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## Labor Displacement in Artificial Intelligence Era: A Systematic Literature Review

### 以系統性文獻綜述談人工智慧時代下的勞力取代

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## Abstract

The rise of artificial intelligence (AI) has made labor displacement once again the hottest issue. The rapid development of AI enhances many functions of machines and has been widely implemented in industries such as medicine, healthcare, service, hospitality, and manufacturing. Since the industrial revolution, machines have been used to complete tasks that humans used to perform, which lead to labor displacement, especially in the manufacturing industry. In the AI era, machines are getting smarter and the predictions are that one day machines may surpass human beings in many ways. Therefore, an intriguing question that asks “will AI take over the human’s job?” has been the central theme in many research inquiries. As an attempt to find clues for the answer to that question, this study conducted a literature review to present the status quo of research and current conclusions of labor displacement research in the AI era. The review included 39 scholarly articles published in the Scopus database between 2016 and 2019. Through open coding and axial coding, three distinctive perspectives emerged on the impact of AI on labor, i.e., the optimistic view (e.g., new jobs, augmentation, added human value), the pessimistic view (e.g., unemployment, technology gaining control over humans, increasing social polarization), and the neutral view (e.g., too early to tell). This paper first provides a brief history of AI then reports the findings from the literature review. A common conclusion in the literature is that AI is still an evolving technology at this time and its future development remains at the hands of humans. It relies on human intelligence to guide the proper advancement of AI applications to benefit the human society.

## 摘要

人工智慧(AI)的發展使得勞力取代再度成為熱門的話題。AI 加速了各個領域中機器功能的使用，如醫藥、醫療、服務、飯店業與製造業等。由過去的工業革命可以看到，原先由人類工作者經手的工作項目逐漸由機器自動化完成，進而導致勞力取代，這種現象在製造業尤其明顯。在 AI 的時代，機器將變得更加聰明，許多專家甚至預測在許多方面機器的能力將會超越人類。因此，“AI 最後是否將完全接手人類的工作？”是近年來熱門的研究議題。為瞭解 AI 對勞動市場的影響，本研究回顧39篇自2016至2019年收錄在 Scopus 資料庫並與 AI、科技、勞動市場、人力取代主題相關的文獻，以呈現相關研究現狀並回答 AI 是否對人力產生取代的研究問題。透過開放編碼與主題編碼的質性資料分析過程，文獻回顧結果呈現三種獨特的觀點—正向（新工作、增能、增加人類價值等）、負向（失業、機器凌駕人類、社會兩極化等）、及中立（為時過早、難有定論）。本文先簡述 AI 發展的歷史，接著以文獻回顧所呈現的三種觀點探討 AI 對勞動市場帶來的衝擊。本研究發現，在回顧的文獻中最常見的結論是：AI 目前是處於開發時期的新興科技，其未來發展掌握在人類手上，須依賴人類的高度智慧來導引 AI 科技的發展過程與方向，使其在未來能造福人類社會。

## Introduction

The rapid growth of Artificial Intelligence (AI) has attracted attention from both academia and practitioners worldwide. AI as a field is generally known as the attempt to reproduce human ability in computer systems.<sup>1</sup> It is a technology capable of interacting intelligently with its environment under the collaboration among algorithms, hardware, and software. It is implemented and widely discussed in several industries, such as medicine,<sup>2</sup> service,<sup>3</sup> manufacturing,<sup>4</sup> healthcare,<sup>5</sup> and hospitality industries.<sup>6</sup> Since the industrial revolution, machines have been used to complete tasks that humans used to perform, which lead to labor displacement, especially in the manufacturing industry.<sup>7</sup> In the AI era, machines are getting smarter every day and the predictions are that they may eventually surpass human beings in many ways. Therefore, an intriguing question that asks

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- 1 Pei Wang, "What do you mean by 'AI'". In *Proceedings of the First Conference on Artificial General Intelligence*, ed. Pei Wang, Goertzel, and Franklin Stan (Netherland: IOS Press, 2008), pp. 362-373.
  - 2 Pavel Hamet and Johanne Tremblay, "Artificial Intelligence in Medicine," *Metabolism*, Vol. 69, Supplement (April 2017), pp. S36-S40.
  - 3 Ming-Hui Huang and Roland T. Rust, "Artificial Intelligence in Service," *Journal of Service Research*, Vol. 21, No. 2 (February 2018), pp. 155-172.
  - 4 Johannes W. Veile et al., "Lessons Learned from Industry 4.0 Implementation in the German Manufacturing Industry," *Journal of Manufacturing Technology Management* (August 2019). <https://doi.org/10.1108/JMTM-08-2018-0270>
  - 5 Q. Waymel et al., "Impact of the Rise of Artificial Intelligence in Radiology: What Do Radiologists Think?" *Diagnostic and Interventional Imaging*, Vol. 100, No. 6 (June 2019), pp. 327-336.
  - 6 Jun Li, Mark A. Bonn, and Ben Haobin Ye, "Hotel Employee's Artificial Intelligence and Robotics Awareness and Its Impact on Turnover Intention: The Moderating Roles of Perceived Organizational Support and Competitive Psychological Climate," *Tourism Management*, Vol. 73 (August 2019), pp. 172-181.
  - 7 M. Dopico et al., "A Vision of Industry 4.0 from an Artificial Intelligence Point of View," In *Proceedings of the International Conference on Artificial Intelligence*, Las Vegas (US: CSREA Press, 2016), pp. 407-413.

“will AI take over the human’s job?” has been the central theme in many research inquiries. The purpose of this study is to present the status quo of scholarly discussion that attempted to answer that question, by reviewing and integrating recent literature on the subject.

Several factors are behind the fast development and adoption of AI in the industries. First, it is propelled by a widely held belief that it brings benefits of improved efficiency and accuracy in many aspects. For instance, the facial recognition technology, one of the popular AI applications, is installed in the customs of many international airports to recognize and record personal information of international travellers on arrivals or departures. The facial recognition system enhances the efficiency of the customs check, which decreases the time of travelers waiting in line in front of the customs; it also reduces the need to hire more customs officers. Amazon and Netflix use AI to track consumers’ internet browsing behaviors, analyze patterns of their purchasing habits, and match this knowledge of consumer psychology with the demographic information they have on a consumer to provide personalized recommendation on merchandises, books, and movies.

Secondly, as some countries with more developed economies have experienced the issue of aging, labor shortage, or skyrocketing labor costs, governments and enterprises have started to rely on robots and AI technology to supplement the workforce.<sup>8 9</sup> For example, the famous Apple and Samsung supplier, Foxconn, is known for its fast move to smart automation in order to

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8 Michael Decker, Martin Fischer, and Ingrid Ott, “Service Robotics and Human Labor: A First Technology Assessment of Substitution and Cooperation,” *Robotics and Autonomous Systems*, Vol. 87 (January 2017), pp. 348-354.

9 Mike Futch, “How Robotics are Automating a Solution to the Labor Shortage & Growing Customer Demands,” *Robotics Tomorrow*, May 23, 2019. <https://www.roboticstomorrow.com/article/2019/05/how-robotics-are-automating-a-solution-to-the-labor-shortage-growing-customer-demands/13677>

overcome labor shortage and rising labor costs in China, where it maintains its major manufacturing operation. Foxconn replaced 60 thousand factory workers with robots in 2016,<sup>10 11</sup> and was reported in 2018 to have planned to invest \$4 billion more in new robotics and automation technology.<sup>12</sup>

However, not everyone welcomes the arrival of the AI era with open arms. While factory owners and company CEOs are quick to take their side by AI, the general workforce is more reserved about the idea. There is a fear that their employer may one day decide to invest in AI technology rather than human labor, which may leave them jobless, like the 60 thousand factory workers in the Foxconn case. This anxiety is magnified by the threatening predictions of some of the famous critics, such as the late scientist Steven Hawking<sup>13</sup> and Tesla CEO Elon Musk,<sup>14</sup> as well as many Hollywood blockbuster movies that pose AI as a threat to humanity (for example, *The Terminator*; *The Matrix*; *I, Robot*). Similarly, the mass media tends to publish disturbing headlines predicting massive job loss whenever a new AI technological breakthrough is made.

