Leadership in an Artificial Intelligence Era

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Abstract

The current literature review attempts to combine the two topics "leadership" and "artificial intelligence" by highlighting the main perspectives in the research field of Leadership in Industry 4.0, dominated by Artificial Intelligence (AI)-based technologies. The current literature review identifies the three main directions of the scholarly and practitioner research: 1) AI as an additional assistance to current leadership functions (enhancement perspective); 2) AI to replace followers and leaders (replacement perspective); and 3) AI as "an oversold idea" (skeptical perspective). This literature review addresses a lack of substantial literature review and empirical data providing a balanced view of different perspectives on AI-based technologies' influence on the leadership of modern organizations. The objective of the current paper is to conduct an initial literature review on Leadership in Industry 4.0, dominated by AI-based technologies, with emphasis on the AI-based technologies' influence on the leadership of modern organizations. The current literature review attempts to answer the following research question: "What are the main perspectives of the scholarly and practitioner research directions in the period 2010-2020 in the field of Leadership in an Artificial Intelligence era?" Possible contribution of this paper is that identified perspectives could become a basis for future empirical research by the author and other scholars and practitioners in the field.

Keywords: leadership; Industry 4.0; artificial intelligence

Introduction

While the concept of leadership has been researched for over 100 years, research in the artificial intelligence field, and moreover – the intersection of leadership and artificial intelligence, is quite recent. The key terms that associate with artificial intelligence (AI) are: big data, automation, machine learning, and Industry 4.0. AI is used in such fields as: entertainment, healthcare, service industry (such as finance, marketing, logistics, e-commerce, agriculture, and accounting), education, and others. Therefore, in the last decade or so the academic community cautiously started to look at the relationship between leadership and artificial intelligence or "Leadership in an Artificial Intelligence based economy" (Moldenhauer & Londt, 2019, p. 155).

As per Naqvi and Munoz (2018), the issue is that "the cognitive transformation is sweeping through the global economy, and it is not like anything traditional leaders have ever experienced before" (p. 1). A survey by Accenture (2017, as cited in De Cremer, 2019) discovered that 85% of questioned executives were planning to extensively invest in AI-related technologies in the period of the next 3 years. Thus, the author raises the questions whether AI-based technologies implementation will influence the heart of the organizations – their leadership, and whether today's leadership will be relevant in the future.

As per the current knowledge of the author of this paper, the *problem* this study addresses is a lack of substantial literature review and empirical data providing a balanced view of different perspectives on the AI-based technologies' influence on the leadership of modern organizations. The *objective* of the current paper is to conduct an initial literature review on Leadership in Industry 4.0, dominated by AI-based technologies, with emphasis on the AI-based technologies' influence on the leadership of modern organizations.

The current literature review attempts to answer the following *research question*: "What are the main perspectives of the scholarly and practitioner research directions in the period 2010-2020 in the field of Leadership in an Artificial Intelligence era?"

Possible *contribution* of this paper is that identified perspectives could become a basis for future empirical research by the author and other scholars and practitioners in the field.

Definitions of the term "Artificial Intelligence"

An era of artificial intelligence (AI) started in the 1950s with English mathematician and logician Alan Turing's invention of the imitation game that later became famously known as the "Turing test" - a test that compares a machine's ability to be able to think like a human being. However, the invention of the term "*artificial intelligence*" is attributed to a professor of math at Dartmouth – John McCarthy. Though AI is not a new invention. A "hot topic" both in business and academic research AI became only a couple of decades ago.

In the beginning of the paper, it is important to define the term "artificial intelligence". The definitions of AI in Table 1 below reflect some of the common definitions of the term in the literature. Most often the authors refer to AI as "*science*", however, there are also terms as: "*collection of technologies*", "*computer program*", "*capacity of machines*", and others. The common idea in most definitions of AI is: intelligence of machines is able (might be able) to be equal or close to the human intelligence and enhance or replace some tasks that current managers and leaders are performing, by providing additional time for more creative tasks that before leaders of organizations and departments did not have. For the purpose of this paper, the author refers more to the concept of AI as *collection* of disruptive *technologies* that are influencing the management world and possible implications for the leadership of modern organizations.

