

HOW THE CURRENT FOURTH INDUSTRIAL REVOLUTION EFFECTING THE LEADERSHIP?

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Abstract

Innovation leadership is critical in enhancing a firm's success in today's changing markets. This research investigates the changes in entrepreneurial leadership attributes amid the fourth industrial revolution and the fast pace of technological advancement. This study helps to understand how leadership traits may help entrepreneurs fully exploit the advantages of this revolution and gain a competitive advantage. The content analysis method used for this research utilized written data regarding 23 leaders from 20 companies from the latest 19th century during the first industrial revolution until the current fourth industrial revolution. Results reveal noticeable leadership attributes emphasized in the fourth industrial revolution, such as communication, coaching, innovation, forecasting future, team-builder, and more. Those attributes are in tight correlation with the current novel digital leadership paradigm and the known effects of the fourth industrial revolution on the firms and leaders. Results reveal that current entrepreneurs tend to be open-minded while avoiding rejecting innovation from other firms and are willing to share the experience with the adjacent technology ecosystem.

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Introduction

When looking at the history of humankind, innovation contributes so much to the achievement of important goals in history, and is one of the essential shaping forces of history, relying on human creativity to overcome any technological restraints. One of the first innovation theorists, Austrian economist Joseph Schumpeter, stated that innovation appears to be one of the significant forces supporting economic development. Schumpeter advocated that innovation is the ultimate source of economic growth and hence is worthy of study (Fagerberg et al., 2013). Furthermore, innovation is the primary driving force for companies to prosper, grow, and sustain high profitability (Christensen, 1997).

Today, the world is at a crossroads- the fourth industrial revolution on the horizon, and the rate of technological advancement has accelerated dramatically. As stated by one of the experts in the field, "We will not experience 100 years of progress in the 21st century — it will be more like 20,000 years of progress [at today's rate]," says Kurzweil (2004, p. 1). Meanwhile, as the barrier to introducing innovative technology decreases due to the accessibility of high-power computing power and of-the-shelf complex systems, the general public's adoption rate of emerging technologies has become very quick. Moreover, the ability to learn independently has

increased, thanks to the extensive internet knowledge base. This enables the development of nonconventional innovations by individuals and groups that were not previously involved in innovation, which means they can deploy and develop new products and technologies much more efficiently than they used to years ago (ourworldindata.org, 2020).

This research examines the relationship between the current time-innovation paradigm, leadership attributes of current technology firms, and the significant changes to the technological environment due to the emergence of the fourth industrial revolution. The primary goal of this paper is to answer the question of how the entrepreneur adapts their leadership attributes to cope with today's rapidly evolving world. Consequently, this research should answer this critical question: What is the effect of the fourth industrial revolution on entrepreneur leadership attributes?

This research contributes to better understanding how the fourth industrial revolution's changes in the current technological ecosystem affect entrepreneurs and urges them to modify their leadership style to achieve their firm's goals and succeed with innovation initiatives. Those findings link the existing academic knowledge in domains like innovation, leadership, and the fourth industrial revolution, and lay a new base-ground for further research. In addition, the study establishes a preliminary foundation for upgrading the fourth industrial revolution's innovation paradigm, which can be included in the theory of the current open, interactive innovation model. Furthermore, the research creates an opportunity for further research regarding companies' management style, which altered and changed due to the fourth industrial revolution.

To establish a common baseline, it is necessary to consider the classic definition of innovation which Miriam-Webster defines as "the introduction of something new" and "a new idea, method, or device — novelty" (Miriam-Webster, 2016), even though the definition of innovation evolves year after year (Khayyat & Lee, 2015). A well-established definition of innovation was written by the Organization for Economic Cooperation and Development (OECD) in its Oslo Manual for Innovation: "An innovation is a new or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes, and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD, 2018, p. 20).

Entrepreneurs are considered the leading force for promoting innovation. Hence, contemporary scholars are seeking to learn more about the entrepreneur leadership attributes that boost innovation. Managing innovation is a challenging and intriguing research topic, even though the causes often remain elusive and there are numerous hurdles to success in innovation. Several researchers attempted to establish a relationship between the role of entrepreneur leadership attributes in a firm's success and its innovation itself (Zuraik & Kelly, 2019). Recently, the relationship between leadership and the fourth industrial revolution and its influences has been studied.