Donald Hislop, Crispin Coombs, Stanimira Taneva, and Sarah Barnard conducted a literature review in 2017 on papers published from 2011 to 2016 to

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10 Jane Wakefield, "Foxconn replaces '60,000 factory workers with robots'" *BBC News*, May 25, 2016. <https://www.bbc.com/news/technology-36376966>

11 BBC, "Google Achieves AI 'Breakthrough' by Beating Go Champion," *BBC News*, January 27, 2016. <https://www.bbc.com/news/technology-35420579>

12 S. Francis, "Foxconn to invest \$4 billion in new robotics and automation technology," *Robotics & Automation News*, February 24, 2018. <https://roboticsandautomationnews.com/2018/02/24/foxconn-to-invest-4-billion-in-new-robotics-and-automation-technology/16182/>

13 Max de Haldevang, "Stephen Hawking Left Us Bold Predictions on AI, Superhumans, and Aliens," *Quartz*, October 15, 2018. <https://qz.com/1423685/stephen-hawking-says-superhumans-will-take-over-ai-is-a-threat-and-humans-will-conquer-space/>

14 Karen Gilchrist, "Elon Musk: 'A.I. will make jobs kind of pointless' — so study this," *CNBC make it*, August 29, 2019. <https://www.cnbc.com/2019/08/29/elon-musk-ai-will-make-jobs-kind-of-pointless-so-study-this.html>

uncover the influence of technology, including AI, on labor.<sup>15</sup> Their research covered several issues related to the general impact of recent emerging technology on society, with work-related outcomes as a part of its findings. As AI is developing in exponential speed, scholarly publications addressing similar concerns have also increased in the past few years. Therefore, there is a need to continue surveying the literature for trends and additional insights into this issue. As a follow-up to Hislop and his colleagues' work, this paper reviewed the extant literature related to AI technology and labor after 2016. Its purposes are to clarify the impacts of AI on the general workforce and to provide clues to the research question of "will AI take over the human's job?". This paper begins with a brief introduction to AI development. Next, the literature review methodology of this study is described, which includes detailed steps for the literature search, screening, and coding. Finally, the findings, which reveal several contrasting perspectives toward the impact of AI on labor, are summarized and discussed.

## **A Brief History of Artificial Intelligence**

The term "Artificial Intelligence" was proposed by McCarthy and his colleagues in 1956. They defined the field of AI as "the science and engineering of making intelligent machines, especially intelligent computer programs."<sup>16</sup> At the beginning, AI was developed to carry out formal logic computation, then its function slowly evolved for complex problem solving with if-then reasoning method, which was cast as an important early form of AI.<sup>17</sup> Even though the

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15 Donald Hislop et al., *Impact of Artificial Intelligence, Robotics and Automation Technologies on Work* (London: Chartered Institute of Personnel and Development, 2017), pp. 1-30. <https://www.voced.edu.au/content/ngv%3A80279>

16 John McCarthy, "What is Artificial Intelligence?" December 26, 2019. <http://jmc.stanford.edu/artificial-intelligence/what-is-ai/index.html>.

17 Council of Europe [COE], "History of Artificial Intelligence." Council of Europe, December 25, 2019. <https://www.coe.int/en/web/artificial-intelligence/history-of-ai>

invention of new techniques such as machine learning and deep learning, which enable AI to learn from data itself, have accelerated the development of AI, these techniques are still being applied on physical machines nowadays.<sup>18</sup>

For more than two decades, the study of AI was not popular, until 1997, when Deep Blue won Garry Kasparov, the chess champion in the world.<sup>19</sup> Afterwards, Google DeepMind's AlphaGo beat not only the other Go programs but also the human players, Fan Hui,<sup>20</sup> Lee Sedol, and Ke Jie in the GO game.<sup>21</sup> The achievement of AlphaGo was made possible by the development of the internet, cloud storage, and big data in recent years. Algorithms and huge datasets are critical elements to support the operation of AI. AI enables a machine to learn from past experiences and data fed to it using machine learning or deep learning techniques until the machine can complete a task under human instruction. Today, AI is believed to be one of the three important driving forces of the new industrial revolution, next to big data and algorithms.<sup>22</sup>

Several definitions of AI can be found in the literature. In 1984, Nils Nilsson defined AI as a “machine that can perform tasks requiring reasoning, judgement, and perception that previously could be done only by human”.<sup>23</sup> Robert Bogue described AI as “an intelligent agent” and “is a system that perceives its

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18 John Howard, “Artificial Intelligence: Implications for the Future of Work,” *American Journal of Industrial Medicine*, Vol. 62, No. 11 (August 2019), pp. 917-926.

19 Michele McPhee, K.C. Baker, and Corky Siemaszko, “Deep Blue, IBM's supercomputer, defeats chess champion Garry Kasparov in 1997,” *New York Daily News*, May 10, 2015. <https://www.nydailynews.com/news/world/kasparov-deep-blues-losingchess-champ-rooke-article-1.762264>

20 BBC, “Google Achieves AI 'Breakthrough' by Beating Go Champion.” *BBC News*,

21 CBC, “Go-playing Google Deepmind AlphaGo Computer Defeats Human Champion.” *CBC News*, January 27, 2016. <https://www.cbc.ca/news/technology/alphago-ai-1.3422347>

22 Klaus Schwab, “The Fourth Industrial Revolution: What it Means, How to Respond,” *World Economic Forum*, January 14, 2016. <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond>

23 Nils J. Nilsson, “Artificial Intelligence, Employment, and Income,” *AI Magazine*, Vol. 5, No. 2 (Summer 1985), pp. 5.

environment and takes actions that maximize its chances of success in a particular task”.<sup>24</sup> Andreas Kaplan and Michael Haenlein believed that it is “a system’s ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation”.<sup>25</sup> These definitions do not always appear consistent; as Pei Wang pointed out, many problems exist in the attempt to define AI.<sup>26</sup> Nonetheless, most definitions in the literature highlighted the characteristics of AI as a technology that is capable of human-like thinking and can interact intelligently with its environment when completing a specific activity.

AI serves as a strong factor in the latest industrial revolution, named as Industry 4.0. The industrial revolution refers to the transition of the production processes, mostly seen in the manufacturing industry, when a new and novel technique is developed.<sup>27</sup> Since mid-18<sup>th</sup> century, there have been three revolutions taking place and the most current one is the fourth industrial revolution. In each of the revolutions, new techniques, technologies, and machines were implemented in various industries, which released human labor from manual routine tasks and enhanced their productivity and efficiency. Spyros Makridakis believed that the industrial revolution raised the standard of living of human beings.<sup>28</sup> However, during the first and the second revolutions, human labor was released from the factory and substituted by machines, which lead to unemployment. AI and its applications were also reported to have the capability to

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24 Robert Bogue, “The Role of Artificial Intelligence in Robotics,” *Industrial Robot*, Vol. 41, No. 2 (March 2014), pp. 119.

25 Andreas Kaplan and Michael Haenlein, “Siri, Siri, in My Hand: Who’s the Fairest in the Land? On the Interpretations, Illustrations, and Implications of Artificial Intelligence,” *Business Horizons*, Vol. 62, No. 1 (January 2019), pp. 15.

26 Pei Wang, “What do you mean by ‘AI’,” pp. 362-373.

27 Dopico et al., *A Vision of Industry 4.0*, pp. 407-413.

28 Spyros Makridakis, “The Forthcoming Artificial Intelligence (AI) Revolution: Its Impact on Society and Firms,” *Futures*, Vol. 90 (June 2017), pp. 46-60.

directly or indirectly impact humanity and society.<sup>29 30</sup> These past experiences of the industrial revolution, together with the rapid advances of the AI technology naturally lead people to have higher anxiety and concern about the possibility of the history repeating itself.

