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# Artificial Intelligence as a Disruptive Technology—A Systematic Literature Review

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**Abstract:** The greatest technological changes in our lives are predicted to be brought about by Artificial Intelligence (AI). Together with the Internet of Things (IoT), blockchain, and several others, AI is considered to be the most disruptive technology, and has impacted numerous sectors, such as healthcare (medicine), business, agriculture, education, and urban development. The present research aims to achieve the following: identify how disruptive technologies have evolved over time and their current acceptation (1); extract the most prominent disruptive technologies, besides AI, that are in use today (2); and elaborate on the domains that were impacted by AI and how this occurred (3). Based on a sentiment analysis of the titles and abstracts, the results reveal that the majority of recent publications have a positive connotation with regard to the disruptive impact of edge technologies, and that the most prominent examples (the top five) are AI, the IoT, blockchain, 5G, and 3D printing. The disruptive effects of AI technology are still changing how people interact in the corporate, consumer, and professional sectors, while 5G and other mobile technologies will become highly disruptive and will genuinely revolutionize the landscape in all sectors in the upcoming years.

**Keywords:** artificial intelligence; disruptive technology; disruptive innovation; blockchain; IoT

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## 1. Introduction

Since the advent of the concept of disruptive technology, coined by [1,2] and completed by [3], and until now, its meaning has undergone an evolution that has somewhat altered its initial connotation. The specialized literature uses disruptive innovation as a synonym for disruptive technology, and it refers to the disruptive effects of new technologies within a domain.

As a result, historically speaking, disruptive technologies provide entirely new bundles of characteristics that the general public is hesitant to employ in the applications they are accustomed to. According to [1], disruptive technologies are introduced and bring value only for new applications and new markets since they stimulate the development of new products and markets.

In his book [3], Christensen distinguished between two categories of technologies that have a great impact on organizations: sustaining technologies and disruptive technologies. In this way, sustaining technologies were regarded as those that would complement and benefit from those that are currently in use. Conversely, disruptive technologies are those that have recently emerged and have the potential to have an unexpected impact on already-existing technologies. They were thus seen as unrefined, underperforming, and lacking in practical ability [4], leading to their poor reputation.

In the meantime, this perception (which was adverse) towards disruptive technologies was quickly enforced in the eyes of specialists. Analysis of the specialized literature supports the disruptive nature of new technologies. Thus, disruptive technologies that are initially tested on niche or small markets may later become more competitive in the mainstream market, thereby displacing products that are based on proven technologies.

This is because a product's level of technological advancement frequently exceeds the rate at which customers typically want or can absorb performance improvements. Furthermore, products whose features and functionalities meet today's requirements will eventually undergo an improvement process that will meet tomorrow's dynamic needs. Whereas products that curretnly perform very poorly in comparison with consumer expectations for the primary components may perform very well in the future and become directly competitive.

Among the recent perceptions of the term "disruptive," we noticed that the authors of [5] contend that these technologies are termed disruptive because they substantially modify the usual way of operating, without bearing any negative implications. In the same stream of ideas, Ref. [6] considers that disruptive technologies are termed as such due to their radical computational power, near-endless quantities of data, and unprecedented technological advances. Others [7] contend that they can cause broader societal transformation by changing the existing economic sectors, working principles, manufacturing characteristics, and consumption behaviors because they have the potential to disrupt the status quo throughout developing a unique set of values.

The topic approached in this manuscript is aligned with the ISO-revealed trends until 2030. Thus, during World Standards Day in 2018, an ISO article [8] stressed that disruptive technologies such as AI, robots, nanotechnology, and the IoT are the hallmarks of the Fourth Industrial Revolution (4IR). Furthermore, in 2019, the ISO [9] elaborated on the four trends that make up the disruptive forces shaping the direction of ISO's future strategy in the period leading up to 2030. Among them is enlisted digital transformation, where AI (through ML) and blockchain supply organizations with a broad range of options, are enhancing their productivity and efficiency while fostering innovation and competitive edge.

In order to highlight AI as a disruptive technology, as well as to present the emerging technologies and sectors where it has been used or had an impact on, this manuscript proposes an immersion into the specialized literature. The structure of this article has been developed using research questions. The most significant weight was given to AI, which has had an influence on a broad range of domains in recent years, from government to the business environment (a sector that deals with significant amounts of money).

The analysis performed during the literature review enabled us to pinpoint a number of gaps that the present paper intends to cover. First, none of the authors whose work has been under examination explicitly state whether the disruptive concept has a positive or negative implication. Second, similar approaches do not reflect how the meaning of disruptive has changed over time with respect to AI and other prominent technologies as well as their contemporary acceptance in terms of polarity. Thirdly, this document lists the industries that are particularly impacted by the top disruptive technologies currently in use.

This manuscript is structured as follows. Section 1 presents the evolution of disruptive technologies, Section 2 presents the methodology used to perform the literature review, Section 3 displays the results, and Section 4 discusses the conclusions, limitations, and future paths of study.

## 2. Materials and Methods

In the current study, our goal was to perform a rapid review of the literature on AI as a disruptive technology and its effects on the most impacted fields. The research methodology is presented in Figure 1. Consequently, we sought to answer the following research questions:

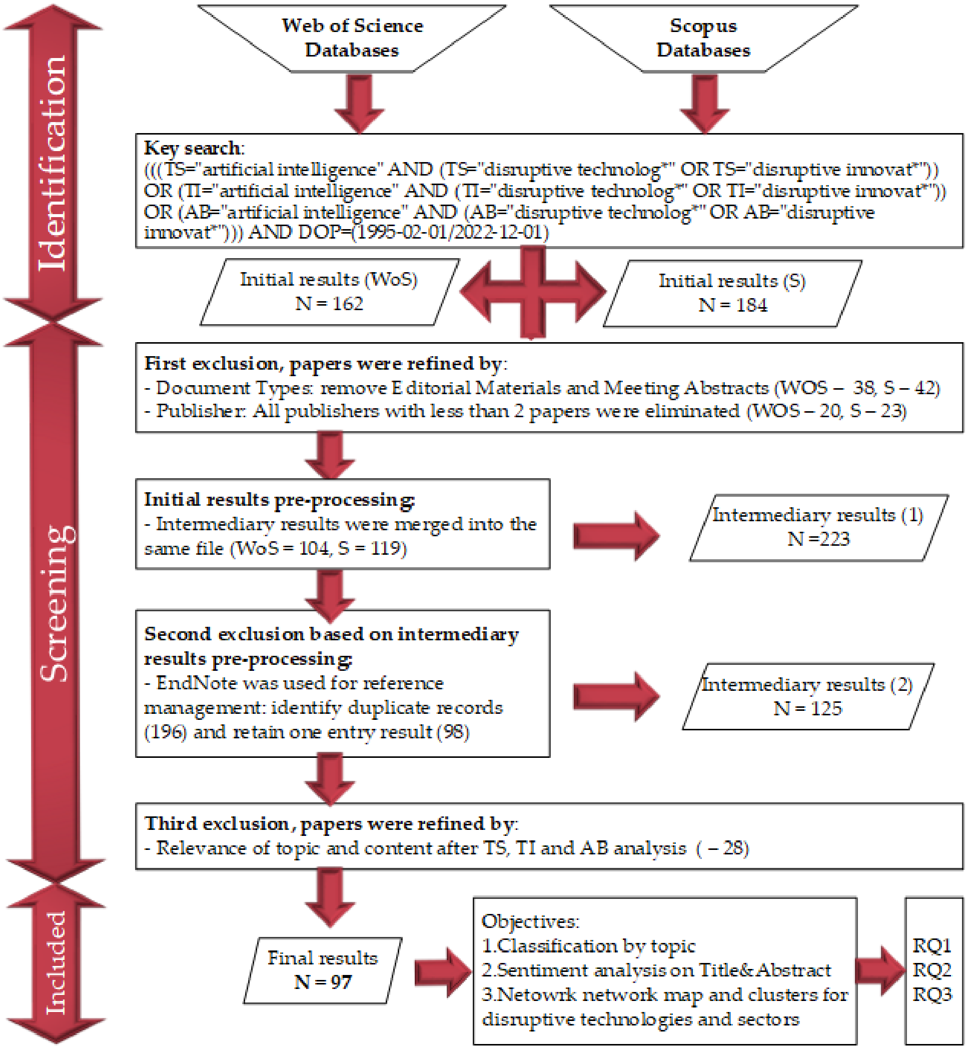


**Figure 1.** Research methodology.

RQ1—How have disruptive technologies evolved over time, and what is their current connotation (positive or negative)?

RQ2—Along with AI, what are the most prominent disruptive technologies in use today?

RQ3—Which domains were impacted by AI and the other top disruptive technologies?

Although there are other studies in the literature with similar titles [10,11], this research is original because it uses sentiment analysis to conduct a worldwide and multi-sector analysis of Titles (T) and Abstracts (A). In order to track the development of positive vs. negative sentiments over the past few years, we extracted the polarity of the two variables (T and A) through analysis and plotted it in Figure 2. This analysis contributes to answering RQ1. In this approach, the manuscript explores the development of AI as a disruptive technology and clarifies the actual meaning of the term "disruptive" through an analysis of papers that have been published internationally and have applications across several industries. Additionally, the research presents the significant disruptive technologies (Table 1) which, when combined with AI (RQ2), foster innovations in the identified industries (RQ3).

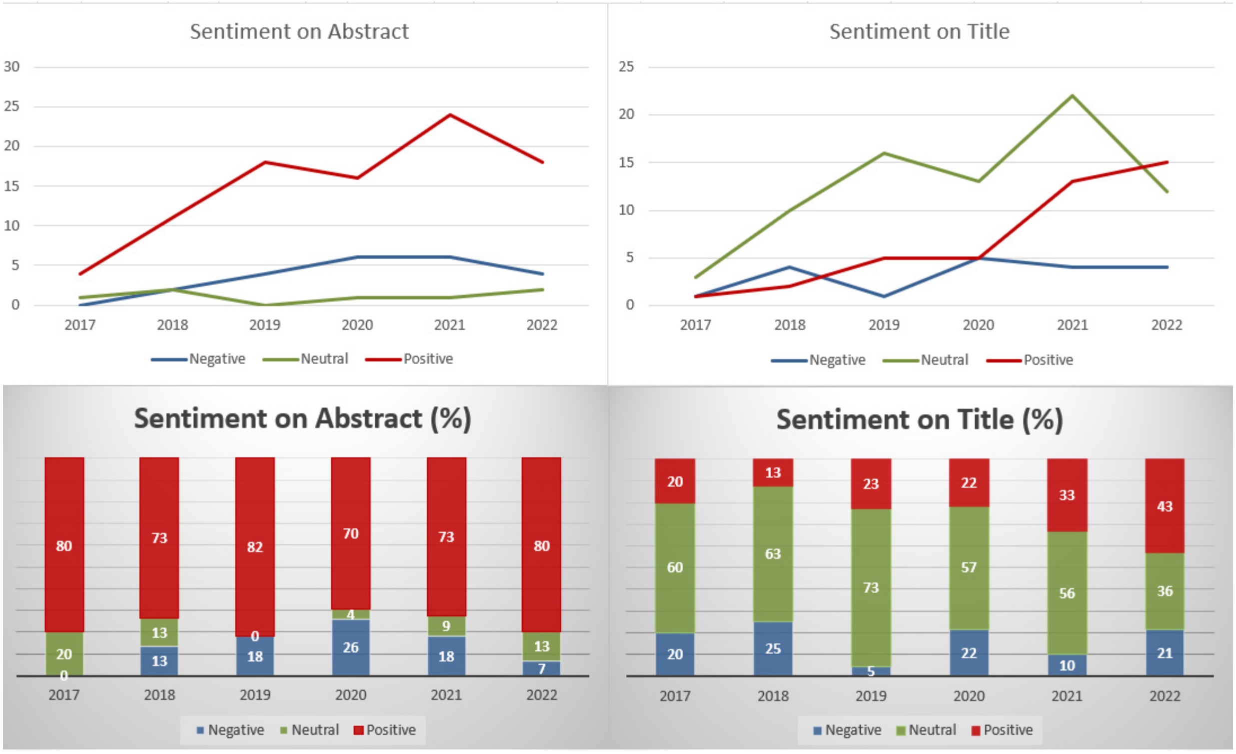


**Figure 2.** Sentiment analysis applied to titles and abstracts.

**Table 1.** Text mining of the frequency of appearance of the most common disruptive technologies from this article's database (n = 97).

| Manuscript-Selected Keyword | Frequency in Abstract | Frequency in Keywords | Frequency in Titles | Total | Frequency (Total) | Rank |
|---|---|---|---|---|---|---|
| AI | 194 | 17 | 41 | 252 | 481 | 1 |
| Artificial intelligence | 125 | 66 | 38 | 229 | | |
| IoT | 33 | 11 | 6 | 50 | 89 | 2 |
| Internet of things | 27 | 7 | 5 | 39 | | |
| BlockChain | 55 | 11 | 9 | 75 | 75 | 3 |
| 6G | 16 | 15 | 4 | 35 | 35 | 4 |
| 5G | 9 | 5 | 3 | 17 | 17 | 5 |
| 3D Printing | 5 | 3 | 4 | 12 | 12 | 6 |

Among the advantages of using a rapid review, as mentioned by [12], we contend that it provides reliable content while fostering the discovery of new additional concepts (1); thus, it is considered a problem-oriented method that supports a flexible knowledge transfer environment (2).