In contrast, an updated type of digital leadership was introduced. The connection in the historical perspective, which may enrich the understanding of the role of leadership in promoting innovation in a changing environment, and how they cope with those changes, is still missing in the current knowledge. This research aims to investigate this issue, which may be beneficial to determine what modifications need to be implemented within the present-day firm's manager role.

After analyzing 23 leaders from 20 companies across the four industrial revolutions, the results of this research affirm the initial assumption that there are a few differences in entrepreneur leadership attributes, as we can analyze nowadays, in the recent past and the distant past. The most significant distinctions are related to social behaviors and execution capabilities. Entrepreneurs nowadays are more communicative, capable of mentoring their subordinates, socially involved, and skilled at team building. They, probably due to the rapid advancement of technology, tend to be performance-oriented and with solid execution capabilities. Entrepreneurs from previous eras tend to be hard workers, ambitious and motivated, had a greater need for power, and were more tough-minded. The results are in line with the current dominant innovation paradigm of the interactive open model, whereby companies should rely on the knowledge of customers, suppliers, universities, and consulting teams rather than developing innovations themselves. Therefore, they should work alongside their open system to develop innovations (Chesbrough, 2003; Cohendet et al., 2017). According to the findings of this study, this is closely related to the attributes of the entrepreneur.

The remainder of this paper is structured as follows. First, we will discuss the literature and the relevant research background, followed by the proposed theoretical framework. Next, we will present an overview of the collected data from the selected firms, an analysis of this data, and the results of each study. The paper concludes with a discussion of the theoretical and managerial implications, limitations, and opportunities for future research.

Literature Review and Research Background

The research tries to merge three domains: the innovation phenomena, the leadership, and the changes in the technology world due to the fourth industrial revolution. There is a way to look at the strategic innovation engine through the leader's perspective or entrepreneurial leadership by the inherent connection between innovation and entrepreneurship.

To investigate the effect of the fourth industrial revolution on innovation, we can check the link between those domains. Therefore, this chapter consists of four main segments – innovation, the fourth industrial revolution, leadership and entrepreneurship, and the last, which connects all the preceding.

Innovation

Innovation is a widely spread phenomenon and not restricted only to the technology field. There is a wide range of points of view on innovation from different fields. The integration of these views should reveal the essential characteristics of innovation. Most scholars see innovation as a process that responds to a need or opportunity, depends on creative effort, introduces novelty, furthers the need for change, and overall brings an invention to use (Kooij, 2018). The innovation can also be realized by the mechanism which produced the innovation – such as the combination of old and new knowledge, the change-factor the innovation brought, or from the scholar's perspective, as it depends on the source and the outcome of the innovation (Kooij, 2013; Ballot et al., 2015; Rajapathirana & Hui, 2018).

If we follow this logic, another approach to categorize an innovation is through the four effects or outcomes of the innovation and the source of the innovation or the problem that needed to be solved. This method categorizes innovation initiatives into four categories – sustainable innovation, disruptive innovation, breakthrough innovation, and basic research (or frontier research). Sustainable innovation is when there is a fair summation and definition of the approach problem and an understanding of how to solve it. This type of innovation neither

affects nor generates a new market. Disruptive innovation, the concept of which was introduced at the end of the 20th century twenty years ago by Christensen (1997), is an idea that describes a process whereby a smaller company with fewer resources can successfully challenge established incumbent businesses. Disruptive innovations introduce a very different value proposition to the market than has been available previously. Usually, disruptive technologies underperform compared to established products in mainstream markets, as described above. Breakthrough innovation (or radical innovation) can be considered as the opposite of sustainable innovation. While the firm invests in major leaps with technology and introduces new products or services, this occurs instead of constant improvement (incremental innovation) (Byun et al., 2020). Primary research is a type of innovation that is based on pure science. As stated by Paula Stephan, in many cases, “basic research provides answers to unposed questions” (Stephan, 1996, p. 1205). This is not the case for the engineer’s search for workable technology. At the same time, the results of this innovation initiative are mostly the discovery of new phenomena, and the measure of this activity is in publications. This contrasts with other types of innovation where the outcome is a product and rising sales and profits (Heraud, 2017), so they directly impact the firm’s performance.

Another way of looking at innovation is to categorize it by type. The widely used categories of innovation are, as mentioned, product, process, organizational, and marketing. This research will focus on the product type of innovation. Product innovation refers to introducing a new (or significantly improved) product or service in the firm’s portfolio to the market, thus influencing sales and product quality, among other business performance measures (Rajapathirana & Hui, 2018).