## **Artificial Intelligence and Labor Displacement Research**

To estimate the possibility of human labor being replaced by machines, two approaches can be found in the literature, which are Carl Frey and Michael Osborne's occupational-level analysis approach<sup>31</sup> and Melanie Arntz, Terry Gregory, and Ulrich Zierahn's task-level analysis approach.<sup>32</sup> Frey and Osborne examined the probability of computerization in order to reveal which occupation was under high risk of computerization which may lead to unemployment. In contrast, Arntz, Gregory, and Zierahn examined the probability of automation under the approach of task-level analysis, that was, whether all tasks of a job could be automated. As a result, Arntz et al. suggested that only 9% of U.S. workers' jobs faced the automation risk, while Frey and Osborne suggested the possibility of automation was 47%. Jeff Borland and Michael Coelli adopted the approach of Arntz et al. on the Australian population and found the same automation risk of 9%.<sup>33</sup>

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29 Bahrin et al., "Industry 4.0: A Review on Industrial Automation and Robotic," *Jurnal Teknologi*, Vol. 78, No. 6-13 (March 2016), pp. 137-143.

30 Katja Grace et al., "Viewpoint: When Will AI Exceed Human Performance? Evidence from AI Experts," *Journal of Artificial Intelligence Research*, Vol. 62 (July 2018), pp. 729-754.

31 Carl Benedikt Frey and Michael A. Osborne, "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting and Social Change*, Vol. 114 (January 2017), pp. 254-280.

32 Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "Revisiting the Risk of Automation," *Economics Letters*, Vol. 159 (October 2017), pp. 157-60.

33 Jeff Borland and Michael Coelli, "Are Robots Taking Our Jobs?" *Australian Economic Review*, Vol. 50, No. 4 (November 2017), pp. 377-397.

Shotaro Tani reported a joint research project conducted by the Nikkei and the Financial Times, which also took the task-level approach to calculate the possible impact of automation in the workplace.<sup>34</sup> The outcome of the project was an interactive calculator which drew on data from the McKinsey Global Institute. The Nikkei Asian Review used this interactive calculator to examine which jobs Asian workers were expected to lose to robots. Based on this interactive calculator, over 80% of the activities performed by manufacturing workers could be automated, compared to nearly 70% in the food industry, nearly 50% in the transportation industry, around 43% in construction, 41% in farming, fishery and forestry, and 25% in health care. Applying this interactive calculator, the Financial Times concluded that although nearly every occupation had some tasks that could be automated, fewer than 5% of occupations can be fully automated due to the limitation of current technology.<sup>35</sup>

The two approaches both suggested how likely new technology might automate jobs or tasks but on a fairly general level, without paying attention to the context of a specific industry or a profession, nor did they probed into other forms of impact AI may bring aside from human-machine substitution. The work of Hislop et al. revealed evidence on how the new technologies have impacted knowledge workers and service professionals specifically, and society in general.<sup>36</sup> Their report was based on four themes: (1) clarification of the definition of emerging technologies and job-related patterns, (2) a framework of specific outcomes and the mediators after installation of technologies, especially in healthcare, transportation and non-specific sectors, (3) the influence of those technologies on the professions and the society, and (4) the ethical issues emerged

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34 Shotaro Tani, "Is Your Job Robot-Ready?" *Nikkei Asian Review*, April 22, 2017. <https://asia.nikkei.com/Features/AI-now-and-tomorrow/Is-your-job-robot-ready?page=2>

35 Robin Kwong et al., "Artificial Intelligence and Robotics. Can a Robot Do Your Job? Find Out How Much of Your Job Can Technically Be Automated," *Financial Times*, April 7, 2017. <https://ig.ft.com/can-a-robot-do-your-job/>

36 Donald Hislop et al., *Impact of Artificial Intelligence*, pp. 1-30.

from new technology implementation. From a review of a total of 182 articles published in the period of 2011 to 2016, Hislop and his colleagues concluded that AI mainly affects the employees by augmenting their ability to complete tasks and expanding their job roles to include other value-added responsibilities that human do better. However, they also cautioned that ethical issues should be concerned for further implementation of AI or new technologies to ensure safe utilization in the human society.

In recent years, research in AI and labor displacement has become a burgeoning field. As advancement of AI technology and applications accelerates, AI-related scholarly publications have also exploded in the last few years. At present, as the technology is still evolving, a periodical review of the literature on AI's impact on the labor market will contribute to the much needed understanding and the necessary preparation of human beings to better adapt in the AI era. Therefore, this paper aims to review the most recent literature on the topic of AI technology and labor to clarify the different impacts of AI on the general workforce.

## **Methodology**

The method for the present study is a systematic literature review. After the research topic and purpose of this study were defined, Hislop and his colleagues' approach in conducting the rapid literature review was followed in order to generate the findings. The process for the review comprises three steps: (1) systematic literature search; (2) literature screening and selection; and (3) thematic synthesis.

## **Step 1: Systematic literature search**

This study searched artificial intelligence and labor related academic articles through the Scopus e-journal platform. This platform has a collection of thousands of academic papers with fairly good quality and it is also the most accessible database for our research team. The search initiated with a publication date range filter from 2016 to 2019, in combination with other terms. Several pairs of search terms were used to search the Scopus platform, including artificial intelligence and labor, artificial intelligence and employment, artificial intelligence and job, artificial intelligence and social impact. Each query was setup to search the entire article for the search terms. Therefore, as long as the combinations of words/phrases above appear in any part of an article (i.e., title, abstract, keywords, main text, references), it would be picked up and included in the search result. This broad initial search resulted in a total of 1761 articles.

## **Step 2: Screening and selection of study**

In this stage, the criteria used for filtering the articles were established. Articles selected for this review had to fulfill the following criteria of being written in English, full-text available and accessible, and published in peer-reviewed articles. Since English is still the official language in most journals claiming international status, only articles written in English were selected to avoid the need for translation before reading and coding. It goes without saying that only the full-text articles could give the research team complete access to the contents of the articles. Furthermore, articles chosen from peer-reviewed journals were assumed to have a certain degree of quality since they would have been evaluated by experts in the field and possibly had gone through several rounds of revisions before official publication. Technical papers that purely published models and algorithms for application purposes, as well as articles which contents were not related to our

research purpose, were excluded. A total of 193 qualified articles survived this screening process. From the list of 193 articles, the research team examined each title and the abstract to ensure the content has the highest relevance to the issue of labor displacement. Finally, 39 articles were included in the present study.

Table 1. Summary of literature search result.

	Result
Initial search with pairs of search terms	1761
Screening criteria applied	193
Highest relevance to AI & labor displacement	39

### **Step 3: Thematic synthesis of selected studies**

Members of the research team in this stage included the authors and three graduate students. They were assigned different articles to code into excel with a given codebook. The team met weekly to review the coding progress and discussed the consistency in coding. When inconsistency or disagreement in coding occurred, the team resolved them through consensus and the codebook was revised. The codebook went through a total of three revisions. The final version of the codebook includes four categories, which are the source, the methodology, conclusions, and implications or suggestions of the article. The coding scheme is shown in Table 2.

Table 2. The coding scheme.

Source	Coding
Name of Journal	Text
Year published	Text
Author	Text
Fields published	Text
Topic discussed	1-Impact of Artificial intelligence 2-The role of artificial intelligence 3-Future of work/ future of employment 4-Labor demand/ labor force 9-Other
Methodology	
Research Design	1-Opinion/ commentary 2-Literature review 3-Data collection (quantitative or qualitative) 4-Secondary data analysis 9-Other
Geographical focus	1-None (Universal) 2-US 3-European countries 4-Asian countries 5-Oceania countries 9-Other
Conclusion	1-Labor replacement/ labor displacement/ replacement/ substitution 2-Unemployment 3-Wages 4-Assistance/ complement/ tool/ platform 5-Create new jobs 6-Improve productivity/ efficiency 9-Others
Implication or suggestion	1-Education 2-Organization 3-Government 9-Other

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## **Findings and Discussion**

This section introduces the key findings of the present study, which are summarized in three general categories under the headings of (1) research method of selected articles, (2) three different schools of views toward AI's impact on labor, and (3) implications discussed in selected articles. The research method of selected articles provides a profile picture of the publication selected into our review, which includes the fields, the types and the topics of these publication, a summary of keywords listed, the research design, and the geographical focus. The three different schools of views toward AI's impact on labor are the optimists, the pessimists and the neutralists. Implications discussed in selected articles are divided into four categories targeting at individual, education, organization, and government entities.