As a main source of data, we focused on the Web of Science library as it includes the most relevant articles published within the mainstream journals that assures each article has been peer-reviewed. The combination of phrases in the keyword search were ((“disruptive technolog*” OR “disruptive innovat*”) AND “artificial intelligence”), and we used the truncation technique for the first phrase in order to include all expressions' forms [13,14] within the search. As depicted in Figure 1, the above-mentioned expressions were used to search the articles' topics (TS), titles (TI), and abstracts (AB) in Web of Science database. Furthermore, the results were filtered according to a minimum date of publication (DOP) of 01/02/1995, as this was when the term disruptive technology was coined by [1,3].

From the pool of 162 (WoS) and 184 (S) papers initially identified using the key searches, we applied several exclusions (check Figure 1) based on the methodology used by researches focusing on similar topics [14,15], namely:

- First exclusion:
  - Document types—the *Editorial Materials* and *Meeting Abstracts* were removed (WoS—38, S—42), leaving 124 (WoS) + 142 (S) = 266 papers;
  - All publishers with only 1 article, as we considered that they did not have a serious approach toward this topic, were removed (WoS—20, S—23), leaving 104 (WoS) + 119 (S). Further, at this stage, the intermediary results (1) were merged into the same file, resulting in 223 articles.
- Second exclusion:
  - With the support of EndNote (used for reference management), it was possible to identify duplicate records (196) originating from the two databases and retain only 1 entry (98). In this manner, we obtained the intermediary results (2), with a total of 125 references.
- Third exclusion:
  - The remaining list was evaluated for relevance based on title, keyword, and abstract analysis, and the articles that did not fit the purpose of the research were eliminated (−28), leaving a total of 97 papers included in the study.

The list with all resulting articles (n = 97) was saved as an Excel file and contains full record. In this step, MonkeyLearn platform played an important role as it automatized the process of topic classification for each article based on the title and abstract (more details are provided in Section 3—Results). Furthermore, the papers were downloaded as PDFs and read in-depth. The content of each article was analyzed in accordance with the defined research questions and topic classification. The main ideas were extracted and included in the manuscript's following sections (Section 3).

As a reference management tool, we used EndNote Online for duplicate reference removal and for the storage, organization, and citation of the list of references for this research. To more effectively extract the key domains and key related technologies within the list of selected papers (n = 97), we used VOSViewer [16] tool, which is known to provide state-of-the-art techniques for network layout and network clustering [14]. More details regarding the cluster generated by VOSViewer are presented in Section 3.

## 3. Results

Within this section, we intend to provide answers to the three research questions.

Several researchers have compared the affordances of Web Services for Sentiment Analysis [17], and based on their findings, we have chosen to use the MonkeyLearn API [18–24] as a tool in our investigation. With the assistance of pre-trained models, this API's user-friendly ML platform enables the rapid submission of keywords and phrases to text classification. MonkeyLearn [25] is a platform that allows users to easily create and test customized ML models in order to solve particular problems that involve, among many others, the development of pre-trained models to address common problems such as sentiment analysis, topic detection, and summarization.

MonkeyLearn [25] replaces manual data processing and thus was beneficial for our research as it allowed us to perform a sentiment analysis based on titles and abstracts (1), the classification of the articles (2), and summarization (3) for a faster analysis of the content (to determine whether each article was relevant for this research) used in the Methodology section in accordance with the criteria of the third exclusion (Figure 1). Another of MonkeyLearn's facilities is its ability to integrate documents with Google Sheet files, wherein, among other actions that can be performed, the software returns the polarity and confidence value of each analyzed line. In our research, this software filed the polarity and confidence values for the titles and abstracts in separate columns.

In terms of the accuracy of the results, the literature review analysis returned several studies that established the overall accuracy (ACC) of this API's results as lying between 63% [26] and 72% [27], while the misclassification rate was 37% [28,29]. In light of the above information, this accuracy range is considered good, as, on average, researchers agree that SA models need to have at least 50% ACC to be considered effective, whereas an ACC around 65% is considered good, and an ACC over 70% is considered nearly as good as human capacity [30].

RQ1—How have disruptive technologies evolved over time and what is their current connotation (positive or negative)?

In order to answer RQ1, we have performed two actions:

- The literature analysis in the Introduction section contributed to the substantiation of the answer to the first part of RQ1. Thus, we have witnessed the evolution of disruptive technologies since 1995, when [2] coined the term. Although the concept had not initially been assigned a clearly positive connotation, recent research has shown that many domains embrace disruptive technologies as edge technologies that bring numerous benefits and challenge the comfort zones of both companies and employees.
- The sentiment analysis performed on the article database, using data from titles and abstracts and applying a MonkeyLearn-trained algorithm, allowed us to provide the answer to the second part of RQ1.

The results of the sentiment analysis (displayed in Figure 2) reveal that the abstract analysis returned mostly positive values, with percentages between 70% (2020) and 89% (in 2022). The title analysis revealed results that correspond more closely to a neutral assessment, although, for most years, the positive percentage is equal to or higher than the negative percentages. The exception to the above rule is the year 2018 (positive 13% vs. negative 25%). This is because the titles from 2018 refer to "disruptive" with a negative connotation, inducing a certain fear of technologies rather than a comforting sentiment. Nonetheless, the study of abstracts, which is more thorough than titles, yields a higher positive percentage (73%) than the negative share (13%). A possible explanation for this could be that the authors might have partially expressed their real sentiments in the titles. Given this circumstance, we highly advise performing sentiment analysis on more complete information (i.e., using abstracts and introductions rather than just titles or keywords), or analyzing variables in pairs (e.g., abstract–title and introduction–title), for a more comprehensive analysis.

Therefore, the results in Figure 2 allow us to answer RQ1, as the analysis of both abstracts and titles over the last 6 years revealed a predominantly positive connotation to the concept of disruptive technologies.

RQ2—Along with AI, what are the most prominent disruptive technologies in use today?

According to the review of specialized literature, the most popular disruptive technologies are listed in Table 1 (column 1). Further, we have examined how frequently they appear in each manuscript's keywords in order to determine those most prevalent (column 7). This allowed us to create the values displayed in Columns 2–6 from Table 1.

As depicted in Table 1, the results justify the selection of AI as the main disruptive technology, which will be analyzed in the current review.

Furthermore, Figure 3a displays the connections between the main (top 3) identified disruptive technologies. Among others, all four (a, b, c, and d) graphical representations show that the term Disruptive technology is more frequently associated with the top three technologies (AI, IoT, and BlockChain) compared with the term Disruptive innovation.

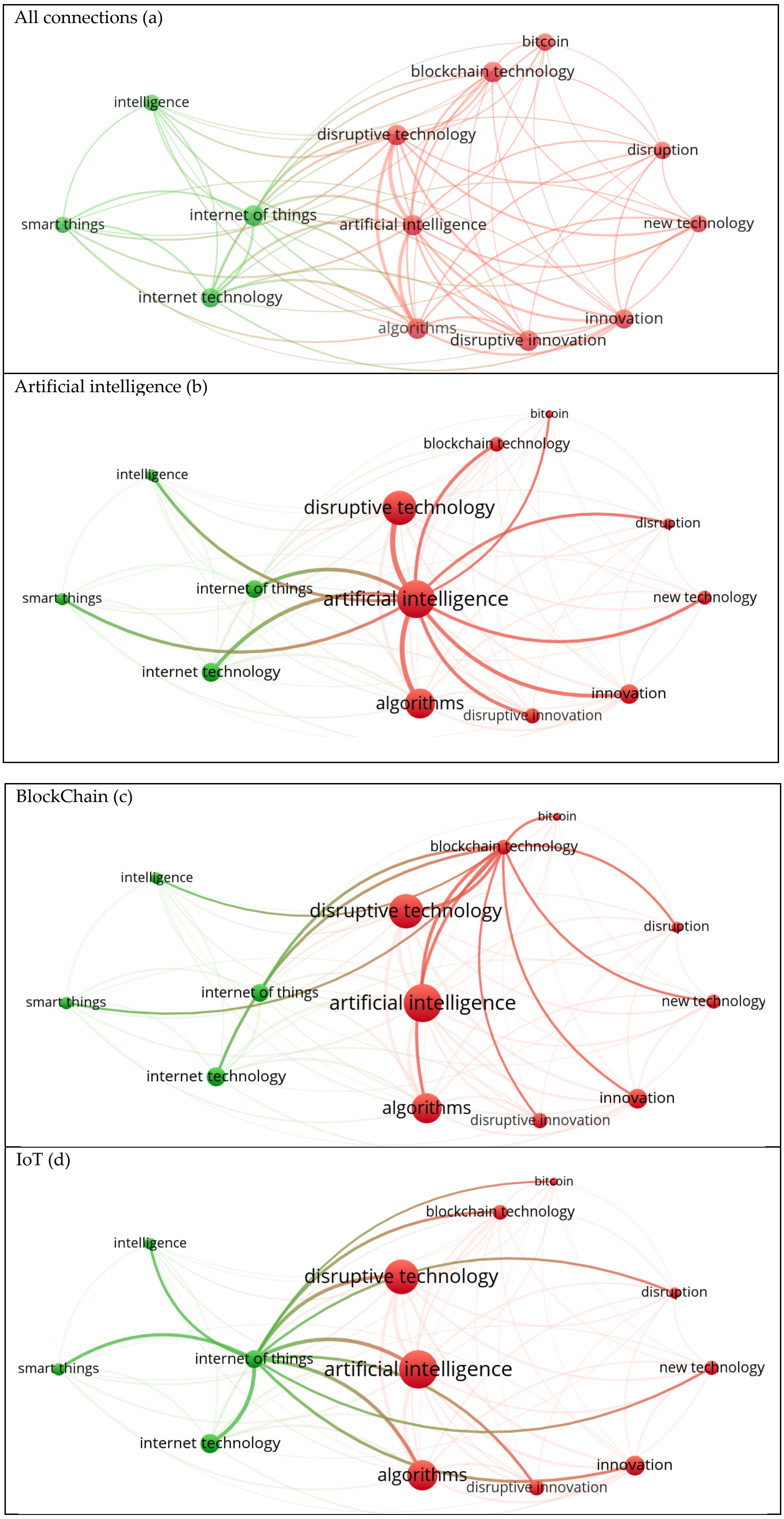


**Figure 3.** The links (**a**–**d**) between the top 3 disruptive technologies within the resulting list of papers (n = 97).

Moreover, it is evident that there is an intercorrelation between the clusters and main keywords. For this analysis, we have exported three variables (titles, abstracts, and keywords) from Web of Science and Scopus, and we analyzed the associations of the main concepts with the titles and abstracts using VOSViewer. For a clear view, we excluded the words that were not relevant for this analysis. In this way, we have eliminated any noise. The results, displayed in Figure 3, reveal strong connections between the main disruptive technologies, as identified in Table 1, within the final list of articles (n = 97). The figure also shows that, within the selected articles, AI occupies a dominant position (based on the number of appearances) and acts as a binding technology among the top disruptive technologies/innovations such as Internet of Things (IoT) and BlockChain. When selected individually, all the top technologies display a connection between them (AI—Figure 3b, IoT—Figure 3c, and BlockChain—Figure 3d) and with the concept of Disruptive technology.

The item density visualization was created using the Association Strengths Normalization Method, with the kernel width set to the minimum value in Figure 4a, as opposed to Figure 4b, where the kernel width was set to the highest value. The fact that the connections between the items (keywords in this visualization) tend to overlap and show significant relationships between them may confirm that the topics are related and thus correctly selected. The overlapping area between the keywords is highlighted with a red circle in Figure 3b. Furthermore, as this review's title suggests, the illustrations in Figures 3 and 4 clearly show that "Artificial intelligence" and "disruptive technology" are the main aspects (keywords) of the analysis and may justify the correct inclusion of the articles in the analysis.