We should also look at innovation paradigms and how they change over hundreds of years. The expected differences between the innovation paradigm eras are the three main dominant models. The first paradigm is the close linear model, which existed until 1970-1980, and treats innovation as a linear process starting with a scientific effort that produces the invention, then the development of the product, and finally, the marketing of the product. The second paradigm is the open interactive model (or complex system of innovation), which sees innovation as a process involving the whole system and led to the development of broader innovation theories, such as national innovation systems and the Oslo Manual. This dominant model existed until the beginning of the 2000s and was founded by establishing a dedicated university institute for the academic field of innovation, such as the Science Policy Research Unit (SPRU) at the University of Sussex. The third and current leading paradigm is the open interactive model of innovation, which reflects the development of innovation theory towards a fully systemic, dynamic, nonlinear process involving a range of interacting agents. This model emphasizes that knowledge flows between actors, expectations about future technology, market and policy developments, political and regulatory risks, and the institutional structures that affect incentives and barriers (Greenacre et al., 2012).

Industrial revolution

The evolution of innovation theories and paradigms must be linked to the current state of technological advancement. Consequently, we can distinguish between the four industrial revolutions during modern history. Each of them had a significant impact on the economic and financial globe. The first revolution in the 18th century was driven mainly by the invention of the steam engine resulting in the first large-scale manufacture of textiles, steel, and other goods (Daemmrich, 2017; Mantoux, 1947). The second revolution occurred at the beginning of the 20th century, i.e., the invention of the internal combustion engine, which led to the car industry, large-scale transportation, and mass-industry facilities. During this revolution, over 70% of

American households gained access to electricity, and a wave of new consumer products entered people's lives (Nye, 1990). The third revolution was the information revolution. It took place between 1960 and 1980 and was driven by the invention of the personal computer and, with it, the ability to conduct fast and efficient data analysis. It also witnessed the establishment of the first foundation anchors of the internet infrastructure as we know it today, allowing us to store and access large amounts of data, information, and other resources (Schwab, 2017).

We are now in the emergence of the fourth industrial revolution. This technological revolution will fundamentally alter the way we live, work, and relate to one another. The transformation will be unlike anything humanity has experienced before in its scale, scope, and complexity. The current revolution, the fourth industrial revolution, started at the beginning of the 21st century and described a world where individuals move between digital domains and offline reality using connected technology that enables them to manage their lives. This revolution emphasizes machines and computers' abilities to link and control the physical world (Schwab, 2017). This revolution is still in its making and represents positive and drastic changes in how we work, live, and do business. It is global and without any physical boundaries in terms of location or geographical center. This revolution is developing at a pace much faster and higher in intensity than the previous revolutions.

This change will be historic in terms of size, speed, and scope. The drivers of this change are physical, digital, and biological. The physical change is made by autonomous vehicles, 3D printing, robots, and new materials. In contrast, digital change is carried out by the internet of things (IoT) and the internet of services (IoS). The biological change can be seen in generic sequencing, genetic engineering, synthetic biology, and biological editing. Even at present, a technological transformation has strongly influenced every aspect of economic and social life, including basic mechanisms like demand formation, capital accumulation, and employment generation (Schwab, 2017; Dosi, 2012).

Under the fourth industrial revolution, the growing digitization of production and processes in the global economy has triggered far-reaching changes in firms and societies. These changes should not be regarded only as engines of transactional efficiency, which leads to much better labor exploitation. These changes also affect the repositories of competencies, knowledge, and creativity in firms and societies and significantly affect society. Accordingly, the 'fourth industrial revolution' refers to technologies and concepts of value chain organization as the European Commission set a path to digitize European industries (Amin & Cohendet, 2012).

Digitization means automation, which in turn means that companies do not incur diminishing returns to scale, or at least less of them do. To understand what this means at the aggregate level, compare Detroit in 1990 (then a major center of traditional industries) with Silicon Valley in 2014. In 1990, the three most prominent companies in Detroit had a combined market capitalization of \$36 billion, revenues of \$250 billion, and 1.2 million employees. In 2014, the three most prominent companies in Silicon Valley had a considerably higher market capital (\$1.09 trillion). They generated roughly the same revenues (\$247 billion) but with about ten times fewer employees (137,000) (Schwab et al., 2016; Manyika & Chui, 2014).