### **Research method of selected articles**

*Fields of publication, types of publication and topics discussed.* The present study reviewed 39 articles in total, including 36 peer-reviewed articles, and 3 working papers and book chapters (see a detail list in the Appendix). Table 3 presents the summary of the types of publication, topics discussed, and the frequency of fields published. The most frequently discussed topics coincide with the research purpose and include the impact of AI and other related technologies on the society and labor, the role of AI and other related technologies, the change in future employment or how future work will likely be shaped, and finally the demand in labor force. The number in fields of publication is cumulative of all articles and the categories or sub-categories they were indexed in the Scopus database. An article can be indexed under more than one category or sub-category. For example, the journal "Futures" is indexed in the category of Economics and in

Regional and Urban Planning. It is interesting to note that the top three fields the reviewed articles published in are Economics (10 articles), Business (8 articles), and Management (4 articles), while only two articles were published in each fields of Computer Science and Artificial Intelligence. This is an indication that the economists and business scholars seemed to have a higher concern over the issue of technology-driven labor displacement than the computer scientists. It is possibly because labor displacement has strong implications for the labor market, in terms of supply and demand of labor and labor cost, all of which are economics and management issues. It is also a warning sign that computer scientists did not seem to have paid enough attention to how AI or related technologies affect the labor force or the general society.

Table 3. Summary of types of publication, topics discussed and fields published.

	Frequency
<i>Types of publication</i>	
Peer-reviewed journal articles	36
Working papers and book chapter	3
<i>Topics discussed</i>	
Impact of artificial intelligence	21
The role of artificial intelligence	4
Future of work/ future of employment	9
Labor demand/ labor force	3
Other	2
<i>*Fields of publication</i>	
Economic	10
Business	8
Management	4
Computer Science	2

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	Frequency
Artificial Intelligence	2
Region & Urban Planning	2
Social Issues	2
Others	15

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\* The number in fields of publication is cumulative of all articles and the categories or sub-categories they were indexed in the Scopus database. An article can be indexed under more than one category or sub-category.

**Keywords used.** Keywords were designated by authors to declare the focus of their articles. By analyzing the keywords, we can get a picture of the topical areas represented by the literature. Table 3 summarizes the frequency of the keywords which were used more than once. The frequently used keywords are artificial intelligence, robot(ics), employment, automation, future of work and machine learning. Some examples of the keywords that appeared only once are big data, economics, human capital, job insecurity, workplace, and leadership. Even though AI is included in the discussion in all of the reviewed articles, only 19 articles chose the term as the keyword. Some articles used the more specific form of AI such as robot(ics) and machine learning as the keywords; some preferred a broader term such as automation, digitalization, new technology or computer/computerization. This is of course a reflection of the diverse definitions of AI resulted from an array of forms, structures and capability of the technology as described in Wang.<sup>37</sup>

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37 Pei Wang, "What do you mean by 'AI'," pp. 362-373.

Table 4. Frequencies of keywords used.

Keywords	Frequency
Artificial intelligence	19
Robot(ics)	9
Employment (Job)	6
Automation	4
Future of work	3
Machine learning	4
Human-computer interaction/Human-machine symbiosis	4
Technological change	3
Digitalization	2
Human resource	2
Industrial revolution	2
Job (work) displacement	2
New technology	2
Computer/Computerization	2

**Research design.** The frequently used research design of the selected articles were literature review, secondary data analysis, and commentary. As shown in Table 4, only 7 out of 39 papers collected original data either by a qualitative or a quantitative approach. It is reflection of a lack of wide spread AI application resulting in difficulty in finding samples to collect data, or a lack of consensus in the definition of AI that led to difficulty in framing and targeting an empirical research to collect data. Table 4 also tabulated the geographical focus of the 39 articles. Two of the selected articles are cross-national comparison studies, one of them contrasted United States against China. Other geographically-specified articles mainly focused on the United States, Asian countries, Oceania countries, and Europe, while the remaining studies did not specify their geographical focus. The United States significantly outweighed other countries or regions in the number of scholarly publications on this topic.

Table 5. Frequencies of research design and geographical focus.

	Frequency		Frequency
<i>Research design</i>		<i>Geographical focus</i>	
Literature review	12	Non-specified	22
Opinion/ Commentary	7	United States	9
Secondary data analysis	7	Oceania	2
Data collection (Quantitative & qualitative)	7	Others (Geographical comparison)	3
Others	6	Asia	2
		Europe	1

### **The impact of technology and AI on labor market**

We coded the conclusions of each selected article by themes using the coding scheme in Table 2. For conclusions that fell under the theme of “others”, they were recoded under new themes such as polarization of the society. Three different schools of views emerged from this analysis were the positive views of the optimists (11 articles), the negative views of the pessimists (11 articles), and the neutral views (17 articles). The optimists advocated the benefits brought by new technology and AI, such as new demands for jobs and tasks, and enhanced quality of decision making and work efficiency. Conversely, the pessimists identified and warned the public of the risks of potential negative consequences when AI and other emerging technologies were adopted, such as a massive loss of jobs. The neutralists consider both the positive and the negative aspects when discussing the

impact of AI on labor and the society. The following sections provide the details of these different views. Table 6 summarizes the impact of technology and AI on labor market in the present study.

### ***The view of the optimists***

***Assisting and augmenting humans.*** From optimists' perspective, AI is recognized as an augmenting tool or a platform to assist humans,<sup>38 39</sup> such as supporting employees to complete their tasks<sup>40</sup> and improving the quality of services.<sup>41</sup> For example, new technologies installed in the hospitals are augmenting health care providers in dealing with the daily tasks and gaining useful information to further enhance the health care design.<sup>42</sup> Waymel et al. (2019) reported that radiologists in French expected that using AI would help them reduce the time spent on explaining the terminology, minimize medical error, and increase time to take care of patients.<sup>43</sup>

***Creating new jobs or tasks.*** Several scholars believed that, similar to the past

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38 Mohammad Hossein Jarrahi, "Artificial Intelligence and the Future of Work: Human-AI Symbiosis in Organizational Decision Making," *Business Horizons*, Vol. 61, No. 4 (July 2018), pp. 577-886.

39 Prasanna Tambe, Peter Cappelli, and Valery Yakubovich, "Artificial Intelligence in Human Resources Management: Challenges and a Path Forward," *California Management Review*, Vol. 61, No. 4 (August 2019), pp. 15-42.

40 Thomas Davenport et al., "How Artificial Intelligence Will Change the Future of Marketing," *Journal of the Academy of Marketing Science*, Vol. 48, No. 1 (January 2020), pp. 24-42.

41 Dogan Gursoy et al., "Consumers Acceptance of Artificially Intelligent (AI) Device Use in Service Delivery," *International Journal of Information Management*, Vol. 49 (December 2019), pp. 157-169.

42 Pavel Hamet and Johanne Tremblay, "Artificial Intelligence in Medicine," pp. S36-S40.

43 Q. Waymel et al., "Impact of the Rise of Artificial Intelligence," pp. 327-336.

industrial revolution, new jobs would be created in this era.<sup>44 45 46</sup> Deggans, et al. argued that new and innovative jobs could be born out of the innovation process as intelligence organizations were catalyzed.<sup>47</sup> Agrawal, et al. also claimed that there would be increasing task demands for technology-related professionals to operate the computation of AI and to maintain the database for training AI.<sup>48</sup> Jacobs and Karen concluded that “new techniques often sharply reduce the cost of an activity and consequently expand the volume demanded. The resulting situation is not simply the replacement of human labor but instead a substantially expanded industry”.<sup>49</sup>

***Improving quality of decision making.*** On the one hand, AI can take over the mundanely repetitive or administrative tasks which will free up humans’ time and energy to focus on making more strategic decisions and doing more value-added innovative work.<sup>50</sup> On the other hand, the ability of AI to quickly navigate volumes of information and provide the most relevant knowledge through its learning algorithm will help overcome the uncertainty and equivocality issues that are usually found during the decision-making process.<sup>51</sup> AI’s continuously-advancing capability in prediction can help overcome the difficulties in many

