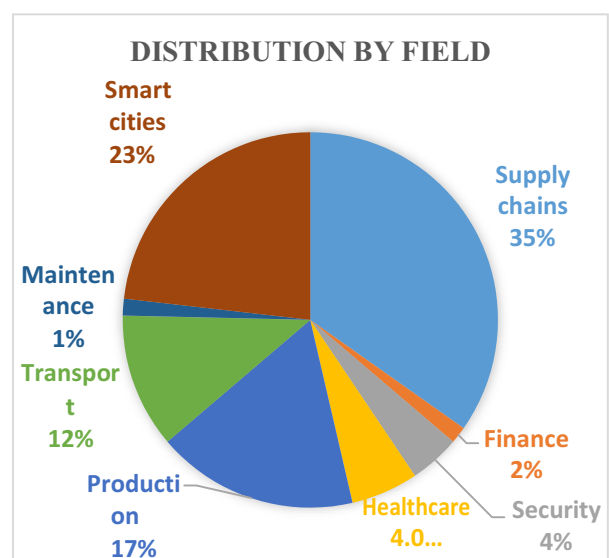

Fig 4. Distribution by field

4.3 Classification of selected articles according to research methods

All selected articles were classified according to their methodological approach and are represented in Figure The analysis shows that the research method: a literature review (56%) dominates the research area studied, followed by the research method Survey (12%), case study, and SLR (10%), and remains the other approaches with 8%.

It can be deduced then that the use of literature reviews and SLR to consolidate and strengthen existing knowledge, in addition, case studies and surveys are used to forge what is proposed in the literature.
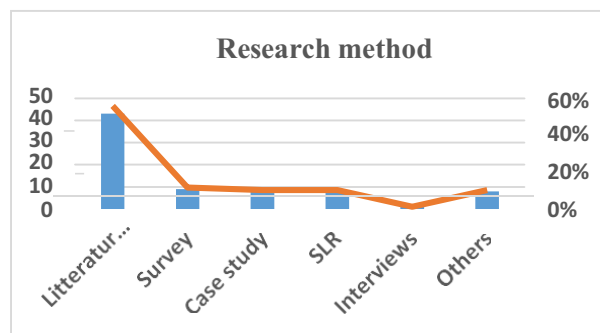

Fig 5. Classification by research method

4.4 Distribution by tool

In our research, we focused on the study of the two tools of Industry 4.0: big data and the Internet of Things, we found that 57% of the articles studied deal with big data, 33% on the IOT since they are considered to be the two basic tools for the implementation of smart cities, in addition, other tools are studied along with them, we find the Blockchain and cloud computing tool with 3%, and Artificial Intelligence with 2%, then machine Learning and CPS with 1%.
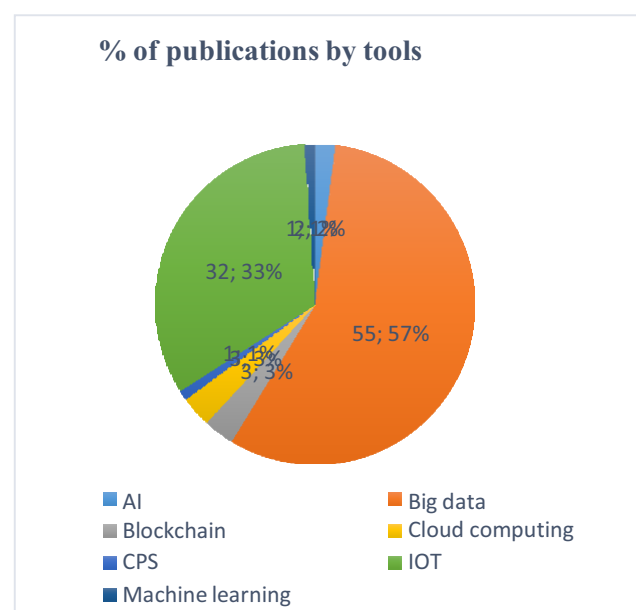

Fig 6. Distribution of publications by tools

4.5 Distribution of publications by country

The distribution of articles by country is presented in the following table. It is clear that China, India, the USA, and the UK are leading the research on the subject with respectively 29 articles (16%), 20 articles (11%), 14 articles (8%), and 14 articles (8%), followed by Australia with 12 articles each (7%), then the low countries with 7 articles.