Table 1

Definitions of the term "artificial intelligence" (created by the author, based on Terblanche, 2020 and Jones, 2018 and professional portal "Artificial Solutions")

"The *science and engineering* of making intelligent machines."	John McCarthy, 1956
"The broad *collection of technologies*, such as computer vision, language processing, robotics, robotic process automation and virtual agents that are able to mimic cognitive human functions."	Bughin & Hazan, 2017, p. 4
"A *computer program* combined with real-life data, which can be trained to perform a task and can become smarter about its users through experience with its users."	Arney, 2017, p. 6
"A *science* dedicated to the study of systems that, from the perspective of an observer, act intelligently."	Bernardini, Sônego, & Pozzebon, 2018
"The *capacity for machines* to employ algorithms with data to make choices similar to those of a human being."	Yao, Jia, and Zhou, 2018

Major types of Artificial Intelligence

According to Terblanche (2020) and other authors of books on AI (Lasse Rouhiainen, David Brown, Joseph E. Aoun), it is important to distinguish two major types of AI: artificial general intelligence (*Strong AI*) and artificial narrow intelligence (*Weak AI*). Strong AI is related to machines' abilities to learn on their own and go beyond what was initially designed by the AI-engineers and other professionals who developed it. Such advanced type of AI that generates responsive, adaptive and/or intelligent equitable to human-like intelligence has won the grandmasters of one of the most complicated intellectual games - Go, i.e. Google's AI program AlphaGo versus human grandmaster Lee Sedol in 2016 and Google's AlphaGo versus grandmaster Ke Jie in 2017 (IBM's AI program has beaten the strongest chess player in the world Garry Kasparov already in 1997).

On the other side, it is important to also mention the second type of AI – weak. Weak AI is considered a complex software program that is able to solve individual problems in a narrow area by performing automatic tasks (Chen, Hsu, Liu & Yang, 2012; Telang, Kalia, Vukovic, Pandita & Singh, 2018; Terblanche, 2020). The current world is mainly dominated by the weak AI that still depends on the human beings that program them. The AI revolution that the media sensationalizes, when AI-machines will take over and become dangerous to humankind, is comparatively far away. Current mass AI-technologies, in general, are not so strong to be able to become a threat to humankind. Therefore, policy makers, practitioners and scholars are raising concerns primarily about the ethical and legal issues related to AI, especially before it will convert from weak to strong in the large scale. As per Kamphorst (2017, as cited in Terblanche, 2020) the main task of AI-technologies' implementation is, "users of technologies … must be

confident that the technology will meet their needs, will align with existing practices, and that the *benefits will outweigh the detriments"* (p. 157).

Leadership in Industry 4.0 dominated by AI-based technologies

As stated during the World Economic Forum in Davos in 2016 (Barnato, 2016, as cited in Breuer & Szillat, 2019), *"We are not in a technology crisis; we are in a technology revolution. We are going to see technology shifts and changes on a scale that we have never seen on this planet"* (p. 26). Thus, we are speaking about the Industry 4.0 that is also called The Fourth Industrial Revolution (the term coined by professor Klaus Schwab – engineer, economist and the founder and executive chairman of the World Economic Forum). The Fourth Industrial Revolution is associated with advancement of AI, Internet of Things (IoT), 3D printing, robotics, and other technologies. Therefore, leadership during these times of disruptive technologies, broadly speaking, is associated with the terms "Digital Leadership" or more specifically - "Leadership in Industry 4.0.".

For the purpose of this paper, the author relies on the following definition of the term digital leadership that is "suitable leadership approach within an age of digital disruption" (Breuer and Szillat, 2019, p. 28; Meffert and Swaminathan, 2018). The authors view this type of leadership as "calculated use of a company's digital assets in order to achieve business goals" (Breuer and Szillat, 2019, p. 28). As for the tasks of the leaders of organizations in the digital disruption times, Abbatiello et al. (2017, as cited in Petrucci & Rivera, 2018) refer to Deloitte Consulting statement, "a [digital] leader will need to innovate and collaborate in new ways in order to bring together vertically integrated, cross-functional teams of people to perform" (p. 55), as well as add that, "a digital leader will need to influence across informal teams, connect networks of teams and people, and create more knowledge sharing all while creating a diverse

and inclusive environment" (p. 55). This list creates parameters for leaders' skills and tasks in the era of disruptive technologies.