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- 44 Ajay Agrawal, Joshua S. Gans, and Avi Goldfarb, “Artificial Intelligence: The Ambiguous Labor Market Impact of Automating Prediction,” *Journal of Economic Perspectives*, Vol. 33, No. 2 (Spring 2019), pp. 31-50.
- 45 Jerome Deggans et al., “Cognitively Enhanced Products, Output Growth, and Labor Market Changes: Will Artificial Intelligence Replace Workers by Automating Their Jobs?” *Economics, Management, and Financial Markets*, Vol. 14, No. 1 (March 2019), pp. 38-43.
- 46 Jerry A. Jacobs and Rachel Karen, “Chapter 2 Technology-Driven Task Replacement and the Future of Employment,” In *Work and Labor in the Digital Age (Research in the Sociology of Work 33)* (London: Emerald Publishing Ltd., 2019.), pp. 43-60.
- 47 Jerome Deggans et al., “Cognitively Enhanced Products,” pp. 38-43.
- 48 Ajay Agrawal, Joshua S. Gans, and Avi Goldfarb, “Artificial Intelligence,” pp. 31-50.
- 49 Jerry A. Jacobs and Rachel Karen, “Chapter 2 Technology-Driven Task Replacement,” pp. 43-60.
- 50 Sofia Olhede and Patrick J. Wolfe, “Artificial Intelligence and the Future of Work: Will Our Jobs Be Taken by Machines?” *Significance*, Vol. 16, No. 1 (2019), pp. 6-7.
- 51 Mohammad Hossein Jarrahi, “Artificial Intelligence and the Future,” pp. 577-886.

business-related decisions by providing decision-makers statistically computed outcomes to make a better or more nuanced choice.<sup>52</sup>

***Improving efficiency and reducing cost.*** One of the major points to support AI development is its ability to improve efficiency and thereby reduce costs associated with business operation.<sup>53</sup> <sup>54</sup> Georg Graetz and Guy Michaels argued that extensive use of robots would increase total factor productivity and wages, and reduce output prices.<sup>55</sup> Jacobs and Karen held a similar belief and stated that AI would provide new techniques to reduce cost of operation, which may lead to lower prices and higher demand for a product, and thus can substantially expand an industry (i.e., more jobs).<sup>56</sup>

### ***The view of the pessimists***

***Causing job loss by human-machine substitution.*** For some scholars, the negative impacts on employment caused by new technology and AI is undeniable.<sup>57</sup> New technology does lead to job substitution, lower labor demand, and unemployment. As the machines gets smarter, jobs that are repetitive and routine,<sup>58</sup> with heavy physical need, low skilled<sup>59</sup> or requiring low education level, will be replaced. Middle-level white-collar employees and blue-collar workers are

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52 Ajay Agrawal, Joshua S. Gans and Avi Goldfarb, “Exploring the Impact of Artificial Intelligence: Prediction versus Judgment,” *Information Economics and Policy*, Vol. 47, (June 2019), pp. 1-6.

53 Ajay Agrawal, Joshua S. Gans and Avi Goldfarb, “Exploring the Impact of Artificial Intelligence” pp. 1-6.

54 Dogan Gursoy et al., “Consumers Acceptance,” pp. 157-69.

55 Georg Graetz and Guy Michaels, “Robots at Work,” *The Review of Economics and Statistics*, Vol. 100, No. 5 (December 2018), pp. 753-768.

56 Jerry A. Jacobs and Rachel Karen, “Chapter 2 Technology-Driven Task Replacement,” pp. 43-60.

57 Ming-Hui Huang and Roland T. Rust, “Artificial Intelligence in Service,” pp. 155-172.

58 Jun Li, Mark A. Bonn, and Ben Haobin Ye, “Hotel Employee,” pp. 172-181.

59 Carl Benedikt Frey and Michael A. Osborne, “The Future of Employment,” pp. 254-280.

expected to be substituted by destructive AI or machines.<sup>60</sup> Frey and Osborne further predicted that workers in the transportation and logistics industry, administrative support, or production line were at risk to be replaced very soon.<sup>61</sup>

***Technology gaining control over humans and demotivating humans to work.*** As AI technology becomes more and more powerful, it will possibly change the nature of the interaction between technology and human. Makridakis described concerns from prior literature that humans may one day lose their dominance over computers and become a “pet” of the new technology.<sup>62</sup> In other words, humans would no longer make decisions by themselves. Instead, computers or AI technology may condition how humans behave or react and tell humans what to do in the future. Anton Korinek expressed a similar concern and commented: “we humans still feel mostly in control of the intelligent algorithms and machines that we have created and that we interact with on a daily basis. However, ...artificially intelligent agents ... are in fact more and more in control of us humans”.<sup>63</sup> As a matter of fact, human beings have become heavily reliant on the computers for information and algorithm-based predictions in the decision-making process. Some scholars concerned that this actually devalued human beings and may lead to a loss of motivation for humans to make decisions.<sup>64</sup> As Paul Cockshott and Karen Renaud illustrated, machines have already taken over some critical decisions in the financial industry with the algorithm trade techniques.<sup>65</sup> Another

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60 Duncan Gallie, “The Quality of Work in a Changing Labour Market,” *Social Policy & Administration*, Vol. 51, No. 2 (March 2017), pp.226-243.

61 Carl Benedikt Frey and Michael A. Osborne, “The Future of Employment,” pp. 254-280.

62 Spyros Makridakis, “The Forthcoming Artificial Intelligence,” pp. 46-60.

63 Anton Korinek, “Labor in the Age of Automation and Artificial Intelligence,” *Economists for Inclusive Prosperity, Research Brief*, (2019), p. 7.

64 Verena Bader and Stephan Kaiser, “Algorithmic Decision-Making? The User Interface and Its Role for Human Involvement in Decisions Supported by Artificial Intelligence,” *Organization*, Vol. 26, No. 5 (June 2019), pp. 655-672.

65 Paul Cockshott and Karen Renaud, “Humans, Robots and Values.” *Technology in Society*, Vol. 45 (May 2016), pp. 19-28.

possible negative consequence along the same line is that human workers may become less involved and demotivated to work.<sup>66</sup>

***Increasing polarization of the society.*** As evidenced in the previous industrial revolutions, technology will enhance the concentration of capital (hence, power), and create wider gaps between winners and losers.<sup>67</sup> Winners in the AI era may be the capitalists or the military who own the first cutting-edge AI development,<sup>68</sup> employers who successfully implemented AI to cut operation costs or enhance competitiveness, and those who have the necessary competence to create and apply AI (e.g., AI developers and those who can work with AI).<sup>69</sup> Losers, on the other hand, are companies and workers who do not update their skill set and are eventually sifted out by the technological advancement.

***Decreasing wage of labor.*** Scholars such as Stephen DeCanio<sup>70</sup> and Anton Korinek<sup>71</sup> warned against the effect of AI in wage decrease. DeCanio predicted that the proliferation of robots would result in declining wages of industrial workers due to a smaller human-robot elasticity of substitution. Korinek observed that the real wages of regular workers have declined over the past four decades corresponding to the technological change over that period. Therefore, he concluded that one negative impact of AI would be the reduction of the regular (unskilled) workers' market wages.

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66 Spyros Makridakis, "The Forthcoming Artificial Intelligence," pp. 46-60.

67 Miron Wolnicki and Ryszard Piasecki, "The New Luddite Scare: The Impact of Artificial Intelligence on Labor, Capital and Business Competition between US and China," *Journal of Intercultural Management*, Vol. 11, No. 2 (June 2019), pp. 5-20.

68 Stephen J. DeCanio, "Robots and Humans – Complements or Substitutes?" *Journal of Macroeconomics*, Vol. 49 (September 2016), pp. 280-291.