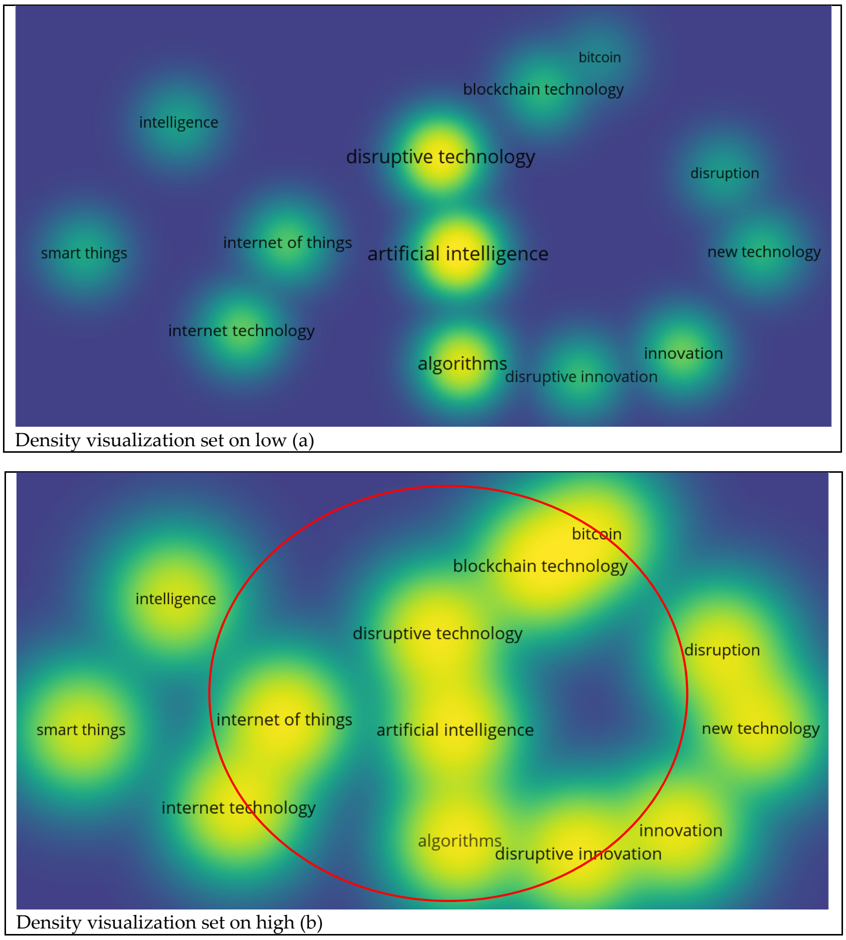


**Figure 4.** The density visualization (**a**,**b**) between the top 3 disruptive technologies within the resulting list of papers (n = 97).

RQ3—Which domains were impacted by AI, and what are the other top disruptive technologies?

The influence of robotics, AI, and automation on each industry is a topic of discussion worldwide [31]. These fields' potential for disruption fosters populism among advocates, engagement in politics, awareness and concern in civil society, and interest in the press and media. Various organizations have conceived of ideal scenarios in which all capital will be dispersed, and humanity will flourish in a workless society driven by cultural and intellectual advancement based on a universal basic income. Some argue that humanity is in decline, while others forecast the demise of all employment. AI and other disruptive innovations frequently result in job losses. Such losses will not affect all members of society, but those who carry out routine duties will be impacted, despite the fact that AI is also creating many brand-new, appealing forms of employment. The debate over how to handle the development of disruptive technologies is urgent and probably inevitable since the future is unforeseeable.

In our endeavor to answer RQ3, we employed the VOSViewer program. This software has been recognized as enabling state-of-the-art approaches [14] to network clustering, wherein the extraction of the key domains and associated key technologies from the database of articles is more effective (n = 97). The four clusters identified by the above-mentioned tools are displayed in Table 2, and the entire network map is revealed in Figure 5.

**Table 2.** Cluster identification and domain- and technology-related keywords.

| Cluster | Domain-Related Keywords | Technology-Related Keywords |
|---|---|---|
| Blue | Healthcare (Digital heath), Medicine, Dentistry | AI (Machine learning), Robotics, digitalization, new technology |
| Green | Business, Organizations, Logistics, Government | AI (Augmented reality), Digital, Automation, RPA |
| Yellow | Agriculture, Smart farming, Industry | AI (Deep learning), Internet technology, Internet of things |
| Red | Education, Society, Smart city, Environment, | AI (applications), Cloud computing, Big Data, Blockchain |

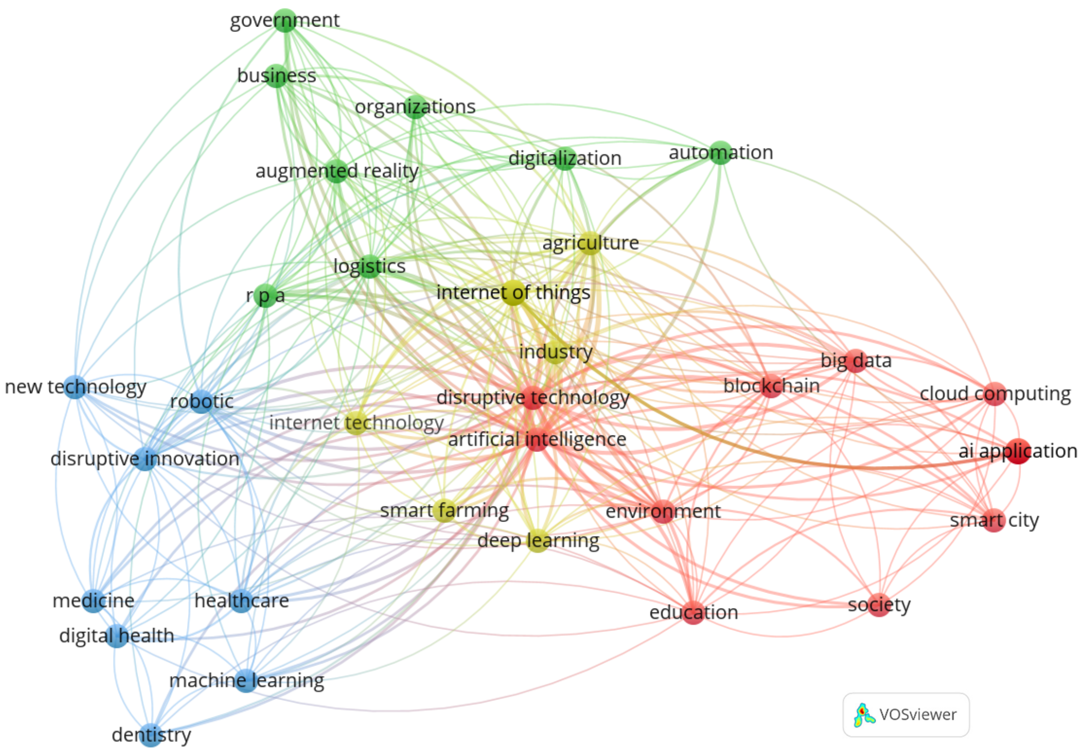


**Figure 5.** VOSViewer network map and clusters for technologies and impacted sectors.

Based on the network map generated by VOSViewer (Figure 5) and the density visualization based on the cluster density (Figure 6), four clusters were identified, and the key domains were extracted. The results are stored in Table 2.

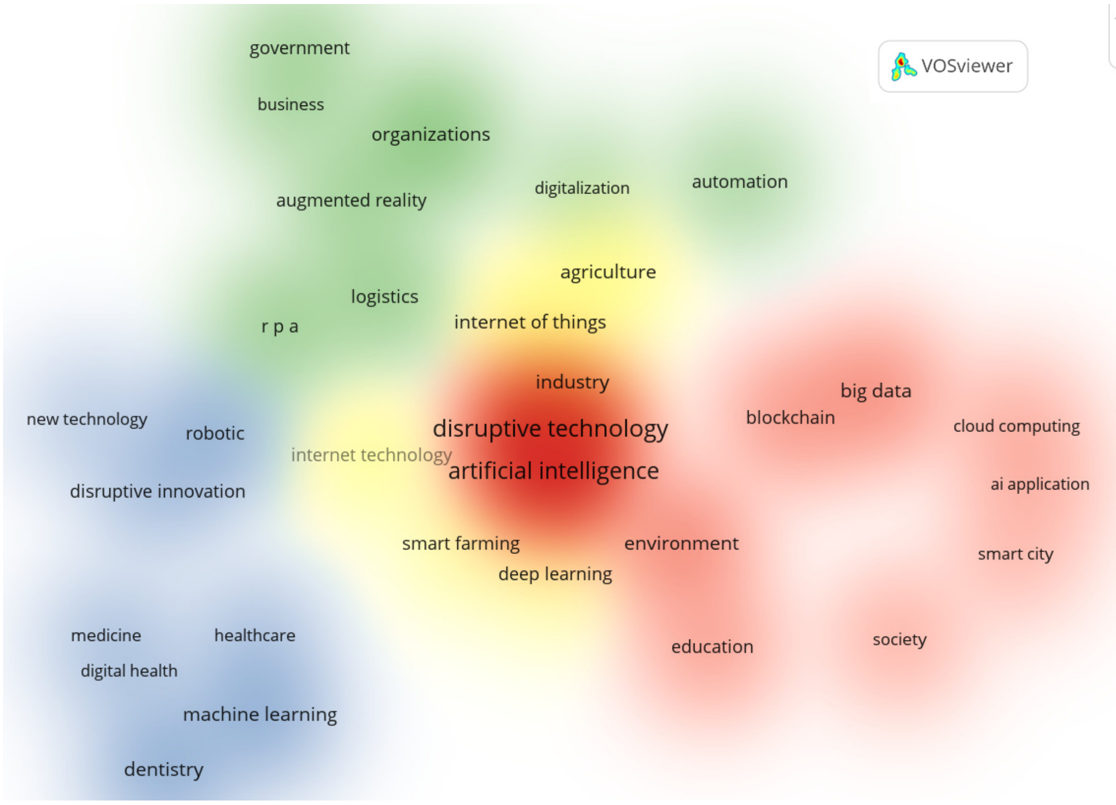


**Figure 6.** VOSViewer density visualization based on cluster density for technologies and impacted sectors.

As depicted in Table 2 and corroborated via the MonkeyLearn-based classification of the articles (in which we used a pre-trained classification algorithm), it was possible to assemble the most pertinent disruptive technologies and the key fields impacted by them. In the following subparagraphs, the impact of AI and other connected disruptive technologies on five key domains (healthcare/medicine, business, agriculture, education, and urban development) will be highlighted.

Bibliometrix is an open-source tool developed by [32] for performing thorough scientific mapping analyses. The investigation was carried out in RStudio using biblioshiny 4.0.1 and was based on the dataset exported from Scopus and WoS. The Bibliometrix analysis produced additional insights that could not be obtained on VOSviewer. We specifically indicate the following statistics in relation to the manuscripts whose focus is on AI as a disruptive technology. The results reveal that the most relevant source of papers is IEEE Access (1); the most relevant author is from Europe, who produced his papers between 2020–2022 (2); the most relevant affiliation is from North America, whose mass production took place between 2018–2022 (3); and the most cited country is USA, whose production increased exponentially starting from 2018.

Based on the aforementioned findings, we decided to create a thematic evolution map (Figure 7) with two cutting points (2018, 2020) to show the topic's evolution over a period with an exponential rise in publications. It is obvious that the exponential increase in publications brought along a wider variety of subtopics and sectors (as the applicative domains for the disruptive technologies).

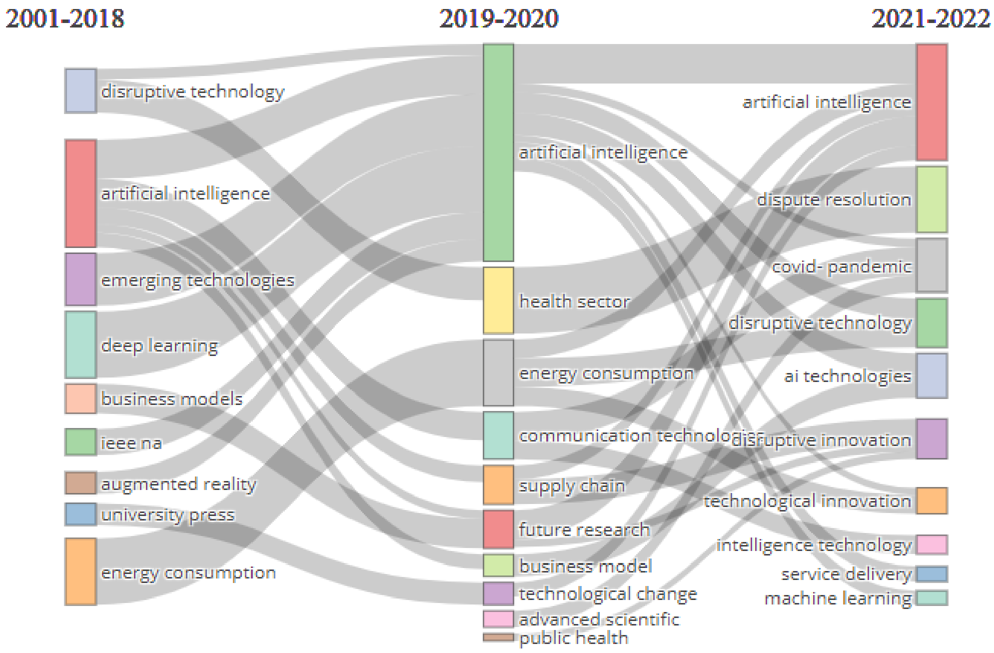


**Figure 7.** Thematic evolution of topics for the selected articles (n = 97).

In order to provide a deeper understanding of the most recent time frame included in our study, in Figure 8, we display the topics' corresponding time slices for the articles published between 2021–2022.