Table 1. Distribution by country

Country	# articles	%
China	29	16%
India	20	11%
United Kingdom	14	8%
USA	14	8%
Australia	12	7%
the Netherlands	7	4%
Hungary	6	3%
Italy	6	3%
France	5	3%
Republic of Korea	5	3%
Spain	5	3%
Sweden	5	3%
Ireland	4	2%
Morocco	4	2%
Switzerland	4	2%
Turkey	4	2%
United States	4	2%
Denmark	3	2%
Germany	3	2%
Hong Kong	3	2%
New Zealand	3	2%
Finland	2	1%
Iran	2	1%
UAE	2	1%
United Arab Emirates	2	1%
Bahrain	1	1%
Canada	1	1%
Ethiopia	1	1%
Indonesia	1	1%
Malaysia	1	1%
Mauritius	1	1%
Mexico	1	1%
Nigeria	1	1%
Poland	1	1%
Singapore	1	1%
Taiwan	1	1%
Tunisia	1	1%

4.6 Literature through journals

In this step we will study the distribution of the articles studied according to the journals, the 81 articles treated were published in 48 different journals, in general, these journals are concentrated on the fields of computer science, industrial engineering, and production, on the other hand, the rest are concentrated

on other fields namely logistics, transport, AI, and others.

According to table 2, we can see that the journal: Materials Today Proceedings which has the largest number of articles in our case with 8 articles, followed by Journal of Big Data with 5, then Computers & Industrial Engineering, International Journal of Production Economics, Microprocessors and Microsystems with 4 articles for each, which shows that these journals represent the journals that bring a great interest for this field and these tools.

Table 2. Distribution by journal

Journal	# articles	%
Materials Today: Proceedings	8	10%
Journal of Big Data	5	6%
Computers & Industrial Engineering	4	6%
International Journal of Production Economics	4	6%
Microprocessors and Microsystems	4	6%
Cities	3	6%
Journal of Business Research	3	6%
Computer Methods and Programs in Biomedicine	2	6%
Internet of Things	2	6%
Journal of Cleaner Production	2	6%
Journal of Industrial Information Integration	2	6%
Journal of Data, Information and Management	2	6%
Journal of Intelligent Manufacturing	2	6%
Technological Forecasting & Social Change	2	6%
Agricultural Systems	1	6%
Agronomy for Sustainable Development	1	6%
AI & SOCIETY	1	6%
Alexandria Engineering Journal	1	6%
Big Data Analytics	1	6%
Chen Journal of Cloud Computing: Advances, Systems and Applications	1	6%
Computer Communications	1	6%
Computer Networks	1	6%
Computers and Operations Research	1	6%
Computers in Industry	1	6%
Displays	1	6%
Engineering	1	6%
Engineering Science and Technology	1	6%
Enterprise Information Systems	1	6%
Global supply chains	1	6%
Future Generation Computer Systems	1	6%
Environmental Technology & Innovation	1	6%
IEEE	1	6%
International Conference on Manufacturing	1	6%
International Journal of Data Science and Analytics	1	6%
International Journal of Logistics Management	1	6%
International Journal of Production Research	1	6%
International Journal of Digital Earth	1	6%
Journal of Management Science and Engineering	1	6%
Journal of Internet Services and Applications	1	6%
Management Systems in Production Engineering	1	6%
Omega	1	6%
Pattern Recognition Letters	1	6%
Procedia computer science	1	6%
Research in Transportation Business & Management	1	6%
Procedia Engineering: 7th International Conference on Engineering, Project, and Production Management	1	6%
Robotics and Computer Integrated Manufacturing	1	6%
The international journal of management science	1	6%
Transportation Research Part E	1	6%

5 Conclusion & Discussion

Over the years, the volume of data has been increasing, which has pushed companies to look for solutions and tools to manage and organize this huge flow.

Now, and with the emergence of Industry 4.0, several techniques and tools have become necessary and play an important and interesting role in the industry, to properly handle data management.

Among these tools are big data and the internet of things.

The main goal of this study was to conduct a literature review on BD, IoT using several data sources, based on SLR over 6 years (2015-2021). Our search identified 81 relevant articles.

The distribution of the identified articles by publication year, field, country, source, search method, and tools was presented and discussed. This study will help researchers and practitioners to understand the digitization tools Big Data and the Internet of Things, and to have a global view on the existing studies and researches related to these two tools, and to be able to use them as a basis in their future studies.

Based on our previous review, we propose the following as some of future research directions:

-We have classified the articles by year from 2015 to 2021, future work could classify these articles differently; for example, it could start from 2021 and produce a knowledge map that shows the evolution of articles/research.

-Our study shows that the digitalization tool: Blockchain and cloud computing are present with Big data and IOT, which shows the interest of future work on these two tools.

-According to our SLR, we found that the use of these two tools cover several domains, except a lack in the areas of health, education ... which may motivate researchers to study the digitization of the latter areas.

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