Methodological approach

The keywords used for the current literature review were: "Artificial Intelligence" and "Leadership". The main database used for the abstracts and article search was: Business Source Complete. This database was selected because artificial intelligence is coming from the business world, and the scholarly research is the most developed in this field. Additionally, the author looked at the most cited articles in the first 10 pages of Google Scholar. Other search criteria included: academic (peer reviewed) articles, and the period of publications: 2010-2020. In result, the author has identified and reviewed 41 full articles and over 180 article abstracts. The compilation of the main ideas from these articles and the abstracts relevant to the research question is reflected below.

Synthesis of the main research perspectives

Most of the results for the current literature review are practitioner and academician views and conceptual papers on this emerging field of research. Though, substantial number of the most cited articles were published in the period: 2018-2020, there is a good balance of articles and publications from the beginning of 2000. As for the journals that published articles on intersection of leadership and artificial intelligence, the main categories of journal types were: technological (e.g., *International Journal of Information Management, IT Professional*), leadership (e.g., *Leadership Quarterly, Journal of Leadership Studies, Strategy & Leadership*) and from the consulting and practitioners' field (e.g., *McKinsey Quarterly, Harvard Business Review*).

Below are mentioned and described the main three perspectives of the scholarly research directions identified in the current literature: 1) *an enhancement perspective*, i.e., AI as an additional assistance to the current leadership functions; 2) *a replacement perspective*, i.e., AI will replace followers and leaders and robot leadership and management will come into place; and 3) *a skeptical perspective*, i.e., AI is "an oversold idea", where the possibilities and influence of AI in modern world is an exaggerated idea, and AI robots will never be able to replace human leaders.

Enhancement Perspective

The first research perspective is the enhancement perspective where <u>AI is an additional assistance to current leadership functions</u>. The main idea is that currently (even more in the near future) AI will enhance organizational leadership by taking care of the tasks that currently require time and energy of managers/leaders of modern organizations, as well as help top leadership of organizations with huge amounts of data and ready-made analysis of it.

As Kolbjørnsrud, Amico and Thomas (2016) put it in their article "How Artificial Intelligence Will Redefine Management" in *Harvard Business Review*, "The fact is, <u>artificial intelligence will soon be able to do the administrative tasks that consume much of managers' time faster, better, and at a lower cost</u>" (p. 2). Also, Plastino & Purdy (2018) state, "AI can augment labor productivity by taking on low value-added or supporting tasks and thus enable workers to focus on high value work" (p. 18). Additionally, Berman, Marshall and Ikeda (2020) refer to IBM's Global C-suite Study, where top executives in different countries were asked about the value they derived from data, how they intended to turn data into a differentiating advantage and about the progress with their plans. The research concluded that CEOs of a small group of enterprises were not daunted by data. On the contrary, they were keen on using it to help to make smarter

business decisions, experiment with new business models and build stronger ecosystems. The AI compiles huge amounts of data and provides the data itself and initial analysis that CEOs can review and make more informed business decisions.

Within this <u>enhancement perspective, technologies and leaders come together and create new cooperation models.</u> De Jong (2020) presents a new equation: SFL (Sustainable Future Leadership = AI (Appreciative Inquiry) + AI (Artificial Intelligence). The author explains the equation by stating:

> There has been a rapid development of reliance on algorithms that help deal with complexity in societies around the globe. In almost all areas there has been a rapid increase in the use of technology to perform many traditional tasks, with more expected in the next few years. (p. 45)

Later in the article De Jong (2020) adds, "Apple, Google and Microsoft ... are releasing innovative products at an incredible pace. They show that as a consequence the landscape around leadership will dramatically change" (p. 45). However, the main overarching author's idea in the article is that despite the fact that the leadership landscape is changing due to technological disruptions, *organizations "will continue to rely on basic values that make a difference between people and machines: creativity, an ability to show empathy and care, imagination and curiosity, genuine respect and understanding*" (p. 45), i.e., leader attributes of all times.