69 Miron Wolnicki and Ryszard Piasecki, "The New Luddite Scare," pp. 5-20.

70 Stephen J. DeCanio, "Robots and Humans," pp. 280-291.

71 Anton Korinek, "Labor in the Age," pp. 1-9.

***The view of the neutralists: Current AI as an evolving infant***

The neutralists believed that it has yet to conclude at this moment whether technological change would end human work or be favorable to the general workforce,<sup>72</sup> as AI is a developing technology and has a couple of unpredictable<sup>73</sup> and uncertain factors.<sup>74</sup> For example, Jeremy Atack, Robert Margo, and Paul Rhode differentiated between changes brought upon by current technologies and by the steam engines in the past, and suggested that while history may repeat itself, we do need to keep in mind that the impacts of these two technologies are fundamentally different.<sup>75</sup> Therefore, we should stand in a neutral position and look forward to its development. Martin Upchurch referred AI as a “dead labor” which could neither pass present value nor bring about the new one, and was created by humans to imitate the human beings.<sup>76</sup> Thus, humans should find our own value as we are the final decision-makers. Agrawal, Gans, and Goldfarb also suggested that the AI’s impact on the job would be a result of multiple factors, involving multiple facets. Therefore, it is too early to tell the overall impacts of AI on the labor market.<sup>77</sup>

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72 Daron Acemoglu and Pascual Restrepo, “Automation and New Task: How Technology Displace and Reinstates Labor,” *Journal of Economic Perspectives*, Vol. 33, No.2 (Spring 2019), pp. 3-30.

73 Katja Grace et al., “Viewpoint,” pp. 729-754.

74 Morgan R. Frank et al., “Toward Understanding the Impact of Artificial Intelligence on Labor,” *Proceeding National Academy of Science USA*, Vol. 116, No. 14 (March 2019), pp. 6531-6539.

75 Jeremy Atack, Robert A. Margo, and Paul W. Rhode, “Automation of Manufacturing in the Late Nineteenth Century: The Hand and Machine Labor Study,” *Journal of Economic Perspectives*, Vol. 33, No. 2 (Spring 2019), pp. 51-70.

76 Martin Upchurch, “Robots and AI at Work: The Prospects for Singularity,” *New Technology, Work and Employment*, Vol. 33, No. 3 (November 2018), pp. 205-218.

77 Ajay Agrawal, Joshua S. Gans, and Avi Goldfarb, “Artificial Intelligence,” pp. 31-50.

Table 6. Summary of the impact of AI and technology on labor market.

<b>Perspective</b>	<b>Description</b>	<b>Example</b>
<b>The view of the optimists</b>	● Assist and augment humans	● Assist and complement employees in completing tasks <sup>78</sup> ● Gain useful information for further enhancing the health care design <sup>79</sup>
	● Create new jobs or tasks	● Increase technology-related task demand <sup>80</sup>
	● Improve quality of decision making	● Navigate information and provide knowledge through algorithms to overcome the uncertainty and equivocality issues during the decision-making process <sup>81</sup>
	● Improve efficiency and reduce cost	● Use of robot increases total factor productivity and reduces cost <sup>82</sup>
<b>The view of the pessimists</b>	● Cause job loss by human-machine substitution	● Middle level white-collar employees and blue-collar workers are expected to be substituted <sup>83</sup>
	● Technology gains control over humans and demotivates humans to make decisions	● Humans follow the order made by computers <sup>84</sup> ● Humans become deeply reliant on the computers' algorithm-based predictions
	● Increase polarization of the society	● Create wider gaps between winners and losers <sup>85</sup>
	● Decrease wage of labor	● Reduce the market wages of regular (unskilled) workers <sup>86</sup>
<b>The view of the neutralists</b>	● Current AI as an evolving infant	● Unpredictable <sup>87</sup> and uncertain factors exist <sup>88</sup>

78 Thomas Davenport et al., “How Artificial Intelligence,” pp. 24-42.  
 79 Pavel Hamet and Johanne Tremblay, “Artificial Intelligence in Medicine,” pp. S36-S40.  
 80 Ajay Agrawal, Joshua S. Gans, and Avi Goldfarb, “Artificial Intelligence,” pp. 31-50.  
 81 Mohammad Hossein Jarrahi, “Artificial Intelligence and the Future,” pp. 577-886.  
 82 Georg Graetz and Guy Michaels, “Robots at Work,” pp. 753-768.  
 83 Duncan Gallie, “The Quality of Work,” pp. 226-243.  
 84 Spyros Makridakis, “The Forthcoming Artificial Intelligence,” pp. 46-60.  
 85 Miron Wolnicki and Ryszard Piasecki, “The New Luddite Scare,” pp. 5-20.  
 86 Anton Korinek, “Labor in the Age,” pp. 1-9.  
 87 Katja Grace et al., “Viewpoint,” pp. 729-754.  
 88 Morgan R. Frank et al., “Toward Understanding the Impact,” pp. 6531-6539.

## **The implications discussed in selected articles**

Most of the reviewed articles recognized that AI is an unstoppable trend and rapid technological development. Therefore, in the implications section of those reviewed articles, the authors also suggested some strategies to deal with this trend. These suggestions were mainly directed at individuals, education institutions, organizations, and the government, as described in the following sub-sections and summarized in Table 7.

### ***Individual***

AI is cast as the next industrial revolution which will bring about large scale skill change. Human beings will be forced to work alongside machines or expand their roles on the job. Mohammad Hossein Jarrahi believed that as AI evolved and improved over time, managers and employees would also have to constantly react and adapt to the change.<sup>89</sup> Many scholars hold similar views that employees will need to get prepared for the transition<sup>90</sup> and “develop new skills to complement advances in AI technology”.<sup>91</sup> The idea of continuously updating AI literacy, i.e., transferring and applying the latest AI technology knowledge into practice, was also suggested to human decision-makers.<sup>92</sup>

### ***Education***

The changing technological environment calls for a reform in the education

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89 Mohammad Hossein Jarrahi, “Artificial Intelligence and the Future,” pp. 577-886.

90 Jerry A. Jacobs and Rachel Karen, “Chapter 2 Technology-Driven Task Replacement,” pp. 43-60.

91 Andreas Kaplan and Michael Haenlein, “Siri, Siri, in My Hand,” pp. 23.

92 Mohammad Hossein Jarrahi, “Artificial Intelligence and the Future,” pp. 577-886.

of children for future workplace in the AI era. Educational institutions can put effort into imparting the knowledge of AI and the ability to use AI, such as the language of system coding and the algorithms.<sup>93</sup> Likewise, Ming-Hui Huang and Roland Rust implied that creative thinking, data interpretation ability, and decision making are also important in the AI era.<sup>94</sup> Scholars also call for more evidence-based research on the development and application of AI and technologies, by which academic community can provide the public with an insight into the current status and the trend of technology.<sup>95 96</sup>

### ***Organization***

Human resource leaders play an important role in the organization in the world of AI. The success of a firm relies on how the talents are hired, motivated, and managed. These processes are not easy to convert to computational procedure, as the final decisions can only be made by a human.<sup>97</sup> Prasanna Tambe, Peter Cappelli, and Valery Yakubovich indicated that a human resource leader also needs to comprehend the crucial developments in this AI era and specify the new competencies the organization may need from a talent. Thus, they can recruit or train a new talent appropriately to fulfill the organization's needs and subsequently sustain organizational growth.<sup>98</sup> Furthermore, human resource practitioners should develop and implement internal training programs to help employees adapt to the changing technological environment and enhance their company's

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93 Sofia Olhede and Patrick J. Wolfe, "Artificial Intelligence and the Future of Work," pp.6-7.

94 Ming-Hui Huang and Roland T. Rust, "Artificial Intelligence in Service," pp. 155-172.

95 Morgan R. Frank et al., "Toward Understanding the Impact," pp. 6531-6539.

96 Jenny S. Wesche and Andreas Sonderegger, "When Computers Take the Lead: The Automation of Leadership," *Computers in Human Behavior*, Vol. 101 (December 2019), pp. 197-209.

97 Spyros Makridakis, "The Forthcoming Artificial Intelligence," pp. 46-60.

98 Prasanna Tambe, Peter Cappelli, and Valery Yakubovich, "Artificial Intelligence in Human Resources Management," pp. 15-42.

competitiveness.<sup>99</sup> <sup>100</sup> A new business strategy needs to be elaborated to catch up on the current trend of AI technology for the organization to succeed, such as adopting a marketing concept of AI as a reliable and efficient partner.<sup>101</sup> For policymakers, Davenport and others suggested paying attention to issues of data privacy, bias, and ethics so that companies could ensure a balance between commercial and individual interest.<sup>102</sup>

### ***Government***

A “lifelong learning” concept could be promoted by the government to keep their citizens posted on the current trends and become more adaptive to the changing environment. In addition, it is suggested that the government should protect the affected workers and retrain them so that they are able to self-adjust and re-gain employment as soon as possible.<sup>103</sup> <sup>104</sup> As AI may bring about unemployment to some extent, the idea of a guaranteed basic income or universal basic income, which is a basic payment given to an individual during a certain period, has been suggested for the AI era.<sup>105</sup> However, the matter of how to implement it, or whether it is necessary is still under debate.<sup>106</sup> Moreover, the robot tax collection from the firms, calculated according to their robot usage, is another debatable suggestion.<sup>107</sup>

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99 Thomas Davenport et al., “How Artificial Intelligence,” pp. 24-42.