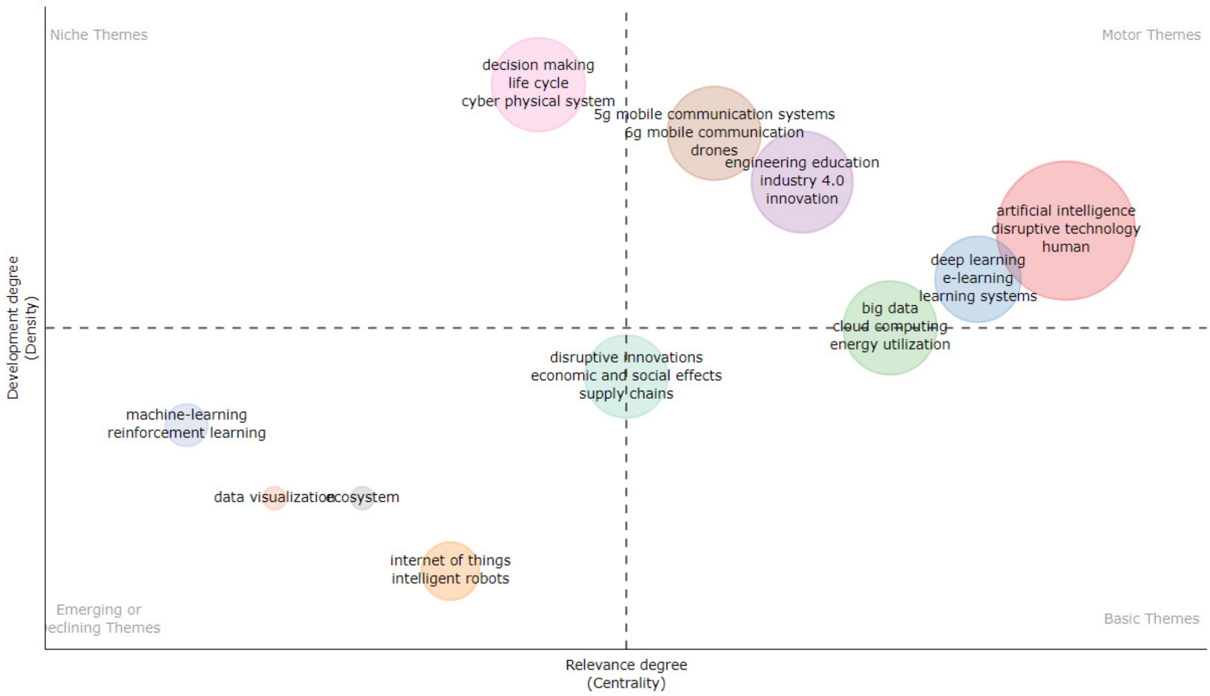


**Figure 8.** The 2021–2022 time slice of thematic evolution for analyzed articles (n = 97).

The graphical representation from Figure 8 reveals that during the production of manuscripts between 2021–2022, the major themes (aspects considered hot topics) were AI, Industry 4.0, DL, Big Data, 5G, 6G; the niche themes were related to the decision-making process, (product) life cycles, and cyber physical systems; and the emerging themes were the IoT, intelligent robots, ML, and reinforcement learning. The Figure also shows that the topic disruptive innovation is placed in a prominent position in terms of its relevance degree (centrality), thus confirming that the manuscripts deal with the disruptive effect of innovative technologies.

Figure 9 reveals the conceptual structure of the most relevant topics (AI and Disruptive technology) over the temporal sub-periods. In this way, it is possible to shape the topical evolution of the domain starting from the thematic evolution (Figure 7), thereby revealing the trajectories of the different topics across time (namely, 2018, 2019–2020, and 2021–2022). Figure 9 shows that while AI and disruptive technology were regarded as fundamental subjects in the 2018-published papers, the manuscripts produced between 2019 and 2020 partially progressed towards regarding them as major themes, and in the papers released between 2021 and 2022, these two topics were considered a fertile area for study.

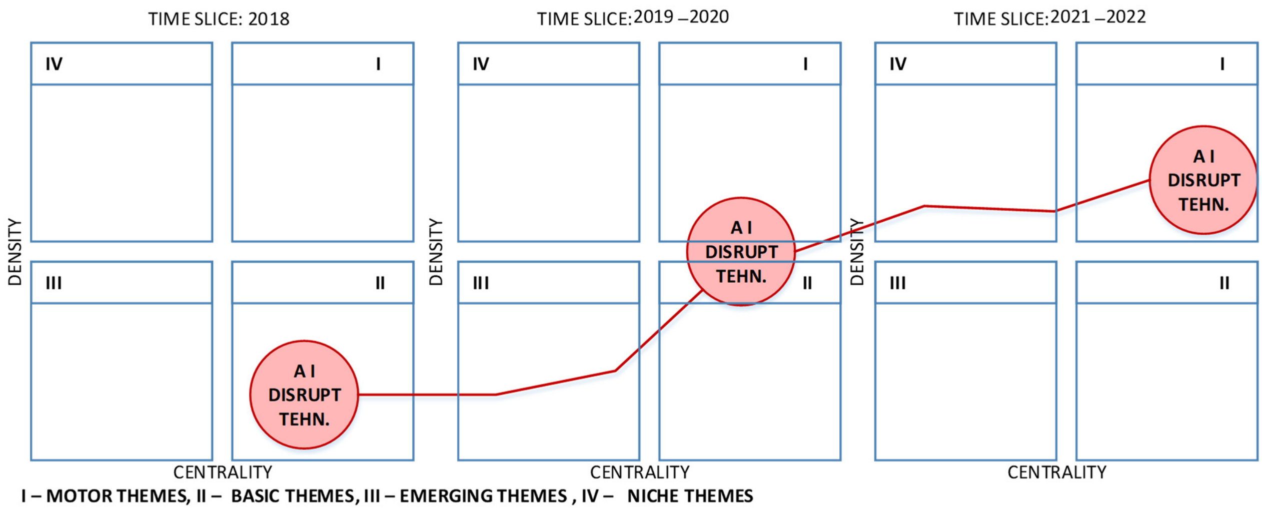


**Figure 9.** Topic evolution across the 3 time slices analysis of thematic evolution (n = 97).

The industries chosen for this investigation are in line with the ISO 2022 Trend report [33] that mentions the disruptive effect of AI, namely, medicine—improved healthcare; business—changing the labor market and effecting more efficient production and consumption; agriculture—more sustainable agriculture; and urban development—more efficient and effective governance. Consequently, in the following four subparagraphs, the most relevant discoveries regarding the impact of AI (and other prominent technologies) as disruptive technology in the four identified sectors will be displayed.

### *3.1. AI as a Disruptive Technology in Healthcare (Medicine)*

The study of the specialized literature emphasizes the applications of AI technologies as the center for disruptive innovation in many areas and professions within the field of healthcare and medicine. Thus, AI impacts surgeons and surgery [34], advanced medical imaging [35], dietetics and dietitians [36], and radiology and the early stages of cancer detection, while [37] builds on dental and oral medicine with a positive impact on dentistry practitioners by using Robotics [38].

One direction regarding AI as a form of disruptive innovation is emphasized by [36]. As such, the study of the medical literature uncovers many instances of customary human tasks being computerized [38] through the adoption and implementation of AI and DL. Integrated electronic and personal health records, mobile apps, wearables, AI and ML, conversational interfaces such as chatbots, and social robots are some examples of such disruptive technologies. The authors of [36] describe how the traditional model of nutritional care delivery is being disrupted by digital health, as well as the opportunity for dietitians to embrace this disruption and take ownership of it in order to improve patient care. According to the four elements of the nutritional care process, namely, nutritional assessment, diagnosis, intervention, and monitoring and evaluation, the article provides an overview of digital health concepts and disruptive technologies.

Although AI is by far the disruptive technology that has had the most important impact in medicine, several other technologies could be combined for better results. Among them, we identified [39] blockchain and ML. Blockchain technology stores a plethora of patient data, such as [36] laboratory results, wearable device data, genomic data, and medical imaging data. Blockchain with AI can be used for corroboration and correlation with ML algorithms applied to managing a patient's history with all their medical records [35]. Further [39], AI (using ML algorithms) might be executed every time a new imaging study is added to the blockchain thanks to smart contracts, thus simulating real-time analysis and augmentation [36].

Summarizing the literature findings, Table 3 includes the healthcare aspects that are being impacted by AI as a disruptive technology.

**Table 3.** The positive and negative aspects of healthcare affected by AI as a disruptive technology.

| Aspect | Positive Impact | Negative Impact |
|---|---|---|
| Diagnosis | Improved accuracy, velocity, and consistency of medical actions. | Limited clinical validity in certain complex cases. |
| Treatment | Personalized treatment plans for patient's particular situation. | Ethical concerns and accountability in cases of misdiagnosis. |
| Clinical Trials | Are efficient and cost-effective due to AI. | - |
| Predictive Medicine | Improved early intervention, reliable and fast screening. | - |
| Healthcare Access | Improved access to medical services due to lower costs. | - |
| Operations | Streamlined workflows and resource management. | Job losses in certain areas. |
| Research | Enhanced medical research. | - |
| Data Privacy | - | Concerns over data privacy and security. |
| Adoption | - | Resistance to change and skepticism from healthcare employees |
| Cost | - | High cost, in the short run, for development and implementation. |

Therefore, through a summary of the analyzed manuscripts, in Table 3 are displayed the positive versus the negative implications of AI as a disruptive technology in healthcare.

#### 3.1.1. Disruptive Features in the Applications to Surgery

AI has strong disruptive features with respect to its applications to surgery [34], a subdomain of medicine, due to its positive impacts recorded in guided surgery and regarding advanced imaging [35]. Given the availability of endoscopic recordings that can naturally guide such treatments, only minimally invasive surgery has been performed so far in this respect [35], and most of the focus thus far has concerned the use of AI for intraoperative assistance. Ref. [40] argues that comprehensive spinal care could be revolutionized by AI. As such, personalized postoperative care, real-time surgical indications, and preoperative patient selection can all be improved for surgeons through the aid of evidence-based and predictive analytics. Although it is still in the early phases of development, robotic-assisted surgery has the potential to increase technical accuracy while decreasing surgeon fatigue. AI-based robots can analyze data from previous surgical procedures to develop new surgical methods. These robots can perform surgery more accurately with reduced accidental movements. Apart from spinal surgery, AI also finds applications in minimally invasive surgery, surgeries assisted by robots, and post-surgery care, such as calculating recovery time. Ref. [41] focuses on the advantages of robotic surgery and draws attention to the fact that there are no such applications in vascular surgery. The authors highlight the positive benefits of disruptive technologies, such as AR/VR for surgery and 3D printing for high-fidelity surgical templates, in the context of the digital revolution of surgery (surgery 4.0).

Robotics is a revolutionary field that will transform dental medicine's diagnostic and therapeutic procedures [37]. The most recent medical dentist robots can conduct patient interventions or remote monitoring independently since robotic systems have evolved dramatically over the past ten years [38]. The authors performed a systematic literature review and extracted the areas of dental medicine where robots are used intensively. The following domains were determined to be very prolific with respect to the implementation of robots [38]: dental implantology, oral and maxillofacial surgery, prosthetic and restorative dentistry, orthodontics, oral radiology, dental hygiene applications, dental assistance, and the production of dental materials. Undoubtedly, robotic dentistry has a disruptive rather than destructive impact.

#### 3.1.2. Disruptive Features in the Applications to Healthcare

Since the early stages of their conceptualization, robots have been designed to replace humans in sectors that endanger human life. The effective employment of robots in healthcare was shown during the COVID-19 pandemic. Thus, to reduce the risk of human contamination and illness in high-tech, developed countries, robot technology was used intensively for various applications [42], including the distribution of food and medicine to ill persons, the provision of assistance to elderly people and those with disabilities, and biopsy extraction (with endoscopy bots) to test for diseases (anemia, bleeding, inflammation, diarrhea, or cancers of the digestive system).

Ref. [42] also brings to attention several other disruptive technologies, such as 3D printing. In this regard, the author emphasizes that 3D printers fabricate low-cost prosthetics where people need them and in a cost-efficient manner. In strict connection with COVID-19 [43], appeals have been made regarding the positive effects of using disruptive technologies (such as blockchain and AI) to address the problems posed by the pandemic.

In [43], the authors examine the potential uses and applications of blockchain and AI in the context of digital healthcare, which makes use of the increased accessibility of health data to identify high-risk patients, monitor the spread of infections, forecast mortality risk, manage healthcare data, and combat COVID-19 and other pandemics. Furthermore, Ref. [44] draws on the features of explainable AI (ExAI) by elaborating on the opportunities and challenges in the context of Healthcare 5.0. The study demonstrates the effectiveness of ExAI in healthcare environments that include real-life model deployments in a variety of clinical applications.

Robotic monitoring systems that identify infections and alert medical personnel to a patient's health status upon their arrival are something we might imagine existing in the future [42]. These types of systems have the potential to benefit humanity financially while also significantly contributing to the expansion of digitalization, and they have a positive impact on robots, as a disruptive technology for medicine, as well as on the use of 3D printing technology.

Since AI improves treatment outcomes, lowers medical errors, and aids diagnosis, it makes it simpler for medical practitioners to care for a larger number of patients [43,45]. Although this technology can help address HR difficulties, such as finding and vetting potential healthcare workers, AI cannot cover the entire spectrum of care (e.g., providing empathy); thus, the human touch and communication are still essential. Although personal connections and trust cannot be replaced by a program, device, or application, the authors contend that AI has great potential as a cognitive assistant [45].

Some authors [46] have examined the larger context of AI and ML liability and how it affects the safe application and innovation of new technologies in clinical care. As a negative aspect of disruptive technologies, these authors broach the issue of algorithm inaccuracy, which can result in poor clinical judgment and unfavorable patient outcomes. These mistakes give rise to worries about patient damage responsibility and may clarify what makes it difficult to implement AI and ML in clinical practice.