Jones (2018) adds to De Jong's idea by stating that, "Leadership as a principal does not change" (p. 60). All the types identified by the leadership community in the last decade (transformational, transactional, situational, contingent, etc.) will stay. *Technologies are simply something additional that will change the landscape, but not the definition of leadership and*

need for human leaders. According to Hyacinth (2017, as cited in Jones, 2018), "AI cannot equal the emotional and humanness of leaders" (p. 60). Jones (2018) continues that:

> Often when a leader is contemplating a decision with negative or life-changing
>
> implications affecting one or more persons, they will consider its emotional impact and
>
> will use the human quality of empathy.... *Leaders are logical and often creative in*
>
> *their intelligence and decision making. AI is logical.* (p. 60)

Additionally, as per DeGroot et al. (2009, as cited in Smith & Green, 2018), "Traditional research in leadership has found that behaviors such as charismatic influences and building strong relationships are important for leading humans. *AI machines have not yet reached emotional intelligence*". (p. 86)

Other authors, such as Krcil (2020), state that *decision-making is going to be redesigned and shared between humans and AI.* Harms and Han (2018) add:

> Humans need not consider algorithms to be rivals so much as a new type of partner,
>
> both for leaders and followers. They can enhance performance and well-being and they,
>
> in turn, will need humans to provide them with information and feedback in order to be
>
> effective at executing their core functions and improving over time. (p. 75)

Additionally, Plastino & Purdy (2018) refer to the survey conducted a few years ago by the global IT consulting company Accenture to measure AI's potential economic impact on 16 industries. Their conclusions were that in practical terms:

> *AI can augment labor productivity by taking on low value-added or supporting tasks and*
>
> *thus enable workers to focus on high value work*… Businesses in every industry will need
>
> to consider AI as a potential change agent in their investment, innovation and human
>
> capital development strategies. To prepare their organizations for a successful future with

AI, business leaders should adopt according strategies. (p. 18)

To sum up, the research direction of the enhancement perspective, where AI is an additional assistance to current leadership functions, refers to the idea that it is simply *a new technological revolution*, the fourth by count (after the first revolution associated with the water and steam power from the 18th to 19th centuries in Europe and America; the second – mass production and assembly line from 1870 to 1914, the third – automation, personal computer and Internet from 1980s to date) that changed the work environment in previous centuries and decades. Thus, going forward, *AI is going to assist organization leaders in decision-making* by providing more data (both in terms of the amount and in-depth) and analysis for faster and data-driven decisions, as well as free their employees from routine/monotonous work by giving more time and space for creative work.

Replacement Perspective

The second research perspective is the *replacement perspective* that <u>AI might replace followers and leaders</u>. The main idea is that the smart machines and robots will take the place of humans, possibly not only performing managerial tasks, but taking over decision-making roles of top leaders of organizations. Both business leaders and academicians are warning about possibility of this scenario, and that according to Moore's Law of exponential growth that describes "a phenomenon in which technological power doubles about every 18–24 months while the cost of the technology decreases (Brock & Moore, 2006; Smith & Green, 2018), the replacement perspective can become a reality faster than expected. Therefore, *developers must be very cautious and take into account a great deal of the ethical and legal considerations.*

As Holtel (2016) put it, "Machines with highly sophisticated mental competencies will turn upside down the knowledge work in every company department. Moreover, intelligent

machines will outperform human brain power" (p. 171). De Cremer (2019) develops this idea by stating that, "Much of the uncertainty exists and is fed by the discussion of whether or not AI *will replace people jobs...Proponents of the idea that AI will replace humans, argue that ...with the emergence of AI, the moment has arrived to replace the human mind*" (p. 81).

According to the World Economic Forum (WEF) Global Agenda Council's survey on "The Future of Software and Society", the results indicate that, "*people expect AI machines to be part of a company's board of directors by 2026 and algorithms are thus expected to take up leadership roles in the future*" (De Cremer, 2019, p. 82).