100 Jun Li, Mark A. Bonn, and Ben Haobin Ye, “Hotel Employee,” pp. 172-181.

101 Dogan Gursoy et al., “Consumers Acceptance,” pp. 157-069.

102 Thomas Davenport et al., “How Artificial Intelligence,” pp.24-42.

103 Jeff Borland and Michael Coelli, “Are Robots Taking Our Jobs?” pp.377-397.

104 Sofia Olhede and Patrick J. Wolfe, “Artificial Intelligence and the Future of Work,” pp. 6-7.

105 Anton Korinek, “Labor in the Age,” pp. 1-9.

106 Andreas Kaplan and Michael Haenlein, “Rulers of the World, Unite! The Challenges and Opportunities of Artificial Intelligence,” *Business Horizons*, Vol. 63, No. 1 (January 2020), pp. 37-50.

107 Anton Korinek, “Labor in the Age,” pp. 1-9.

Table 7. Summary of implications discussed in selected articles.

<b>Implication</b>	<b>Example</b>
<b>Individual</b>	<ul style="list-style-type: none"> <li>● Get prepared for change<sup>108 109</sup></li> <li>● Upgrade skills<sup>110</sup></li> </ul>
<b>Education</b>	<ul style="list-style-type: none"> <li>● New AI related course design and delivery<sup>111</sup></li> <li>● More evidence-based research on AI<sup>112 113</sup></li> </ul>
<b>Organization</b>	<ul style="list-style-type: none"> <li>● Heighten role of human resource manager<sup>114</sup></li> <li>● Provide employee training programs on AI application<sup>115 116</sup></li> <li>● Incorporate AI in marketing strategy<sup>117</sup></li> <li>● Pay attention to issues of data privacy, bias, and ethics<sup>118</sup></li> </ul>
<b>Government</b>	<ul style="list-style-type: none"> <li>● Promote lifelong learning concept</li> <li>● Protect &amp; retrain workers affected<sup>119 120</sup></li> <li>● Provide guaranteed basic income or universal basic income<sup>121</sup></li> <li>● Collect robot tax<sup>122</sup></li> </ul>

## Conclusions

This systematic review is an attempt to synthesize recent scholarly publications on the issue of AI technology’s impact on labor displacement, in order

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108 Jerry A. Jacobs and Rachel Karen, “Chapter 2 Technology-Driven Task Replacement,” pp. 43-60.

109 Mohammad Hossein Jarrahi, “Artificial Intelligence and the Future,” pp. 577-886.

110 Andreas Kaplan and Michael Haenlein, “Siri, Siri, in My Hand,” pp. 15-25.

111 Sofia Olhede and Patrick J. Wolfe, “Artificial Intelligence and the Future of Work,” pp. 6-7.

112 Morgan R. Frank et al., “Toward Understanding the Impact,” pp. 6531-6539.

113 Jenny S. Wesche and Andreas Sonderegger, “When Computers Take the Lead,” pp. 197-209.

114 Prasanna Tambe, Peter Cappelli, and Valery Yakubovich, “Artificial Intelligence in Human Resources Management,” pp. 15-42.

115 Thomas Davenport et al., “How Artificial Intelligence,” pp. 24-42.

116 Jun Li, Mark A. Bonn, and Ben Haobin Ye, “Hotel Employee,” 172-181.

117 Dogan Gursoy et al., “Consumers Acceptance,” pp. 157-169.

118 Thomas Davenport et al., “How Artificial Intelligence,” pp. 24-42.

119 Jeff Borland and Michael Coelli, “Are Robots Taking Our Jobs?” pp. 377-397.

120 Sofia Olhede and Patrick J. Wolfe, “Artificial Intelligence and the Future of Work,” pp. 6-7.

121 Anton Korinek, “Labor in the Age,” pp. 1-9.

122 Anton Korinek, “Labor in the Age,” pp. 1-9.

to provide an up-to-date overview of the progress in this field of study. Through the review of 39 scholarly articles published between 2016 and 2019, we have reported the types of research that have been published (fields of publication, types of research design, etc.) and the issues being debated (optimistic vs. pessimistic vs. neutral views).

The review found this field of study is still at an early stage. Particularly, most published articles just discussed the general impacts or the roles of AI in the workforce at a conceptual level. These articles appeared in the form of literature reviews or commentaries, mostly published in journals whose foci were on economics or business. Only a third of the reviewed articles reported empirical evidence.

Regarding the impacts of AI on labor, three distinctive perspectives emerging from the literature were the optimists', the pessimists', and the neutralist's views. The optimists advocated the benefits that new technology and AI would bring, such as assisting and augmenting humans in a workflow, creating new demand for jobs and tasks, enhancing the quality of decision making and work efficiency, and reducing cost. Opposite to the optimists, the pessimists identified and warned the public of the risks of potential negative consequences when AI and other emerging technologies were adopted, such as a massive loss of jobs, the control of technology over humans, the humans' complacent and demotivation in decision making, the increasing polarization of the society, and the decrease of labor wage. The neutralists considered both the advantages and disadvantages when discussing the impacts of AI on labor and society.

Similar to the conclusion of Hislop et al., when considering the work-related outcomes of emerging technologies, the concept of augmentation of humans and human work permeates the literature. The body of research published between 2016-2019 seemed to agree that the new AI technology would surely replace humans but only in certain algorithm-ready tasks, taking those performed by the

production and assembly line workers in the manufacturing sector as an obvious example. However, for other sectors studied, the replacement is mostly carried out on the task level and appears gradually as a form of efficiency or quality improvement, “rather than wholesale replacement” of a job.<sup>123</sup> Using the flourishing application of AI in FinTech as an example, through smart algorithms, companies are now able to match the needs of customers to financial products, which enables the service representatives to accurately target their efforts, increase efficiency of sales, and improve customer satisfaction.

Another consensus from the reviewed papers is the urgent need for humans to realize that the tide of AI technology is real and has gained enough momentum for large scale implementation. Hence, unless humans learn to surf the technological wave, we are likely to be drown in it. One dominant scenario that has been reported in this AI wave is the human-machine collaboration. As described above, in most sectors, AI does not replace an entire job but rather accompanies or interacts with humans in the completion of certain tasks. Therefore, to meet the demand of future human-machine collaborated workplaces, humans need to master a different set of knowledge, skills and abilities (KSAs) to work with smart machines successfully. These KSAs may include basic AI literacy, domain specific technology applications, the psychology of human-machine interface, ethical development and application of AI, as well as the ability to seize control of the technology instead of being controlled by it. Massive skill change initiatives are advocated by many scholars, regardless of their optimistic or pessimistic views.

In short, AI development is still in its infancy. At present, most applications of AI bear little resemblance to the characteristics in its documented definitions (i.e., a technology that is capable of human-like thinking and can interact

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123 Donald Hislop et al., *Impact of Artificial Intelligence*, p. 18.

intelligently with its environment when completing a specific activity), and the success of AI implementation is mostly anecdotal. It will take time for AI technology to achieve more general and wider influence on the society. Grace et al. (2018) suggested that at least ten more years are needed for the AI technique to achieve the mature stage for full-scale implementation.<sup>124</sup> Nonetheless, with the powerful implication of what this technology can do to the human society, it is imperative that we humans have to fully understand the potential repercussions in order to get prepared for the coming AI era. It is undeniable that AI can cause serious impacts on the labor market, in the form of labor substitution or skill change, however, it also creates new jobs, augments humans to undertake difficult tasks or demands, and releases humans from the repetitive routines to do what humans do best. Moreover, it could bring several positive influences on the national economy with a long term perspective.<sup>125</sup> Hence, in the AI era, it is important to master the new knowledge and discipline of AI and its applications.