We do not yet know just how this revolution will continue. However, one thing is clear: our response must be integrated and comprehensive, involving all stakeholders of the global polity, from public and private sectors to academia and civil society. At the same time, the central aspect of this revolution is automation, or the machine era, and the use of big data in the field of brain, mind, neurosciences research, and more. The prediction is that the fourth industrial revolution will increase global income and, thus, promote the global economy. The revolution

will also improve the quality of life for the global population, mainly those who have access to the digital world. Technology will create new products and new markets and introduce new services that increase the efficiency and pleasure of our personal lives (Rostow, 1985; Johannessen, 2018; Maynard, 2015).

Leadership and entrepreneurial leadership

The question of managing and promoting innovation within the firms still does not have a concrete answer and is considered an interesting research topic. At the same time, the prerequisite often remains elusive (Heraud, 2017) and the barriers to achieving success in innovation (Rajapathirana & Hui, 2018). Thus, there is a need to create links between entrepreneur leadership attributes, the firm's success, and the firm's innovation. One of the best-known and well-used definitions of leadership was made by Stogdill, who in 1950 defined it as "the process (act) of influencing the activities of an organized group in its efforts toward goal setting and goal achievement." This definition regarding the influencing process and its outcome is also acceptable by present-day scholars (Antonakis et al., 2004; Fiedler, 1996).

The term entrepreneurship is generally associated in everyday use with a person creating a new organization. However, to link it to this research, the term entrepreneurship is used as the principal label to cover all research that involves "the process of uncovering and developing an opportunity to create value through innovation and seizing that opportunity without regard to either resource (human and capital) or the location of the entrepreneur – in a new or existing company" (Churchill, 1992, p. 586; MacVaugh and Schiavone, 2010). Thus, entrepreneurs are involved in innovation initiatives at any firm's scale – from small and newly established to large corporations.

To define the term of entrepreneurial leadership, there is a need to check the outer layer of the role of this type of leadership as a critical area in which entrepreneurs can maintain their competitiveness when faced with dynamic and changing environments (Fernald et al., 2005). Entrepreneurial leadership is positively related to business performance through encouraging innovation and development within customer and competitor orientation (Van Zyl & Mathur-Helm, 2007) and provides a means to explore the role and influence of leadership within entrepreneurial settings. An entrepreneurial leadership style is used "...to solve complex business, social, and environmental problems" (Greenberg et al., 2013, p. 57). Entrepreneurial leadership can be defined as a derivative of leadership as a type of leadership that creates imaginative scenarios that can be used to assemble and mobilize a "supporting cast" of participants who become committed by the vision to the discovery and exploitation of strategic value creation (Gupta et al., 2004, p. 242). The definition of entrepreneurial leadership can be summarized as the responsibility to maintain the firm's competitive advantage in changing and dynamic enrolment, the ability to promote innovation, solve complex business problems, and increase the strategic values of the firm. Entrepreneurial leadership exists in any type and scale of organizations, but on the condition that the organization is promoting innovation initiatives.

There is a long-term debate regarding the sets of attributes of leadership and entrepreneurship. This debate deals with the combination of the attributes of those two terms, whether they are overlap or separate (Antonakis and Autio, 2007). Even-thou while trying to define the attributes of entrepreneurial leadership, the common understanding is that the related attributes arise from both domains (Cogliser and Brigham, 2004; Renko et al., 2015). While trying to define what is the optimal set of leadership attributes, there is a slight disaccord. However, there is no doubt about their importance (Goffee & Jones, 2006). Entrepreneurial leadership attributes are considered critical factors in addressing challenging conditions and recognizing and exploiting

new potential opportunities for the firm (Harrison et al., 2016). Those attributes result from extensive academic investigations and research and can be linked to several essential categories such as charisma, creativity, decision-making ability, ambition, knowledge, vision, and more, and will be used in this research. When trying to link the leadership attributes of the current industrial revolution, research defines several attributes as superiors - creativity, inspiring, credibility, more comprehensive knowledge, collaborative and interactive and trustfulness of the subordinates (Sandel, 2013)

Intersection between innovation, leadership, and fourth industrial revolution

This research aims to investigate the changes in the innovation phenomena, and more precisely the leadership phenomena related to innovation, entrepreneurial leadership, due to the changes in the world as part of the fourth industrial revolution, and due to the significant changes in the world followed it. Some of those effects rose debate within the scholar communities, such as the effect of the fourth industrial revolution on the leadership.