In this regard, Harms and Han (2018) combine the previous research and terms related to the leadership and add components of AI under the roof term "algorithmic leadership" that combines "elements of e-leadership" (Avolio, Kahai, & Dodge, 2000), distributed or shared leadership (Carson, Tesluk, & Marrone, 2007), and substitutes for leadership (Kerr & Jermier, 1978). Kotter (1990, as cited in Harms & Han, 2018) states, "It is argued that algorithmic leadership, where machines or programs assume activities ordinarily associated with leaders*,* such as motivating, supporting, and developing workers, will also become more prevalent in the future" (p. 74). Harms and Han (2018) continue, "*Of the 14 core functions of leadership identified by Yukl (2012), it is argued that only three (networking, representing, and envisioning change) are not immediately in danger of having humans replaced by machines*" (p. 75).

Moreover, almost a decade ago, Samani et al. (2012) proposed that, "the technological ecosystem not only is suited for machines to assume leadership positions but rather is inherently headed towards it" (p. 158). In their article the authors describe the "robotics leadership", where robots should not be anymore perceived as only machines, but rather *"robot leaders" that manage resources in such industries as stock brokering by maintaining rational and stable*

(stress-free) decision-making. According to the authors, in the future, *such robot decision-makers could prevent tragic instances similar to the global financial crisis of 2008-2009, crash of Air France flight 447*, and others. Samani et al. (2012) continue that robots have been assisting humans for over 80 years, and people have become dependent on them (e.g., GPS). Thus, developing the authors' idea, *robots moving from the role of service providers to decision-makers is a feasible possibility*. It is the next technologically possible step in evolution. Samani et al. (2012) advise the human race to be prepared for the future and challenges it will bring associated with the robot leadership. Brynjolfsson & Mcafee (2017) imply that although AI is used by thousands of companies, "most big opportunities have not yet been tapped" (p. 3). Humanity is at the initial step of AI development and abilities. What is mostly referred to AI in 2020, is still a "weak AI".

Additionally, Smith and Green (2018) elaborate that "*AI follower*" will inevitably replace *human employees due to the rise in retired-age individuals and the aging population in the Western world and China – the power houses of AI innovations*. Thus, for countries with an aging population, AI followership is not a choice, but necessity. The authors state, "With this new position, AI leaders will engage in processes that focus on leading the programmers of the AI machine as well as influencing decisions made by AI machines post-programming" (p. 85). Developing the idea further, Smith and Green (2018) state, "Within human-to-human management and leadership, discussions of the differences between leadership and management extend at least back to 1990 (Kotter, 1990). Leading robots may reinvigorate the discussion of robot management and leadership" (p. 86). As per Moore's Law, technologically it is not impossible and as *AI futurists* from the business world, e.g., Ray Kurzweil, Elon Musk, who develop and commercialize AI products, *are warning*: *humanity should be ready in terms of*

ethical behavior and leadership, when the day of robots as leaders and decision makers come.

According to Smith and Green (2018):

> Stakes are high, many unknowns exist, and leaders will need to be adaptable to manage
>
> teams of AI machines and their associated programmers successfully. Getting back to the
>
> basics by utilizing leadership fundamentals for these versatile teams may be necessary in
>
> the *beginning stages of AI leadership.* (p. 87)

To sum up, the second research direction is a replacement perspective that AI will replace followers and leaders. This may be the next step in the evolution of AI, because the technological side of the process is ready for it. This perspective does not necessarily bring only negative consequences. It is a solution for countries with an aging population at retirement age, where there is a lack of working age people, and machines will fill in these vacant positions. Also, robot management and leadership could potentially prevent global tragedies of the last decades (e.g. the global financial crisis of 2008-2009, crash of Air France flight 447) that took place mainly due to human mistakes. Robots do not get tired or emotional, and take decisions rationally.