The encouragement of the use of disruptive technologies in the clinical laboratory is necessary for a number of reasons, including the rising expenses of health care, the need for improved accessibility to diagnostic care, and the growing need for laboratories in the era of precision diagnostics [47]. When combined with other medical data, such as clinical biology and genetic data, these technologies will significantly alter how the medical system is structured and organized [48,49].

Although the many ethical questions and challenges that arise from the use of AI in medicine are not covered by this research, they cannot be ignored. AI has the potential to advance medical practice in the future, but there are [50] numerous ethical and legal issues associated with its use in the healthcare industry [48]. The legal and ethical debates [51] surrounding AI in medicine involve many different parties [34]; additionally, there is considerable reluctance towards disruptive advances expressed by current technology suppliers and governmental regulatory authorities [47]. To mitigate the legal and ethical issues related to AI in healthcare, a multidimensional approach encompassing legislators, developers, healthcare practitioners, and patients is essential.

Table 4 displays the disruptive features and technologies that impact the healthcare and medicine sectors.

**Table 4.** Disruptive use of AI in healthcare and medicine.

| Impact on | Disruptive Feature | Disruptive Technologies | Reference |
|---|---|---|---|
| Healthcare: patient data such as laboratory results, wearable devices' data, genomic data, medical imaging | Has positive aspects such as improved management of patient medical history but also generates plenty of legal and ethical issues. | Blockchain and AI | [36] |
| Medicine: guided surgery and advanced imaging | Development of new surgical methods based on previous procedures, a revolution in spinal care via AI, Robotic assistance decreases surgeon fatigue. | AI: Robots, ML, and DL | [34,35,40] |
| Healthcare in COVID-19 pandemic | Robots used intensively for distribution of food and medicine to ill persons, assisting elderly people, biopsies (with Endoscopy bots); 3D prosthetics printing. | AI: Robots and 3D printing<br>AI and blockchain | [42,43] |
| Healthcare support in HR process of hiring medical personnel | AI aids HR with respect to finding and vetting potential healthcare workers. In addition, it has great potential as a cognitive assistant but cannot replace humans. | AI | [45] |
| Healthcare by Healthcare 5.0 | EXAI is a revolutionary AI innovation that enhances clinical healthcare procedures and provides transparency to predictive analysis. | AI: Explainable AI, Healthcare 5.0 | [44] |
| Medicine by Surgery 4.0 | The digital transformation of surgery. | AI: AR/VR, 3D printing | [41] |
| Dentistry | Revolutionizes dental medicine's diagnostic and therapeutic procedures. | AI | [37,38] |
| Medicine: ethical issues | AI algorithms can be inaccurate, which leads to low clinical judgment and unfavorable patient outcomes. | AI and ML | [46] |

Finally, the current review argues that the development of three radical disruptive innovations—namely, the digitalization of medical imaging techniques to enable their parametric use (1), the development of algorithms to enable the use of NLP on medical records (2), and the development of DL algorithms to treat uncategorized data (3)—led to the emergence of AI in the medicine and the healthcare system. As a result of these disruptive technologies' greater accuracy compared to that offered by radiologists, they can already automatically detect lesions and pave the path for the identification of different types of cancer [48].

### 3.2. AI as a Disruptive Technology in Business—Logistics and Transportation and the Labor Market

Blockchain and AI are currently two of the most popular and disruptive technologies [52] across all industries, particularly business. The disruptive technologies that are driving the digital revolution [53] may assist businesses in terms of solving complex problems and improving consumer value across all business areas.

On the one hand, blockchain technology enables decentralized, secure, and trustworthy access to a shared ledger of data, transactions, and records. Additionally, this technology enables the implementation of smart contracts to control participant interactions without the use of a middleman or trustworthy third party. Some [54] believe that as smart contracts become more comprehensive and self-executing, we will enter a phase of conflict resolution in which there will no longer be any need for the assistance of a neutral third party (an arbitrator, conciliator, or mediator), or perhaps a situation wherein disputes cease to exist entirely. On the other hand, AI provides robots with intellect and decision-making skills comparable to those of humans.

The subdomains of business where AI manifests its disruptive features are logistics and transportation and the labor force.

#### 3.2.1. Logistics

The current state of the logistics industry is set to be disrupted [55,56] by the fourth industrial revolution (4IR), but there are also opportunities that can be seized in order to exploit disruptive technologies to develop new business models while retaining the current ones. This pattern has led to an increase in the number of stakeholders who are concerned about how disruptive and edge technologies will impact freight transportation and how decision-making in logistics management will be enhanced. The literature elaborates on the major emerging technologies in freight transportation (T) and logistics (L) and presents research wherein disruptive technology brings numerous benefits to L. For example, Ref. [57] argues that disruptive technologies (especially blockchain) enhance the sustainability and resilience [58] of L, while [59] refers to green L (green distribution, reverse L, and green warehousing). Moreover, due to the COVID-19 pandemic, Ref. [58] emphasize the acceleration of the digitalization trend in L based on the adoption of disruptive technologies focusing on blockchain, the IoT, data, drones, robots, and autonomous vehicles.

By combining the IoT, smart robotics, and digital twins, Ref. [60] further details one of the disruptive effects of Industry 4.0/5.0 known as reverse L. This information might aid remanufacturing enterprises with respect to making a smart and easy transition to the new industrial era. Another original study [61] builds a framework for identifying disruptive technologies and chooses the intelligent logistics robot technology to conduct an empirical examination in the AIoT sector. The study shows that efficient, intelligent control operations; positive human–computer interactions; the precise avoidance of safety obstacles; and efficient and accurate location detection are the future development paths of intelligent logistics robots.

The disruptive technologies in L and T and their practical applications [55–59] are presented in Table 5.

**Table 5.** Examples of disruptive technologies and their impacts on L and T.

| Disruptive Technology | Impact on Logistics | Impacts on Transportation | References |
|---|---|---|---|
| AI | Terminal operation (e.g., identifying ill passengers and luggage controls to facilitate efficiency in terms of human logistics within railways and airports), congestion mitigation, and traffic flow prediction | Vehicle routing, optimal route suggestion | [55,58] |
| Autonomous vehicles | Indirect impacts | Individual vehicles and groups of vehicles traveling together, e.g., platoons; features wireless communication | [59] |
| Automated robots | Short-distance deliveries | Mainly based on economic viability, accessibility to the public, acceptance by different stakeholders, and benefits associated with their use | [55,59] |
| Drones | Low impact | Provide access to unreachable areas and future use in last-mile delivery | [55,58] |
| 3D printing | Disrupts traditional manufacturing and logistics processes | Indirect impacts/consequences | [55,58,59] |
| Big Data | Enhance collaborative shipping, forecast demand, and manage supply chains | Real-time traffic flows, aid the navigation of ocean vessels, forecast train delays, adjust ocean vessel speeds, manage infrastructure maintenance, optimize truck fill rates, increase transport safety, locate charging stations, improve parking policies | [59] |
| IoT | Low impact | IoT is the backbone that supports vehicle-to-vehicle, vehicle-to-person, and vehicle-to-infrastructure communications | [59] |
| Blockchain | Exacerbates data-sharing provenance issues, ownership registry issues, and issues including trust, privacy, and transparency | Track-and-trace affordances; credit evaluation; increases transportation visibility; strengthens transportation security—including with respect to shipping and ports—regarding the tracking of goods; reduces inefficiencies due to extensive paperwork; and reduces disputes regarding logistics of goods | [58] |
| Electric Vehicles | Impacts on urban consolidation centers, off-peak distribution (wherein its environmental benefits are important) | City deliveries involving small vehicles—vans and bikes—as well as medium-duty trucks and also heavy-duty trucks | [55,59] |

Ref. [56] highlight the demand for technology adoption and process digitalization in Logistics among Logistic Service Providers (LSP). According to the authors, disruptive technologies, particularly blockchain, the IoT, and Bigdata, have the potential to expand the boundaries of supply chains' traceability, transparency, accuracy, and safety.

Based on the literature analysis, a summary of the positive and negative implications of AI as a disruptive technology in L and T is displayed in Table 6.

**Table 6.** The positive and negative impact of AI as a disruptive tool on L and T.

| Aspect | Positive Impact(s) | Negative Impact(s) |
|---|---|---|
| Fleet Management | Decreased downtime; increased efficiency through vehicle allocation optimization. | System failures may occur; increased costs for installation and maintenance may be incurred. |
| Product's delivery | Maximized efficiency; minimized delivery time and costs. | Delivery workers may lose their jobs. |
| Supply Chain Management | Route optimization; reduced consumption; facilitates cleaner environment. | Ethical issues such as lack of accountability for supply chain disruptions. |
| Traffic Management | Optimized traffic flow; reduced congestion; optimized routes. | Privacy concerns due to surveillance; potential job losses for traffic officers. |
| Environmental Sustainability | Reduced carbon emissions; increased efficiency of fuel consumption. | Dependence on technology leads to greater energy consumption. |
| Safeness | Superior driver assistance; fewer accidents. | Ethical issues regarding autonomous vehicles; potential job losses for drivers. |

### 3.2.2. Labor Market

The specialists warn that in the upcoming decades, disruptive technologies such as AI will have a significant influence on the workplace by widening the work force's skill gaps more quickly than educational systems can adjust [62]. Thus, on the one hand, educational systems should adapt their curricula to incorporate edge technologies. On the other hand, employers should invest in training courses to raise awareness among their employees with regard to disruptive technologies and their impacts on the workforce.

As new jobs are being created, new skills should be developed. Ref. [63] predicts that in the 4IR, disruptive technologies (AI, robots, and algorithms) will replace 1/3 of the existing jobs. At the same time, because some jobs are being assumed by technology, employees should be retrained and diverted to other jobs. The involvement of academic institutions is vital in the case described above, and employers should collaborate with universities and keep them updated regarding technological changes that affect business.

According to some authors [62], social innovations and inclusiveness can be used as tactics to lessen the effects of disruptive technologies, which are expected to occur increasingly often.

To create and use AI [64], specific technical expertise is needed, which is a certain sign that the number of technical jobs is rising. However, this particular demand represents a significant barrier in terms of skill acquisition and the employability of middle management, senior workers, and all of an organization's human resources (HR) staff. One study [64] concentrated on the introduction of AI-based technologies into an organization as well as the new potential and challenges with respect to managing HR while accounting for both technical and nontechnical resources inside businesses.

Through the numerous technologies that derive from AI (NLP, ML, Reasoning, and Computer vision), AI is disrupting the workforce arena. In order to render computers intelligent [64], researchers involved in the development of AI are currently seeking to give machines characteristics resembling those of the human brain. All around us, there are several instances of this process that can be observed, including in terms of speech recognition technology, robots, digital customer service agents, and personal digital assistants. By employing algorithms and programming, it is possible to teach machines to exhibit traits like those of humans, including knowledge acquisition, problem solving, learning, perception, planning, manipulation, and others.

Robotic Process Automation (RPA) is another example of disruptive technology that impacts the workforce [58]. RPA is replacing human laborers; this is not because it is smarter, but because it is less expensive, more readily available, and less physically demanding than human laborers.

Table 7 reveals the disruptive features and technologies that impact L, T, and the labor market.

**Table 7.** The impact of disruptive technologies on L, T, and the labor market.

| Impact on | Disruptive Feature | Disruptive Technologies | Reference |
|---|---|---|---|
| Logistics and Transportation | Impacts L and T and the opportunities to support management decisions in the L industry. | Autonomous vehicles, automated robots, drones, 3D printing, big data, IoT, blockchain, electric vehicles | [54,58] |
| | Enhance the sustainability and resilience of L and green L (green distribution, reverse L, and green warehousing) | Blockchain, Internet of Things (IoT), smart robots | [56,58–60] |
| Logistics by LSP | Expand the boundaries of supply chain traceability, transparency, accuracy, and safety | Blockchain, IoT, and bigdata | [56] |
| Labor market: new jobs created | Require specialized technical knowledge to develop and operate them; new jobs are being created; new skills need to be developed | NLP, ML, reasoning, computer vision | [62,64] |
| Labor market: jobs taken | Replacing human laborers to reduce expenditures | RPA | [58] |

With regard to managing and enhancing organizational growth, technology and personnel perform optimally when used jointly [63]. The sole condition for humans to compete with and outperform AI is for them to improve their existing talents and show a desire to learn new ones based on knowledge.

AI (ML) has the ability to influence [65] organizational strategy, management procedures, and customer behavior, producing virtually infinite volumes of data (big data). Companies must radically adapt to new ideas and technology, such as the IoT, big data, ML, AI, and others. Additionally, they must establish systems (frameworks) for the ongoing examination of the potential advantages and challenges posed by disruptive technologies.

Upon analyzing the references with respect to the labor market, the analysis of the impact of AI (as a disruptive tool) on this sector is summarized in Table 8.