The first inter-relation to examine is between leadership theory and the fourth industrial revolution. The updated leadership model is digital leadership or e-leadership, a term derived from the fourth industrial (or digital) revolution. The term digital leadership is relatively new and combines both leadership skill and digital capability to optimize the benefit of the current fourth industrial revolution and its technologies that boost the firm's business performance (Mihardjoa et al., 2019). Gartner (2018) has set the standard definition of this term "Digital Leadership is the preferred corporate leadership approach to lead in the digital age." Digital Leadership described by Sow & Aborbie (2018) as a demonstration of strategies adoption positively influencing digital transformation processes, or as the process of social influence mediated by technology to produce a change in attitudes, feelings, thinking, behavior, or performance with individuals, groups, and organizations (Stana et al., 2018). Digital leadership can adapt to rapid technology development. It is considered the critical factor to facing the fourth industrial revolution era, which has also been proven destructive for companies that cannot go hand in hand with the changing times (Syam and Sharma, 2018; Berman, 2012; Jovane et al., 2008).

Ideal e-leadership considers a leadership that follows the fourth industrial revolution demands. Consequently, leaders who follow technology development must have skills in influencing, encouraging, guiding, directing, and moving others in the fourth industrial revolution era (Utomo & Darma, 2020). The leadership attributes which link to the digital leadership model are the ability of innovation, digital skills, strong networks, collaboration, participatory engagement and vision, curious, risk-taking, adaptive to changing environment, teamwork efficiency (Kazim, 2019; Swift et al., 2019; Toduk, 2014). Those attributes are with connection to today's corporate leaders' duties, as described – to carefully assess how to harness emergent digital imperatives, to apply new ways of collaboratively working, to deliver new levels of personalized customer servicing, and to incorporate new digital technologies and platforms (emerging technologies) for digital transformation (Danoesastro et al. 2018).

The second inter-relation is between the innovation theories during the time and the industrial revolution. This can be summarized in the following table, which links the main innovation paradigms and theory to the relevant industrial revolution.

Table 1 Innovation Model During the Time

Era	Main Innovation Paradigm	Innovation Theories	Major Historic Events	Industrial Revolution	Noticeable Firms
1930-1970	The Linear Closed Model	Older Linear Model Linear and Closed Model Creative Destruction Technology-Push - Demand-Pull Model National Level Research	WW2	2nd - Engine and motorized	Ford Moros AT&T
1970-2010	Interactive and Closed Model	Innovation System National Innovation System Complex System Theories System Integration Networking Model	Cold War	3rd – Digital Revolution	IBM Microsoft
2010 -	Open Interactive Model	Open Innovation Open Innovation Ecosystem Interactive Model collaborative process Innovation Disruptive Innovation	Globalization	4th – Automation and Artificial Intelligence	Google Facebook AirBNB UBER

Source: Author own editing (2021)

Method

This research used the content analysis method to extract data about entrepreneur leadership attributes and find the variations between different eras of time and different industrial revolutions. The content analysis method is a qualitative research method that starts with actual observations and the collection of original documents and then proceeds to code layer after layer, employing analysis and comparisons to refine concepts and categories before constructing a systematic theory (Fendt and Sachs, 2008). Content analysis can analyze written, verbal, or visual communication messages (Krippendorff, 2019) and has a long history of use in different academic areas. As a research method, content analysis involves being systematic and using an objective method of describing and quantifying phenomena (Krippendorff, 2019; Downe-Wamboldt, 1992).

The content analysis method is more conducive to eliciting the underlying leadership attributes of the entrepreneurs from documents and other written texts. This approach allows us to make validated inferences from different kinds of sources. It enables us to condense words into fewer content-related categories. Words, sentences, and the like are believed to have the same meaning when categorized into the same categories (Cavanagh, 1997). An advantage of this method is that large volumes of textual data and different textual sources can be dealt with and used in collaboration (Elo & Kyngas, 2007).

Data Collection and Analysis

To build the sample for the content analysis, three steps were conducted. The first list of companies that participated in the NYSE (New York Stock Exchange) was taken from the early beginning of the 19th century until now. In the second step, 20 companies were chosen arbitrarily from this list (as well as 2 of the company from other sources) as a sample for the

research, reflecting the presentation of each industrial revolution. In the third step, the notable leader was recognized for each company, and written data was gathered regarding his leadership, precisely the linked leadership attributes.