Discussions about robot management and leadership should continue, not only from the technological point of view, but also and largely from the *ethical perspective*, and considering *what consequences this type of non-human leadership and management can bring*. Academic literature and research in the leadership field has proven that not everything is and should be rational in decision-making processes. The decisions by leaders should also involve human emotions: emotional and cultural intelligence, circumstances, and possible gains and losses in the long-run. Also, robots are programmed by people, who have *bias* that could be programmed into robots, and *eventually might lead to unethical and sometimes even disastrous decisions and*

actions. These aspects should be reviewed and considered before the replacement perspective becomes (if ever) a reality of non-human leadership in organizations.

Skeptical Perspective

The third research perspective is the skeptical perspective where <u>AI is "an oversold idea"</u>. The main idea is that the possibilities and influence of AI in the modern world, including leadership and management, is *an exaggerated idea*, and it must be *considered and evaluated critically*.

Watkins (2018) considers that AI hype "is an oversell." In his article the author mentions an example of the popularity and predictions about the big data that "has been sold as another golden egg that will serve humanity faithfully" (p. 75). The author continues, "Yet, we have discovered that there are holes in that hype, that if mixed with a measure of skepticism, could be realistically assessed and evaluated" (p. 75). According to Weissman (2018, as cited in Watkins, 2018), "After an experiment by Amazon to develop an AI program to help mechanize the company's headhunting process, its engineers found out that the AI program was duplicating human biases in favoring men over women for software development jobs" (p. 75), thus, instead of decreasing bias, AI amplifies them. Additionally, as per Grove & Meehl (1996, as cited in De Cremer, 2019), "AI is perfectly suited to do one thing very well and, in that respect, outperforms any human" (p. 82). De Cremer (2019) adds, "However, leading an organization represents a more complex reality where the context and social sensitivities of any decision will have to be taken into account. AI, as it stands now, does not have such emotional and empathic skills" (p. 82). The author summarizes, "Realizing that organizations today need to take up wise and responsible leadership to integrate the interests of all stakeholders, *AI should not be considered to replace humans in their leadership role*" (De Cremer, 2019, p. 82).

To sum up, the third research direction is the skeptical perspective that AI is "an oversold idea," referring to the idea that it is still early to state that AI will replace human decision-makers in their positions. Decision-making is a much more complex process than using big data and making rational decisions. Human qualities of leaders should stay as part of important business decisions and actions. Therefore, the replacement perspective states that *AI machines cannot fully replace human decision-makers*.

Discussion

As per Antonakis & Atwater (2002, as cited in Ayman and Lauritsen, 2018), "Along with the expansion of the virtual workplace, e-leadership gained [more] attention" (p. 152). Additionally, Avolio & Kahai (2003, as cited in Ayman and Lauritsen, 2018) state, "Early research on e-leadership showed how technological structures or processes can moderate leadership effects on group process and outcomes" (p. 152). Regarding the digital literacies of the leaders of the technological era, Ng (2012, as cited in Ahlquist, 2014) mentions, "This literacy includes an intersection of technical (online interfaces, applications), cognitive (critically thinking), and social– emotional (netiquette, safety) dimensions in digital literacy" (p. 59).

Some scholars believe that what the scholarly community has been researching in the leadership field in the last 100 years will be relevant also in Industry 4.0 with dominance of AI-based technologies. Petrucci and Rivera (2018) state that leaders in Industry 4.0 "will need to use proven leadership concepts in an integrated manner *with* technology" (p. 55). Also, authors add, "the digital leader will exemplify traditional leadership concepts while embracing new trends to influence their peers and drive performance outcomes" (p. 55). *The future research in leadership in Industry 4.0 with disruptive and continuous technological developments of AI will concentrate*

on research of how leaders will lead alongside AI and what capabilities should be added to

currently required leadership skills in order to be effective leaders in an AI era.