**Table 8.** The positive and negative impacts of AI, operating as a disruptive tool, on the labor market.

| Aspect | Positive Impact(s) | Negative Impact(s) |
|---|---|---|
| Job Creation | New AI-related jobs. | Job losses due to tasks replaced by AI. |
| Skill Development | Opportunities for skill development and upskilling. | Reduced demand for certain skills and job losses for workers. |
| Productivity | Automation increases efficiency and reduces manual labor. | Increased dependence on technology. |
| Wage disparities | Wage raises for high-skilled workers. | Wage decreases for low-skilled workers. |
| Working Conditions | Improved safety; reduced physical labor. | Technological addiction; ethical implications related to AI. |

### *3.3. AI as a Disruptive Technology in Agriculture*

In the literature, the trends in agriculture and adjacent domains that are most influenced by the AI's disruptive properties are smart farming, 4IR, agriculture 4.0, and digital twins.

The relevant papers included in our analysis reveal that disruptive technologies can contribute immensely [66] to agriculture. Some of the disruptive technologies identified as contributory to agriculture include the IoT, smart devices, and a multitude of AI techniques such as ML [66,67], Image Recognition [68], Modelling and Simulation, and Data

Analytics [66]. According to [69], the emergence of disruptive technology such as artificial intelligence has a significant impact on raising agricultural outputs.

Some authors list technology as one of the factors that contribute to the creation of forms of wealth such as natural resources, capital, labor, and others. More specifically, AI, the IoT, and blockchain technology have been identified as commonly used disruptive and innovative technologies in many domains, including agriculture. In Asia, more specifically in the Philippines, Japan, and China, Ref. [68] contend that although AI is among the most controversial technologies to date, it has benefited many areas, including agriculture. Moreover, Ref. [68] highlights that Asian countries have estimated that their future AI market will grow (until 2030 or 2035), namely, by 23.51% in Japan and 40% in Singapore, and that this will transform China into a world leader. Furthermore, in the Philippines, the investments in AI will accelerate the innovation rate by 1.7% while doubling employees' productivity rates [70]. These achievements are due to governmental involvement in crafting a national AI road map to which many Philippines's Departments adhere, including the department of agriculture. This strategy aims to place the Philippines as an AI powerhouse in the Asian region, and it can be considered a best practice with world-wide applications.

The study of the specialized literature allowed for the summarization of the positive and negative disruptive impacts of AI on agriculture, which are displayed in Table 9.

**Table 9.** AI's positive and negative disruptive impacts on agriculture.

| Sectors | Positive Impacts | Negative Impacts |
|---|---|---|
| Agricultural research | Innovations in predictive analytics, disease control, and breeding programs. | Disparities with respect to access to research. |
| Labor force in Agriculture | Reduced manual labor tasks | Job losses due to task automation. |
| Livestock management | Improved decision making through data analysis | Privacy concerns regarding data collection and analysis. |
| Crop production and Precision agriculture | Increased crop yields and profitability. | Potential system failures; high costs of implementation. |
| Smart farming | Water is saved via smart irrigation; crop diseases can be identified on site. | Limited access to Internet; chaotic regional development. |

AI, as a disruptive technology, is very frequently associated with the concept of smart farming (and digital twins).

### 3.3.1. Smart Farming

In terms of software development for smart agriculture and smart farming, world-leading companies such as Microsoft have implemented [70] AI techniques on agriculture via a mobile application (Krops) for the Philippines' agricultural department. The above-mentioned Azure-based mobile platform helps local farmers optimize their profits from yield by disrupting the old buying and selling practices, where small networks of buyers control prices and access to markets. Furthermore, in the United States [68], the farming sector is benefitting from AI technology's innovation of the aquaponics market [71]. Consequently, the same technology supports households' ability to save water through smart apps such as Skydrop that integrates weather forecasting with smart irrigation.

The constraints and potential future steps for modeling and modelers in the animal sciences are being considered by a group of researchers [72] examining the disruptive innovations in animal farming. The authors conducted an analysis and emphasized how the identified models, supported by AI, might provide a superior and long-lasting function in the field of animal sciences. They concluded their research by making suggestions for how future animal scientists might support themselves, farmers, and their discipline while considering the benefits and difficulties presented by technological progress.

Another disruptive feature of AI is emphasized by [68] through an image recognition technique that enabled users to browse through more than 50,000 plant images to help identify crop diseases at certain sites. In addition, Ref. [73] elaborate on the use of satellite or drone image analysis to provide vigor and water stress indices or even trigger alerts for pests and diseases. Such apps are available for mobile devices, have a success rate close to 100%, and assist or even replace specialists in the fields in question.

#### 3.3.2. Digital Twins

The concept of digital twins is considered a disruptive technology [74] that has revolutionized the industrial world, particularly the manufacturing industry, the construction and healthcare sectors, smart cities, the energy industry, agriculture, and modern animal farming.

The concept of digital twins denotes the development of a digital copy for a real entity in which the physical and biological states and behaviors of the entity are simulated based on a set of input data. Some authors [67,74] have revealed the real world applications of this concept in many areas including agriculture and animal farming. The use of digital twins in the livestock-farming industry represents the next frontier and has the potential to enhance the utilization of technology and equipment, large-scale precision livestock-farming methods, and the health and welfare of a range of farm animals. Using AI-based recognition technology that analyzes facial traits such as ear positions and the white regions of the eye, it is possible to keep track of the mental and emotional states of animals. Digital twins, through the usage of modeling, simulation, and AR technologies, can help farmers construct more energy-efficient buildings, predict heat cycles for breeding, discourage undesirable animal habits, and possibly much more. The adoption of digital twin technology will necessitate a detailed cost–benefit analysis of each farm, as is the case with any disruptive technical advancement.

The benefits of digital twins in relation to the disruptive effects of technology consist of the ability to predict, optimize, and improve the decision-making process.

#### 3.3.3. The Fourth Industrial Revolution (4IR)

The 4IR affects every agricultural player regardless of their size (whether family subsistence farmers or massive producers) in terms of food manufacturing and related goods. Under the impact of technology and globalization, worldwide agriculture players use technological tools based on AI, blockchain, and the IoT for profit maximization and business strategy improvement. In the context of the 4IR, which impacts many industries including agriculture, the extant literature mentions a new concept termed AgriTech. Some authors [75] have elaborated on this concept, even developing a taxonomy of its various types, and identified the AI-driven techniques that form the continuously shifting definition of AgriTech.

Very few researchers have [76] tackled the role of blockchain with respect to operations traceability in areas such as e-commerce, agriculture, public services, etc. In this respect, [77] aimed to extract and determine the relationships between the enablers of blockchain adoption in Agriculture Supply Chains (ASCs). The results were intended to help practitioners design strategies for blockchain's implementation in agriculture by creating a real-time, data-driven ASC by blending the IoT, AI, and 3D printing disruptive technologies.

Ref. [73] brings to attention the adoption of disruptive technologies, such as AI and blockchain, by start-ups, SMEs, and other companies for developing smart farming, precision and urban farming, and data management to reduce waste in order to redefine their business models.

As a general benefit [73] brought by AI's disruptive features in agriculture, we identified the improvements in both the general quality of yield and a product's traceability, the developments in agriculture's supply chain auditability through blockchain, and the economic and environmental impacts of the constraints on agricultural activity.

Table 10 succinctly presents the disruptive features and technologies that impact agriculture.

**Table 10.** Disruptive use of AI and additional technologies with respect to agriculture.

| Impact on | Disruptive Feature | Disruptive Technologies | Reference |
|---|---|---|---|
| Farming | Smart irrigation systems (Skydrop) | AI and weather forecast | [68] |
| | Keeps track of the mental and emotional states of animals | AI-based recognition technology | [67,74] |
| | Innovations in the market of aquaponics: intelligent management system for aquaculture | AI | [68,71] |
| | Krops: disrupts the old buying and selling practices | AI techniques and Azzure | [68,70] |
| | Identification of pest and crop diseases and provision of vigor and water stress indices | AI-based image recognition via satellite or drone image analysis | [68,73] |
| | Smart farming and urban farming | AI and blockchain | [73] |
| Agriculture Supply Chain (ASC) | Real-time, data-driven ASC | Blockchain, AI, IoT, and 3D printing | [76,77] |

Among its positive effects, Ref. [74] state that AI can also lead to an increase in the employment rate in all economic sectors if governments implement a proper talent-training strategy. Another benefit brought by disruptive innovation in agriculture consists of the maximization of production [69]. Thus, farmers now use precision farming, which employs AI techniques to monitor crop health, detect weeds, identify and detect plant diseases, and forecast weather and commodity pricing. Since there is a lack of labor in the agricultural industry, AI-based tools such as bots and drones are frequently deployed.

Consequently, in order to counteract the negative effects brought by AI as a disruptive technology, a dissemination of AI's positive benefits for humankind should be undertaken. Although humans are superior in terms of creativity and imagination, AI can enhance their abilities by assisting them in processes that involve data analytics and the use of precise and advanced algorithms. In addition, in the areas where human health can be endangered, robots can replace them to save lives.

### *3.4. AI as a Disruptive Technology in Education*

The modern education system is founded on intelligent learning environments and competence-based learning, and it uses a wide variety of platforms that rely on AI technologies in the education process [6,78,79]. More than ever, engineering education, and specifically fields such as computer science and engineering, must adjust to the changes brought about by cutting-edge technology. The necessity for skill-oriented, project-based learning over traditional engineering education that places a strong emphasis on theoretical notions is explored and emphasized by the authors of [80]. Within an integrated and unified educational system, novel methods for engineering education are already offering [81] innovative, technology-enhanced, individualized, student-centered curricular experiences. All industries are predicted to experience an increase in talent and skill shortages in the upcoming years, yet disruptive technology can also help to close these gaps.

The keyword for this new stage of education is education 4.0 [6,82], which involves the use of disruptive technologies [83] such as AI, robotics, blockchain, 3D printing, 5G, IoT, digital twins, and augmented reality. Moreover, Ref. [7] links education 4.0 with Industry 4.0 by urging governments and universities to step-up and adopt Education 4.0 to produce skills for the workforce of industry 4.0. In this endeavor, they conducted an electronic survey and contributed [7] by identifying 35 disruptive technologies, among which 13 were quantified as key technologies: the IoT, big data, 3D printing, cloud computing, autonomous robots, Virtual Reality (VR) and AR, cyber-physical systems, AI, smart sensors, simulation, nanotechnology, drones, and biotechnology. They emphasize the urge to link education (through curricula adjustments) to the above key technologies with Industry 4.0 requirements.

While AI and blockchain are expected [6] to be the most disruptive classes of technologies over the next 10 years due to the development of radical computational power, near-endless quantities of data, and unprecedented advances in deep neural networks, they can be used to improve the methods and tools in the learning process. Furthermore, the authors identified in this study investigated the relationships between these disruptive technologies and education and revealed that blockchain can be used for the automatic validation and transfer of academic credits, the storage of students' learning materials (either formal and non-formal, such as learning at the workplace), and the verification of the authenticity of documents. Ref. [6] also mention the use of blockchain to pay for courses using cryptocurrencies and allow for student identification using biometric identification on smartphones. Alternatively, AI can be used for education management and delivery, learning and assessment, empowering teachers and facilitating teaching, dialogue-based tutoring systems, and providing lifelong learning possibilities.

Some of the educational activities that involve AI in the management of academic organizations include admissions, timetables, attendance, and homework monitoring [84]. Moreover, AI may contribute to selecting relevant learning content across learning platforms for each student in accordance with each individual's personalized needs [85].

Some [78] refer to the disruptive character of data analytics in accounting as an education field of study. They consider that data analytics redefines the business processes and that the response of academia must be immediate. The authors point out that although data analytics has gained attention at the college level, it has "received little or no coverage in accounting curricula".

The use of AI as a disruptive technology is strongly impacting sports, both as an activity and a field of study. Some argue that AI, together with its companion technologies (robotics, enhanced vision, and AR/VR), impacts the field of sports as an education discipline, highlighting certain ethical issues [5]. The previously cited author argues that the disruptive aspects of AI impact sports in terms of four constitutive elements, namely, athletes, coaches, judges, and fans, wherein each impact has positive and negative connotations. As such, Laukyte [5] emphasizes the AI technologies that affect the four above-mentioned elements, concluding that "the technology can turn an athlete into a cyborg and use AI to train and judge it, but we cannot imagine non-humans watching and enjoying the sport competition". Therefore, fans are the most human component of the field of sports, where AI has the most non-invasive impact. The other three components are or can be highly impacted (mostly in a negative way) by the disruptive force of AI technologies. Moreover, the paper draws on the ethical aspects of AI as a disruptive tool that we consider should be disseminated and debated within sport curricula on different education levels. In this manner, the negative disruptive effects of AI could be reduced or even eliminated.

Ref. [86] contributed original research to the literature by extracting 12 internal and 10 external success factors for smart professional disruptors in university. The authors also bring into discussion new disruptive technologies that impact education, such as mixed reality (MR), extended reality (XR), and the internet of behaviors (IoB).

The disruptive technologies used in education and their impacts are as follows:

- AI (through VR and AR) has been used in education since the 1990s to teach subjects such as mathematics, geometry, physics, chemistry, and anatomy [7];
- AI is a technology that augments human cognition in education [87,88];
- The IoT [89] is crucial for improving the caliber of educational experiences and student performance, alongside assisting instructors in their everyday tasks, managing school facilities, managing student transportation, and offering remote-learning opportunities.

Table 11 reveals the disruptive features and technologies that impact education.