The total sample was of 23 leaders, all founders or general managers of those companies– 11 from the phase before the fourth industrial revolution and 12 after its occurrence, so this distribution is balance. This study's data was digitalized documents and texts from open databases, such as the internet, newspapers, and online digital archives. Those documents include interviews with the firms' CEOs, biographies, and historical descriptions of their leaders. Therefore, the chosen firm's leadership attributes have been extracted and analyzed due to this data's focal point. The complete dataset analysis enabled the examination of the changes in those attributes during the various industrial revolutions. For each leader, at least three different sources were used. The next step is to perform content analysis. For this stage, a list of 58 leadership attributes was used. This list was gathered from the current knowledge for leading entrepreneurship leadership attributes (Bindlish and Nandram, 2018). This list was the basis for the content analysis phase (while the majority, approx. 70%, included in the content analysis results).

Results

This chapter discloses the results and outcome of this research and the leadership attributes of the managers within the firms to recognize the effect of the fourth industrial revolution on leaders.

The content analysis results reveal salient differentiation between the leadership attributes in the fourth industrial revolution era and before. We can notice several significant differences in several attributes. First, attributes that are more common in the early industrial revolution other than in the current one include ambition, motivation, hard-working, and resource management. On the other hand, several attributes were more common after the fourth industrial revolution, such as coaching, communication, ethics, execution, forecast future, innovation, inspiring, strategic thinking, and team building. The analysis reveals that achievement and creativity, risk-taking, social influencing, and proactive attitude of the leader is quite common in both eras.

The table attached summarizes which leadership attributes were more common before the fourth industrial revolution and after. The research also revealed other leadership behaviors which cannot be assigned to one of the leadership attributes but contribute to the analysis. Before the fourth industrial revolution, we can notice aggressive behaviors through the rivals' fighting and conflict (H. Osborne Havemeyer from The American Sugar Refining Company and A. Carnegie from United States Steel Corporation). On the contrary, more collaborative attitudes were noticed after the fourth industrial revolution, such as working with the ecosystem and sharing experience, collaborating with customers and other companies (H. Vestberg from Verizon, M. Benioff from Salesforce, M. Parker from Nike, and A. Gorsky from J&J). Both eras seem to acknowledge the importance of hiring the best employees who fit the company culture.

Table 2 Leadership Attribute Before and After the Industrial Revolution

Before fourth industrial revolution	After Fourth industrial revolution
Ambition	Communicate
Motivation	Coaching
Resource management	Ethics
Hard working	Execution
	Forecast future
	Innovation
	Influence
	Performance oriented
	Strategic thinker
	Team builder
	Achievement
	Creativity
	Friendly
	Risk taker
	Social influencing
	Visionary

Source: Author own editing (2021)

Conclusion and Discussion

The research’s primary purpose is to answer the research problem of how the entrepreneur adjusts their leadership attributes to cope with the current fast-changing world as a preliminary or pilot test with a relatively small dataset. This research answers the question: What is the effect of the fourth industrial revolution on entrepreneur leadership attributes?

The research results affirm several insights regarding the impact of the fourth industrial revolution. First – the results indicate that this revolution altered and adjust the leadership attributes of the entrepreneur. Several attributes are more noticeable in this fourth industrial revolution era than in previous industrial revolution eras. This research suggests that those attributes can be linked to the characteristics of the revolution and disclose how the current-time leaders should cope with the significant changes related. Among those attributes, some as innovation, forecast future, execution, and performance-oriented can be linked to the speed of technology advancement and the excessive adoption rate of new products. Other attributes may link to the need to share information and work along with the technology ecosystem and must form an excellent professional group to cope with those changes; among those leadership attributes, we can specify communication, team builder, and coaching. The results emphasized few timeless attributes common throughout all generations and the previous industrial revolutions, such as risk-taking, achievement, and creativity. The results also link to the digital leadership paradigm, which describes the leadership attributes and skills needed to promote the digital transformation within companies and boost a firm’s business performance, among those attributes – strategic thinking, execution, and visionary mindsets of the leaders. Even though to the limited sample (23 firm’s leaders), there is a distinct relationship between the existing knowledge of the fourth industrial revolution and its effects, the leadership paradigms, epically the digital leadership theory, to the results in this research, mainly in the necessity of the leader to cope with the high pace of the technology. This unique phenomenon of the fourth industrial revolution forces the leader to adjust himself, mainly in execution, performance, and innovation, as reflected in the research results.