### **Limitations and Future Research Suggestions**

This study used the systematic literature review as the main approach. This approach synthesizes key themes and emerging debates in the literature to track current progress of a topic and is beneficial for researchers interested in the topic. However, a major limitation of this approach is the inability to create new knowledge related to the topic reviewed. In addition, due to the accessibility issue of databases and the availability of full texts in the database, this study may have missed important research findings in the past four years. Finally, as this study discovered, the field of study lacks sufficient empirical evidence. As such, most of

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124 Katja Grace et al., "Viewpoint," pp. 729-754.

125 PWC. *Preparing for Tomorrow's Workforce, Today* (PWC, 2018), <https://www.pwc.com/gx/en/people-organisation/pdf/pwc-preparing-for-tomorrows-workforce-today.pdf>

the discussion of AI's impact on labor is still speculative.

In light of the progress observed in this line of study, we call for more extensive and robust studies that generate empirical knowledge of the issue of interest. Two broad categories of research are suggested for future researchers to accomplish this. One is to fully exploit the technique of big data analysis and machine learning to track the demand of new job titles or job tasks being created and compare that to the decrease or disappearance of existing job titles or job tasks. Another important research stream is devoted to how humans interact with AI technology, under the topics of AI technology acceptance by different users, human-machine collaboration psychology or behavior, and ethical considerations.

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- 2019 "The New Luddite Scare: The Impact of Artificial Intelligence on Labor, Capital and Business Competition between US and China." *Journal of Intercultural Management*, Vol. 11, No. 2 (June 2019), pp. 5-20.

## Appendix. Articles reviewed in the present study

No.	Title	Author(s) and year published	Journal
1	Automation and new task: How technology displace and reinstates labor	Acemoglu, D., & Restrepo, P. (2019)	Journal of Economic Perspectives
2	Artificial intelligence: the ambiguous labor market impact of automating prediction	Agrawal, A., Gans, J. S., & Goldfarb, A. (2019)	Journal of Economic Perspectives
3	Exploring the impact of artificial intelligence: Prediction versus judgment	Agrawal, A., Gans, J. S., & Goldfarb, A. (2019)	Information Economics and Policy
4	Revisiting the risk of automation	Arntz, M., Gregory, T., & Zierahn, U. (2017)	Economics Letters
5	"Automation" of Manufacturing in the Late Nineteenth Century: The Hand and Machine Labor Study.	Atack, J., Margo, R. A., & Rhode, P. W. (2019).	Journal of Economic Perspectives
6	Algorithmic decision-making? The user interface and its role for human involvement in decisions supported by artificial intelligence	Bader, V., & Kaiser, S. (2019)	Organization
7	Testing the employment	Barbieri, L.,	

No.	Title	Author(s) and year published	Journal
	impact of automation, robots and AI: A survey and some methodological issues	Mussida, C., Piva, M., & Vivarelli, M. (2019)	
8	Are robots taking our jobs?	Borland, J., & Coelli, M. (2017)	Australian Economic Review
9	Technology, innovation, employment and power: Does robotics and artificial intelligence really mean social transformation?	Boyd, R., & Holton, R. J. (2018)	Journal of Sociology
10	Smart technology, artificial intelligence, robotics, and algorithms (STARA): Employees' perceptions of our future workplace	Brougham, D., & Haar, J. (2018)	Journal of Management & Organization
11	Humans, robots and values	Cockshott, P., & Renaud, K. (2016)	Technology in Society
12	How artificial intelligence will change the future of marketing	Davenport, T., Guha, A., Grewal, D., & Bressgott, T. (2019)	Journal of the Academy of Marketing Science,
13	Robots and humans-complements or substitutes?	DeCanio, S. J. (2016)	Journal of Macroeconomics

No.	Title	Author(s) and year published	Journal
14	Service Robotics and Human Labor: A first technology assessment of substitution and cooperation	Decker, M., Fischer, M., & Ott, I. (2017)	Robotics and Autonomous Systems
15	Cognitively Enhanced Products, Output Growth, and Labor Market Changes: Will Artificial Intelligence Replace Workers by Automating Their Jobs?	Deggans, J., Krulicky, T., Kovacova, M., Valaskova, K., & Poliak, M. (2019)	Economics, Management and Financial Markets
16	Toward understanding the impact of artificial intelligence on labor	Frank, M. R., Autor, D., Bessen, J. E., Brynjolfsson, E., Cebrian, M., Deming, D. J., ... & Wang, D. (2019)	Proceedings of the National Academy of Science
17	The future of employment: How susceptible are jobs to computerisation?	Frey, C. B., & Osborne, M. A. (2017)	Technological forecasting and social change
18	The quality of work in a changing labour market	Gallie, D. (2017)	Social Policy & Administration
19	When will AI exceed	Grace, K.,	Journal of Artificial

No.	Title	Author(s) and year published	Journal
	human performance? Evidence from AI experts.	Salvatier, J., Dafoe, A., Zhang, B., & Evans, O. (2018)	Intelligence Research
20	Robots at work	Graetz, G., & Michaels, G. (2018)	Review of Economics and Statistics
21	Consumers acceptance of artificially intelligent (AI) device use in service delivery	Gursoy, D., Chi, O. H., Lu, L., & Nunkoo, R. (2019)	International Journal of Information Management
22	Artificial intelligence in medicine	Hamet, P., & Tremblay, J. (2017)	Metabolism
23	Artificial intelligence in service	Huang, M. H., & Rust, R. T. (2018)	Journal of Service Research
24	Technology-Driven Task Replacement and the Future of Employment	Jacobs, J. A., & Karen, R. (2019)	In Work and Labor in the Digital Age (pp. 43-60). Emerald Publishing Limited.
25	Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making	Jarrahi, M. H. (2018)	Business Horizons
26	Rulers of the world, unite! The challenges and	Kaplan, A., & Haenlein, M.	Business Horizons.

No.	Title	Author(s) and year published	Journal
	opportunities of artificial intelligence	(2020)	
27	Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence	Kaplan, A., & Haenlein, M. (2019)	Business Horizons
28	Labor in the age of automation and artificial intelligence	Korinek, A. (2019)	Economists for Inclusive Prosperity
29	Computers and populism: artificial intelligence, jobs, and politics in the near term	Levy, F. (2018)	Review of Economic Policy
30	Hotel employee's artificial intelligence and robotics awareness and its impact on turnover intention: The moderating roles of perceived organizational support and competitive psychological climate	Li, J. J., Bonn, M. A., & Ye, B. H. (2019)	Tourism Management
31	Frontiers: Machines vs. humans: The impact of artificial intelligence	Luo, X., Tong, S., Fang, Z., & Qu, Z. (2019)	Marketing Science

No.	Title	Author(s) and year published	Journal
	chatbot disclosure on customer purchases		
32	The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms.	Makridakis, S. (2017)	Futures
33	Artificial intelligence and the future of work: Will our jobs be taken by machines?	Olhede, S., & Wolfe, P. J. (2019)	Significance
34	When Robots Replace Human Managers: Introducing the Quantifiable Workplace	Sahota, N. (2019)	IEEE Engineering Management Review
35	Artificial Intelligence in Human Resources Management: Challenges and a Path Forward	Tambe, P., Cappelli, P., & Yakubovich, V. (2019)	California Management Review
36	Robots and AI at work: the prospects for singularity	Upchurch, M. (2018)	New Technology, Work and Employment
37	Impact of the rise of artificial intelligence in radiology: What do radiologists think	Waymel, Q., Badr, S., Demondion, X., Cotten, A., & Jacques, T. (2019)	Diagnostic and interventional imaging
38	When computers take the	Wesche, J. S., &	Computers in Human

No.	Title	Author(s) and year published	Journal
	lead: The automation of leadership	Sonderegger, A. (2019)	Behavior
39	The New Luddite Scare: The Impact of Artificial Intelligence on Labor, Capital and Business Competition between US and China	Wolnicki, M., & Piasecki, R. (2019)	Journal of Intercultural Management

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