**Table 11.** Disruptive use of technologies (especially AI) in education.

| Impact on | Disruptive Feature | Disruptive Technologies | Reference |
|---|---|---|---|
| Education: management of academic organizations | Lack of physical (human) supervisor. | AI, blockchain | [84,85] |
| Education: Sports | AI poses unethical concerns involving the transformation of athletes into cyborgs (1) and the robotization of training and judgement processes (2). | AI: robotics, enhanced vision, AR/VR | [5] |
| Education: emergence of Education 4.0 | A lack of interaction between students and professors, robotization of education. | AI, robotics, blockchain, 3D printing, 5G, IoT, digital twins, and augmented reality | [6,7,82,90] |
| Education 4.0 should integrate Industry 4.0 concepts into academic curricula | Rapid and massive disruption to all sectors in terms of demand for occupations and skills | 13 key technologies: IoT, big data, 3D printing, cloud computing, AR, VR/AR, cyber-physical systems, AI, smart sensors, simulation, nanotechnology, drones, and biotechnology | [7] |
| Education: Instructors and students | Enhances the integrity of educational experiences | IoT | [89] |
| Education: engineering students and professors | Generates a paradigm shift in engineering education | 4IR boosted by AI | [80,81]. |
| Education: dentistry students | Dental students can be trained using full-body robots | Robotics | [38,91] |

In education, robotic systems can also be useful. Before students operate on actual patients, dental students can be trained using full-body robots, haptic interface technologies, and sophisticated simulations [38,91].

Ref. [81] argue that the advent of the 4IR, boosted by AI, justifies a paradigm shift in engineering education. All industrial sectors are subject to disruptive change, which increases uncertainty and hampers the anticipation of the future. AI will enable efficient, individualized student learning in this disruptive environment, which will be crucial for future academic achievement. In this context, teachers will teach and program AI in addition to serving as social facilitators.

In conclusion, whilst an impressive number of manuscripts presented the contributions of AI (and other) technologies to the field of education, very few mentioned its disruptive character. Therefore, we have observed that some side effects of using disruptive technologies (mostly AI) in education consist of: the replacement of face-to-face communication with robots (software or physical), the transformative effect of augmenting human cognition in learning [87,88], the robotization of evaluation and grading processes, and the computerized surveillance of student's attendance using cameras equipped with face recognition. From students' perspective, these negative effects may lead to a high course dropout rate, the development of fraud mechanisms, and, ultimately, the loss of the main qualities of education, which consist of building student's knowledge and cultivating their appetite for various disciplines.

Table 12 summarizes the positive and negative effects of AI as a disruptive tool exerted on the education sector.

**Table 12.** AI as a disruptive tool and its positive and negative impacts on education.

| Aspect | Positive Impact | Negative Impact |
|---|---|---|
| Personalized Learning | Customized learning experiences for students. | Eliminates social interactions. |
| Skill Development | AI-based skill development for instructors and students. | Reduced demand for certain skills and job losses for educators. |
| Teaching | Improved teaching efficiency and effectiveness. | Decreased face-to-face interaction; automation leads to job losses for educators. |
| Assessment | More accurate and efficient assessments. | Lack of accountability for assessment outcomes, i.e., who is to blame in case of errors? |
| Equity | Improved equity in education; reduced educational disparities. | Data collection and analysis create privacy concerns. |
| Accessibility | Improved accessibility to education; reduced costs of education. | Dependence on technology may lead to potential system failures and unavailability of data. |

### *3.5. AI as a Disruptive Technology with Respect to Urban Development—Society, Smart Cities, and Smart Government*

Among the disruptive technologies applied in urban development, the literature mentions the IoT, image processing, AI, big data, and smartphone apps [92–94]. These technologies may be coordinated and seamlessly integrated to enhance [93] both the infrastructure for urban growth and the overall wellness of citizens living in smart cities. The term "smart city" has recently been used to describe the integration of disruptive technologies into urban settings to improve citizen experiences. Due to the persistent scientific study that has been conducted in this field over the past ten years, the concept of the smart city has expanded and grown more complex since it was originally defined at the dawn of the twenty-first century. Leading researchers, academics, and industry professionals gathered in 2021 at the International Conference on Sustainable Smart Cities and Territories to exchange knowledge and experiences about the emerging trends and concepts in the transition from smart cities to smart territories [95] as well as real-world smart city implementations. In this research, the impact of disruptive technologies on urban development is considered from following dimensions: society, smart cities, and smart government.

#### 3.5.1. Disruptive Technology's Impact on Society

Since it represents the pinnacle of monitoring and restriction, the development of AI chatbots in some countries offers a fascinating field of research. This is especially crucial now that China has elevated disruptive technologies such as AI and big data as an essential tool for national security and a major element of achieving the country's dream of national rejuvenation. Several Western fears regarding data security and governmental control have already been fulfilled in China, whether through the introduction of a national social credit system or the widespread use of face recognition technologies. However, it also suggests that China is at the forefront of any possible weak areas and rifts within the party–state–corporate apparatus. The authors of [96] highlight issues regarding the boundaries of humanity in the context of an AI-driven future, while also addressing methodological issues with human–machine interaction while conceiving of new forms of resistance.

The combination of disruptive technologies supports society's ability to minimize the effects of natural disasters. Accordingly, Ref. [94] advocate for the adoption of blockchain (combined with the IoT) as a permanent record keeper, and cite the Japanese company Zweispace as an example, which uses blockchain to store data from the country's earthquake sensory data. Zweispace creates proprietary blockchain solutions for the real estate sector as well as real-estate-related apps such as Robot Architect AutoCalc and Namazu for earthquake-resistant measurement. Employing disruptive technologies, the company produced an inheritance smart contract using the Smarter Contract platform, and they began to offer solutions in the financial and construction sectors in order to reshape the future for their clients [97].

Industry 5.0 is one of disruptive technology's promising future paths [93]. By focusing on human-centered, resilient, and sustainable design, Industry 5.0 will be built on the foundations of Industry 4.0. The conceptualized pathways [93] of Society 5.0, in which a highly integrated cyber and physical platform is constructed, with people playing a prominent role, are another significant development supporting disruptive technology. One study conducted a literature review to explain how disruptive technologies influence many facets of sustainable urban development. The predicted effects of these results' positive and negative aspects were revealed by the researchers. They emphasize that the digital transformation of several societal sectors—such as healthcare, disaster management, innovative nature-inclusive economic models, the potential future value of disruptive technologies, the transition from Industry 4.0 to Industry 5.0, and the emergence of Society 5.0—are the main ways that disruptive technologies influence the advancement of society. The study stressed that the positive secondary impacts resulting from Industry 5.0 and Society 5.0 initiatives had the greatest overall impact. The reconstruction of industry and society is of the foremost importance from among all the benefits that disruptive technologies may provide, and this establishes the groundwork for subsequent technical advancement.

Drawn from the literature review, Table 13 highlights the positive versus the negative aspects that are being precipitated by AI as a disruptive tool in society.

**Table 13.** The positive and negative aspects of society effected by AI as a disruptive technology.

| Aspect | Positive Impact | Negative Impact |
|---|---|---|
| Employment | decrease in manual labor; development of new jobs. | some professions may become obsolete; pay gap between low- and high-skilled individuals. |
| Healthcare | enhanced patient care; lower medical expenses. | health data privacy issues; job losses for healthcare workers. |
| Education | customized learning; minimized educational costs. | technology dependency; possible loss of teaching positions. |
| Entertainment | enhanced production and distribution of content. | reduced face-to-face engagement and social skills. |
| Communication | high accessibility; fewer language obstacles | addiction to technology. |
| Privacy | enhanced data security | privacy issues due to data collection and analysis |

### 3.5.2. Smart Cities

Smart Cities are the outcome of disruptive innovations [98] that harness the technological advances of connectivity, business, sustainability, and government to achieve effective urban development. Urban resilience is a promise [99] included in the concept of the smart city, which broadly refers to a city's ability to foresee, absorb, react, respond, and restructure in the face of disruptive changes and perturbations. As a result, big data and AI are being hailed as methods or improving and realizing important resilience-related factors.

In the urban development literature, AI and the IoT are fundamental [95] for the construction of truly intelligent cities. According to the authors, it is possible to design citizen-centric smart city models by combining the aforementioned technologies, obtaining massive quantities of data from all smart city services and facilities, automating processes within a city to improve efficiency and promote sustainable urban development, fostering the economy, providing opportunities for citizens, and preserving the environment. Both the IoT and AI have the benefit of enabling the real-time analysis and addressal of issues, which are essential to improving all of the operations inside a smart city. Data collection used to be quite costly since the IoT and sensor technology were not yet standardized. However, contemporary advancements have reduced the cost of sensors, computation, and storage, thus enabling their widespread application throughout cities.

The most significant disruptive technologies with respect to the creation of the smart city are also examined by [94], and some new ones are currently being introduced. They believe that every smart city is a dynamic, intricate system that draws an increasing number of people in the quest for realizing urbanization's advantages. By 2050, 68% of the world's population will reside in cities, which poses issues due to the lack of infrastructure and a variety of resources such as energy, water, fuel, transportation systems, etc. New and emerging technologies are being developed to address these issues, including the IoT, big data, blockchain, AI, data analytics, and ML and cognitive learning, with the aim of bringing forth several changes in important spheres of urban development, such as health, energy, transportation, education, and public safety, among others. Disruptive technologies, according to the authors [94], are a major force behind the development of smart cities. They determined the most prevalent ones that, via integration, make cities smarter by providing citizens with improved living circumstances and simpler access to goods and services.

The need for AI-enabled innovations has risen with the emergence of smart cities, which are metropolitan areas that use community, technology, and policy to bring productivity, innovation, livability, wellness, sustainability, accessibility, good governance, and excellent planning [92]. The authors of [100] have elaborated on the importance of water management, quality, and availability by indicating the importance of deep learning as a disruptive force in urban water management. These authors carried out a review on the existing literature and revealed some of the practical effects of this disruptive technology on water management, such as anomaly detection, system state forecasting, asset monitoring, and assessment. They conclude that urban water systems should be enhanced by deep learning to become highly intelligent and autonomous.

To achieve a technological revolution, disruptive digital technologies [101] must be used in the built environment and its related sectors, including construction, city planning, real estate, architecture, and urban planning. Therefore, integrated smart city, construction, and real estate goals may be accomplished in line with the United Nation's Sustainable Development Goals to foster sustainable development in the smart city environment [102]. Such Industry 4.0-compliant disruptive technologies (a.k.a. Smart Tech 4.0) have been established in a number of smart city settings [103]. More than 20 such technologies have thus far been realized, including AI, big data, IoT, Unmanned Aerial Vehicles (UAVs), clouds, 3D scanning and printing, wearable technologies, wireless technologies, VR, AR, Mixed Reality (XR), robotics, blockchains, Software as a Service (SaaS), digital twins, ML, ubiquitous computing, mobile computing, renewable energy, autonomous vehicles, and 5G communications [102]. The authors believe that despite the built environment's enormous potential for the adoption and uses of these technologies, there has only been little progress made with respect to their implementation.

The authors of [94] bring into attention the use of a Convolutional Neural Network (CNN) as a disruptive technology applied in smart cities. By using the new information in a user's request to enhance the neural network by a new epoch, an AI agent (AIA) surpasses the trained framework, as it gains knowledge while working. The authors suggest that humankind may successfully construct a far more prosperous and powerful smart city economy by using the appropriate AIA or CNN with the data supplied from a blockchain.

Anywhere there are large volumes of data and users who are learning from these data there is a comparable potential. Thus, the AIA and/or CNN can be used to control traffic and other issues involving city transportation, education, and health.

Table 14, which is based on the literature review, contrasts the advantages and disadvantages of using AI as a disruptive tool in smart cities.

**Table 14.** The positive and negative impacts of AI as a disruptive technology on smart cities.

| Aspect Impacted | Positive Impact | Negative Impact |
|---|---|---|
| Urban planning | effective urban planning. | benefit- and access-related disparities. |
| Environmental sustainability | better air quality; low carbon emissions. | technological addiction may lead to system breakdowns. |
| Traffic management | improved traffic flow; less congestion; route optimization. | surveillance privacy concerns; job losses for traffic officers. |
| Waste management | enhanced waste collection and management; waste reduction. | job loss; potential system failures. |
| Citizen's Satisfaction | improved quality of life. | ethical and moral issues. |
| Energy management | Energy benefits via AI-monitored energy usage; reduced energy consumption. | AI systems consume more energy, which might negate any environmental benefits. |

#### 3.5.3. Smart Government

Standardized frameworks and procedures for integrating technology, citizens, and governments are necessary to allow cities to become smart. The potential use of blockchain technology as a facilitator for e-governance in smart cities has been explored by numerous academics [104] by assessing the issues that citizens confront on a daily basis and contrasting them with the benefits offered by blockchain integration. The usage of blockchain technology is now widespread and is increasing daily. As a result, all smart cities now have smart governments thanks to their blockchains.

A contradictory use [105] of disruptive technologies emerged in Australia, where the government is of the opinion that there is a great opportunity to use market capabilities to offer evaluations against visa requirements. Utilizing business service solutions, well-established enabling technology (such as RPA and data analytics), and cutting-edge disruptive technologies (such as AI ML), the automation of visa processing can be achieved. The federal government in Australia is drawing on disruptive technologies to fast-track visa processes and transform the current system while negating 3000 jobs.