According to Bass & Avolio (1994, as cited in Petrucci and Rivera, 2018), "Proven

leadership concepts such as transformational leadership (TL) and the leadership challenge (TLC)

have been studied and written about in the leadership literature for many years" (p. 53). Petrucci

and Rivera (2018) continue, "Most, if not all, of these *foundational pillars of leadership will*

likely remain important in the future. However, how we deliver and enable them as leaders is

already changing, and is likely to change further" (p. 53). Continuing the idea of irreversible

leadership in the technological setting, Egan and Chesley (2018) mention, "*Knowing that what*

can be automated will be automated gives significant importance t*o what makes us uniquely*

human: curiosity, humor, empathy, creativity, wisdom, and passion. These are the things that

will *add value in the future of work*" (p. 1). Adding to the human part of leadership during the

Revolution 4.0, Jones (2018) states, "*AI and leadership have coexisted for years and will*

continue to do so with a few changes. Leadership will become more data focused, and decisions

will involve fewer people as the workforce shrinks. Outcomes will not change. AI will best

benefit those leaders who study, understand, and use it" (p. 61).

A balanced view is presented by Brock & Wangenheim (2019), who in their article state,

"AI certainly holds a lot of promise but it is not a panacea" (p. 29). As per the authors, we are

speaking about and should research the discipline of "AI leadership" and "AI leaders" of

tomorrow. Brock & Wangenheim (2019) continue, "AI will provide important information to

assist the leaders. Through network analysis, technology will enable the digital leader to

understand complex flows of interactions and activities in agile networks of teams and … AI

connects the dots for the digital leader and their followers" (p. 55). Shukla, et al. (2017) invite

the future leaders *"to establish a culture that empowers employees to thrive alongside intelligent machines"* (p. 1087).

Limitations

As this has been the very first and initial literature review on Leadership in Industry 4.0, dominated by AI-based technologies, the study has several limitations that could be covered in future research by the author herself, as well as other scholars and practitioners in the field. The author of the current literature review has used for the article search the keyword combination: "Artificial Intelligence" AND "Leadership" by looking at two sources: Business Source Complete database and first 10 pages of Google Scholar. The current review is based on the main ideas from 41 full articles and over 180 article abstracts published in the period 2010-2020. Though, one of the selection criteria was "peer-reviewed scholarly articles," most of the yielded results were practitioner and academician views and conceptual papers on this emerging field of research. During this search, the author was not able to identify empirical studies in the field.

Future research

Future research could concentrate on an expanded range of academic databases, outside the Business Source Complete and Google Scholar, by expanding the keyword with terms related to AI such as: "machine learning", "deep learning", "big data", "cloud computing", etc., as well as looking/producing more empirical work in the leadership field in AI era in general or in specific areas like higher education, government agencies, non-governmental sector, corporate sector, etc.

Conclusion

AI development will be relevant for all industries and professions of the future, including academicians and practitioners of the field. The Fourth Industrial Revolution is rapidly developing and cannot be avoided. As Egan and Chesley (2018) put it:

> As we are well aware, we are immersed in the smart machine revolution. If we are to thrive as a society, we must bring our full human capacity to the table and we can only do this by attending to and developing our mind, brain, and relationships. Being fully human and being active authors of our own life stories—with curiosity, humor, empathy, creativity, wisdom. (p. 4 – 5)

The current paper attempted to identify the intersection of leadership and artificial intelligence in the academic literature. Though, the three balancing research perspectives of influence of AI developments on the modern leadership of organizations have been identified, i.e. 1) AI as an additional assistance to current leadership functions (*enhancement perspective*); 2) AI will replace followers and leaders (*replacement perspective*); and 3) AI is "an oversold idea" (*skeptical perspective*), there is still a lack of empirical evidence that could prove or refute the three perspectives above.

Additionally, this is only the initial stage of the technological progress of AI-based products as we are still mainly speaking and using weak AI. Therefore, it is unlikely that we will see an "AI CEO" or "AI Board" matching a human leader at C-level any time soon, though *ethical and legal implications* should be on the agenda of the policy makers, businesses, programmers and other stakeholders embracing the AI revolution. Also, the scholarly research in the field is very shallow. This is an exciting new direction of research in which robust theoretical frameworks and empirical studies are not readily available at this stage.

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Also, there is an open question of where and how this area of research will fit into leadership studies. There could be a place for it under "e-leadership" (Antonakis & Atwater, 2002; Avolio & Kahai, 2003; Avolio, Kahai, & Dodge, 2000), or it could become a separate area as "AI leadership" within the vast and diverse areas of leadership studies.

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