Theoretical Contribution

Due to the current state of the emerging fourth industrial revolution, the technological environment is undergoing enormous changes. The pace of these changes keeps growing (Schwab, 2017; Dosi, 2012). On the other hand, entrepreneurs need to align themselves towards much more complex innovative environments because the knowledge is developed by all the ecosystem members, including customers, direct and indirect competitors, universities, and consulting teams (Chesbrough, 2006). This situation forces the entrepreneur to adjust their leadership attributes to cope with situations, bring about innovation, and stimulate economic and marketing success for the firm. Also, there is a link between the research results to digital leadership characteristics, such as the tendency to coach the employees, communication channels within the organization, and the importance of speed all over the development phase (Yücebalkan, 2016).

This research aims to link all the mentioned factors and step into an interesting intersection, which has hardly been explored yet, to answer how entrepreneur leadership attributes have changed as a result of the fourth industrial revolution. In order to answer this question, an intensive literature review was conducted on those main topics and consisted of three main segments, the first dealing with the innovation phenomena and the different types of innovation and summarized the changes in the innovation paradigm over the last two centuries. Second, regarding the past industrial revolutions and the current ones, and what their implications have been. Third, about entrepreneurship and leadership, focusing on the impact of leadership on innovation and what attributes enhance the innovation factor within leadership.

This research suggests a new method to analyze innovation and adaptability to the current era, thus by checking the development and changing leadership attributes during the era of time, specifically on different periods of industrial revolutions. We would suggest a new perspective to look upon the firm's strategy, mainly the role of the leaders to adjust the firm's decision-making and aligning the selections at the innovation pathway. This research suggests that leaders choose a collaborative mindset to share ideas within their ecosystem. This mindset may enhance the ability of the firm to utilize the knowledge and the products available in the technology ecosystem and focus the firm investment in more needed projects while avoiding waste in unnecessary efforts.

The research outcomes also influence the factors by which new startups can be measured and analyzed, mainly in their first stages. As we demonstrated, the pace of technology nowadays, due to the fourth industrial revolution, is much higher than in the past, so firms should adjust themselves to the changing environment and gain competitive advantages. The research brings attractive leadership attributes that may be used to analyze the firm's leaders and predict the firm's success rate with this current changing economic and technological environment.

Different contribution perspectives may be to the field of managers education and training academic field, as the research emphasizes several leadership attributes that may benefit current managers. As most of the leadership attributes are part of life-long training and learning, the research results, as the preferred leadership attributes, may be emphasized during the current study programs of managers and business leaders.

Managerial Implications

There are some valuable managerial takeaways in this research. The first is the need for firms to train and improve top management, which should be adapted to the fast-changing

environment of the present day. Second, academic institutions should enhance study programs, especially management ones, such as MBAs. Third, venture capital institutes and related funding firms should predict the success rate of startup companies in their earliest stages. This research may help guide them in this process.

The results affirm that the current era of the fourth industrial revolution forces the entrepreneur to adapt and improve their ability to use off-the-shelf technologies, which accelerates innovation. The current entrepreneur must work within a close technological ecosystem and share common problems and solutions to utilize the technology's capabilities, so the entrepreneur can focus only on the firm's next invention. Thus, today's entrepreneurs should be adept at on-the-shelf technology capabilities such as cloud computing, open-source codes, software module sharing with the public, complex algorithms for known problems, and more. A willingness to use them will enhance the ability of the firm to keep up with the fast pace of the current revolution.

Limitations & Future Research Directions

The limitations of this research are its very nature, as it considers somehow small-scale research consists of only 23 leaders from a considerable period. The dataset should be broader, so the statistical reliability increase; this is the plan for the following research project. Other limitations are concerning the newness of the fourth industrial revolution as it is still in progress, so some of the associated attributes may still be developing. The proposed solution for this is to assure a similar result after the situation stabilizes. Another limitation is the research method itself, as content analysis extracts the information from the written texts. Thus, this information may be biased, either from the writer's perspective, which may be the leader himself, i.e., in an autobiography, or from the writer's perception, which may differ from the actual situation. Some of the leadership attributes may be emphasized at a particular time. In contrast, others may be dimmed due to cultural effects, so that historical perspectives may be biased.

Other than analyzing a much broader sample, future research proposals try to link the leadership not only to the industrial revolution sequence but also to the industry segment and the firm's success rate. This research may reveal a deeper layer by linking a specific leadership attribute to the market segment. Combining with the firm's success rate may be valuable for future understanding of the manager's role.

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