A new disruptive concept was observed by [106] regarding the implementation of IT in the public sector. The authors debate the integration of AI and IoT and the emergence of the AI of Things (AIoT) [61]. The study intends to identify the drivers of and constraints on AIoT integration in the public sector and provide a modular framework for it. According to the authors, this effort is crucial for developing laws and policies that would maximize the potential advantages for public institutions in the governmental sector.

In conclusion, based on the specialized literature, the positive and negative effects of AI on smart government are presented in Table 15.

To conclude [92], the use of AI as a disruptive technology in the context of smart cities is an emerging field of research and practice. The literature study shows that AI technology, algorithms, and their present and future applications are the primary topics of research. In the context of smart cities, AI applications mainly concern business efficiency, data analytics, education, energy, environmental sustainability, health, land use, security, transport, and urban management.

Table 16 succinctly presents the disruptive features and technologies that impact urban development.

**Table 15.** The positive and negative disruptive effects of AI on smart government.

| Aspects | Positive Impact | Negative Impact |
|---|---|---|
| Public Service Delivery | reduced wait times; customized public services. | privacy issues concerning data collection; job losses for government employees. |
| Public Safety | predictive policing; improved emergency response times. | ethical concerns regarding biased algorithms and predictive policing. |
| Public Decision Making | high accuracy and reduced bias; enhanced data analysis. | Algorithm-related ethical concerns; lack of accountability for decisions made by AI. |
| Elections | increased participation; reduced voting fraud. | Algorithm-related ethical concerns; lack of accountability for AI decisions. |
| Public Fraud Detection | high accuracy of detection; fewer fraudulent activities. | data collection concerns. |

**Table 16.** Disruptive use of AI in urban development.

| Impact on | Disruptive Feature(s) | Disruptive Technologies | Reference |
|---|---|---|---|
| Society | It is an essential tool to national security and a major element of achieving the country's dream of national rejuvenation | AI chatbots: AI and big data | [96] |
| | Society 5.0—a highly integrated cyber and physical platform—is constructed, with people playing a prominent role | Industry 5.0/Society 5.0 | [93] |
| | AIoT is disrupting the public sector. | Artificial Intelligence of Things (AIoT) | [106] |
| Smart cities | Precipitates both positive and negative effects in the business world | Blockchain combined with AI, Cloud and IoT | [95] |
| | Integration between smart cities, construction, and real estate | Smart Tech 4.0 | [101,102] |
| | The development of a prosperous and powerful smart city economy | CNN and/or AIA | [94] |
| Smart government | humans replaced by machines (negation of 3000 jobs) | AI, RPA, and Big data | [105] |

## 4. Discussion and Conclusions

AI technology's disruptive effects continue to alter relationships between business, consumers, and occupational sectors, while 5G and other mobile wireless technologies will be especially disruptive and will truly revolutionize the landscape in the next few years [107].

The current research revealed that the majority of recent publications (which were included in the literature analysis) offer a positive connotation regarding the disruptive influence of edge technologies, and the top five examples (based on sentiment analysis of titles and abstracts) of such edge technologies include AI, the IoT, blockchain, 5G, and 3D printing. Moreover, the investigations performed using VOSViewer and MonkeyLearn on the final list of articles (n = 97) returned four clusters that indicated the sectors that should be included in the analysis (healthcare/medicine, business, agriculture, education, and urban development). Alongside the numerous advantages that have given rise to the general positive perception of AI as a disruptive technology in the analyzed sectors of activity, AI's negative aspects will also be highlighted within this section.

The list of industries that AI is impacting (which were included in this study) proved to be consistent with the trend report [33] released by the ISO in 2022. The report emphasized the disruptive impact of AI on healthcare (improving the speed and accuracy of diagnosing diseases); business, with respect to the labor market (in which there have been disruptions to many current jobs); and production and consumption, with a focus on sustainable agriculture, education (personalized learning), and governance (aiding the formulation and evaluation of the effectiveness of government policies). This confirms that the industries selected for analysis in this study were relevant and accurately represented global trends.

In healthcare (medicine), a novel treatment is considered disruptive [51] if it is much faster, more effective, and less expensive than any previous solution. Medical robots can support healthcare providers by constantly transferring patients and equipment, while AI-driven algorithms can diagnose patients more quickly than doctors. For hospital patients, virtual reality devices help ease their discomfort and fears. Thin sensors worn as digital tattoos can warn a patient of alarming changes in their health parameters and vital signs, while exoskeletons, i.e., wearable robotic constructions, allow disabled persons to regain movement [48]. Disruptive technologies offer countless opportunities, but they also carry with them a number of risks and moral dilemmas. Disruptive technology is already being developed to solve many healthcare issues, and thousands of patients have access to their genetic information, thus revealing the diseases they are predisposed to. Wearable technology facilitates the monitoring of health metrics and vital signs outside of a doctor's office, while surgical robots' accuracy enables doctors to perform previously inconceivable techniques [50,107].

The potential benefits of AI in healthcare emphasize the criticality of continuing to make ethically and responsibly guided investments in this field of technology development. Moreover, AI has the potential to significantly enhance healthcare by bringing about a number of beneficial changes and developments, including:

- Enhanced diagnosis, as AI algorithms can examine a large number of medical data to help clinicians make more accurate diagnoses, thus minimizing the possibility of misdiagnosis;
- Personalized medicine, since by using a patient's particular medical history and genetic data, AI can aid the development of individualized treatment approaches;
- Superior patient outcomes, as AI may be used to track patients, anticipate future health difficulties, and alert medical professionals to take preventative action before significant health issues arise;
- Expedite drug development, because AI can analyze massive volumes of data to hasten the process of developing new drugs and bringing them to market;
- Improved clinical trials, due to the fact that data from clinical trials may be analyzed using AI algorithms, thus assisting in the selection of the most efficient therapies and enhancing patient results.

In addition to the above-listed advantages, using AI technology in healthcare has also a disruptive effect that consists of a number of drawbacks. Among them, we have drawn the following from the literature:

- The development of AI in healthcare creates ethical issues, such as the issue of responsibility in situations of misdiagnosis or treatment suggestions;
- Limited clinical validity poses a serious problem, because in certain complicated medical situations, AI algorithms may not be as accurate as human specialists and may not be completely verified for assessing all medical disorders;
- Healthcare professionals and patients who are suspicious about the accuracy and dependability of the technology can be resistant to the adoption of AI in the industry.

In business, according to [103], the labor market would be significantly disrupted by the digital revolution and industrial transformation. The majority of low-skilled jobs, according to experts [108,109], will be eliminated by digitization and the development of labor-saving technologies (such as intelligent robots, ML, DL, autonomous vehicles, and cloud solutions), while countless job opportunities in a variety of fields, including automation engineering, control system design, AI, and software engineering, will be created.

In business, for analyzed subdomains (logistics and transportation and the labor market), according to the literature, there are many positive and negative aspects associated with AI's role as a disruptive technology. Among the positive aspects, we identified the following from the literature:

- For improved supply chain management, AI may aid routing, scheduling, and delivery optimization, which lowers transportation costs and increases delivery times;
- Transportation safety may be improved by using AI to track and improve driver behavior, reduce collisions, and increase road safety;
- AI can enhance logistics efficiency, as it may be used to improve inventory management, optimize storage and picking procedures, and expedite warehouse operations;
- AI is transforming the labor sector by replacing many old manual jobs while also opening up new career prospects in programming and data analysis;
- AI may improve customer experience as it can be used to offer updates on tracking and delivery in real-time, thereby reducing wait times and raising satisfaction;
- AI may aid the maximization of fuel use and the cutting of emissions through effective vehicle scheduling and routing and thus contribute to minimized environmental impacts;

The negative aspects of AI that disrupt the business subdomains analyzed in this review are as follows:

- Many laborious and repetitive tasks will be automated, which may result in fewer jobs and employment possibilities, particularly in sectors such as logistics and transportation;
- As the demand for more high-skilled positions in AI and data analysis increases and fewer low-skilled occupations are automated, the rising usage of AI may worsen already-existing income discrepancies;
- The widespread usage of autonomous cars may result in substantial social and cultural changes, such as the loss of individual driving abilities and the demise of the automobile culture.

With regard to agriculture, Ref. [73] identified significant improvements in both the general quality of yield and the traceability of the product as a general benefit brought about by AI's disruptive features. In addition, the authors identified developments in the supply chain auditability of agriculture through blockchain, as well as the economic and environmental impacts of the constrained agricultural activity. Modern farmers utilize [69] precision farming, which makes use of AI techniques, to monitor crop health, detect weeds, identify and detect plant diseases, and predict weather and commodity prices. The agriculture industry is struggling with a workforce shortage; thus, AI-based products such as bots and drones are regularly used. Overall, AI brings numerous benefits to agriculture, for which the literature mentions the following:

- Improved agricultural yields and less waste are possible with the use of AI, which may help farmers optimize planting, irrigation, and fertilization;
- Better resource management may help farmers conserve energy, water, and other resources while decreasing waste and enhancing sustainability;
- Enhanced food safety can be enforced by tracking the whole food production chain from farm to table, while AI can assist in the identification and prevention of food-borne diseases;
- AI can provide real-time analysis of crop, soil, and weather variables, thus enabling farmers to make educated decisions;
- Predictive maintenance may reduce downtime and boost production by predicting when machines and equipment need maintenance.

Several drawbacks (or negative implications) of AI in agriculture were also observed in the analyzed literature:

- AI systems are not immune to technical glitches or malfunctions, and the agricultural sector might suffer significantly as a result, leading to crop losses and possible food shortages;
- The usage of AI in agriculture may have unforeseen environmental effects, including increased pesticide and herbicide use, degraded soil, and the loss of biodiversity.

In education, the most relevant impact of disruptive technologies lies in the paradigm shift in engineering education [81] and the demand for new course content (for education sector), forms of employment (in society), knowledge (education), and skills (human resources) [7].

The education sector is greatly impacted by the disruptive effects of AI. The most relevant positive aspects, as derived from the academic literature, are as follows:

- A decrease in dropout rates and improved student results due to AI's ability to detect students' areas of need and offer focused support;
- Education that is customized to each student's requirements, interests, and learning preferences may be achieved by using AI to deliver personalized learning experiences for students;
- Improved assessment and feedback due to AI's ability to automate, enhance, and optimize the grading and feedback process and provide students faster, more precise, and more thorough feedback on their work;
- Lifelong learning is possible because of AI, which can help people continue to learn and advance their expertise.

Despite the above advantages, AI also has some negative implications for education:

- Education quality may suffer due to the usage of AI in the classroom when human interaction, creativity, and critical thinking abilities are substituted by automated procedures;
- A lack of critical thinking abilities may be precipitated by AI because the use of AI-powered tools and resources may lessen the necessity for critical thinking and problem-solving abilities, which may retard the development of these skills among, students,
- The dependence on technology due to an overreliance on AI in the classroom may result in a lack of creativity, independence, and decision-making abilities, which will reduce students' capacity to think and work independently.

In urban development, AI is one of today's most disruptive technologies [92], and interest in its application to urban development is only growing. Moreover, blockchain has recently become recognized as a game-changing technology with the potential to disrupt and advance several subdomains of urban development [104]. Blockchain technology is one of the most recent arrivals to the overall philosophy of Smart Cities as a decentralized, unchangeable distributed ledger. The main areas where AI applications in the context of smart cities are addressed include business efficiency, data analytics, education, energy, environmental sustainability, health, land use, security, mobility, and urban management.

The disruptive effects of AI have numerous influences on urban development. From the literature, we indicate the following influences:

- An increase in transparency, as by using AI to render governmental processes more open and accountable, individuals will be able to better understand how choices are made;
- Enhanced fraud detection, since AI may be used to identify and stop corruption and fraud in government systems, thus increasing public confidence in these organizations;
- Better resource allocation, because governmental organizations may use AI to more effectively direct resources, including money and staff, to the areas where they are most needed;
- The introduction of predictive analytics, as through the use of AI, government agencies may employ predictive analytics to proactively address prospective concerns before they become problems.

Along with the above-mentioned benefits, there are also negative implications of the use of AI in urban development that disrupt operations within this domain with respect to the following issues:

- Privacy issues—Government entities frequently deploy AI algorithms that rely on substantial volumes of personal data, which raises privacy concerns regarding how these data are gathered, kept, and used;

- Lack of transparency—AI technologies employed by government agencies may be opaque, making it difficult for the public to comprehend how and why choices are being made;
- The employment of AI in governmental affairs may result in greater control and surveillance, which may have detrimental effects on free expression and civil rights;
- When an AI system utilized by a government errs or causes harm, it may be challenging to pinpoint the culprit, which results in a lack of accountability.

The upcoming disruptions of AI in the domains analyzed (healthcare/medicine, business, agriculture, education, and urban development) have not been adequately examined, and this is one the limitation of the study. The ethics concerning the use of AI and other disruptive technologies in the selected sectors have also been neglected by the article, and this is the second limitation. The above-mentioned limitations will be overcome in future studies.

To conclude, the disruptive technologies definitely provide more advantages than disadvantages in healthcare (medicine), business, agriculture, education, and urban development, and only the future will demonstrate the correctness of such a statement.

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