



TECHNOLOGY ENTREPRENEURSHIP AND FOURTH INDUSTRIAL REVOLUTION ERA

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Abstract

Entrepreneurial factor is understood to be an issue under factors of production, which must be explained via remuneration through income for the entrepreneur along with the shortage of people with entrepreneurial capabilities. Technopreneurship is not a product but a process of synthesis in engineering the future of a person, an organization, a nation and the world that is digital, knowledge based society, strategic directions or decision-making processes will be demanding and complex. Technopreneurs are entrepreneurs who are into the core businesses involving technology-based industries. They make use of technology to come out with new or innovative products through a process of commercialization. The unprecedented revolution of information communication technology or the global digitalization has advanced the actual meaning and state of technology entrepreneurship across the world through the emergence of the fourth industrial era. The objectives of this study are to identify and examine technologies driving the fourth industrial revolution era and to identify and examine technology enterprises pivoting the fourth industrial revolution era. The significance of the study provides opportunities for researchers, entrepreneurs/industrialists and policy makers to discuss concurrently the implications of this new concept on the global economy and the frontiers of sustainable development of the human race. Exploratory research approach was adopted for the study. This study therefore, recommends that the promoters of technologies and technology enterprises driving and pivoting the fourth industrial revolution era to assist the developing countries by leap frogging into the fourth industrial revolution era to avoid large scale global differential catastrophe of system collapse and high level technology and development dichotomy through technology complementarity approach.

Keywords: Technology Entrepreneurship, Technopreneurship, Technopreneurs, and Fourth Industrial Revolution Era

1. Introduction

Entrepreneurship is often discussed under the title of the entrepreneurial factor, the entrepreneurial function, entrepreneurial initiative, and entrepreneurial behavior and is even referred to as the entrepreneurial spirit. The entrepreneurial factor is understood to be a new factor in production that is different to the classic ideas of land, labour and capital, which must be explained via remuneration through income for the entrepreneur along with the shortage of people with entrepreneurial capabilities. Its consideration as an entrepreneurial function refers to the discovery and exploitation of opportunities or to the creation of enterprise. Entrepreneurial behaviour is seen as behaviour that manages to combine innovation, risk-taking and proactiveness (Miller, 1983). In other words, it combines the classic theories of Schumpeter's innovative entrepreneur (1934, 1942), the risk-taking entrepreneur that occupies a position of uncertainty as proposed by Knight (1921), and the entrepreneur with initiative and imagination who creates new opportunities. Reference to entrepreneurial initiative underlines the reasons for correctly anticipating market imperfections or the



capacity to innovate in order to create a new combination. Entrepreneurial initiative covers the concepts of creation, risk-taking, renewal or innovation inside or outside an existing organization. Lastly, the entrepreneurial spirit emphasizes exploration, search and innovation, as opposed to the exploitation of business opportunities pertaining to managers. Schumpeter looks at entrepreneurship as innovation and not imitation. Schumpeter's innovator as an economic and social leader does not care much about economic profits and only joy he gets from being an innovator and being a server to his society. Schumpeter's entrepreneur is an innovator in the entrepreneurship arena. In the Schumpeterian theory, the entrepreneur moves the economy out of the static equilibrium.

Technopreneurship, according to entrepreneurs (2017) is not a product but a process of synthesis in engineering the future of a person, an organization, a nation and the world that is digital in nature, knowledge based society, strategic directions and/or decision-making processes will be demanding and complex. Hence, this will require tertiary level and professional development programmes and training to produce strategic thinkers who will have the skills to succeed in a dynamically changing global environment. Traditional educational programs, however, lack the methodology to transform today's students into creative, innovative, visionary global leaders who understand the importance of technopreneurship. Meanwhile, a technopreneur is an entrepreneur who is technology savvy, creative, innovative, dynamic, dares to be different and take the unexplored path, and very passionate about their work. They take challenges and strive to lead their life with greater success. They do not fear to fail. They take failure as a learning experience, a stimulator to look things differently and stride for next challenge.

Technopreneurs continuously go through an organic process of continual improvement and always try to redefine the dynamic digital economy. Technopreneurs are entrepreneurs who are into the core businesses involving technology-based industries. They make use of technology to come out with new or innovative products through a process of commercialization. The businesses are generally marked with high growth potential and high leverage of knowledge and intellectual property. Potential technopreneurs must be equipped with both technical and business skills. The unprecedented revolution of information communication technology or the global digitalization advances the actual meaning and state of technology entrepreneurship across the world through the emergence of the fourth industrial era.

With the advent of information technology, which is currently reducing the world to a global village, the authors consider it necessary to conduct a study on technology entrepreneurship in the fourth era of industrial revolution. The study try to identify and examine technologies driving the fourth industrial revolution era, and also to identify and examine technology enterprises pivoting the fourth industrial revolution era.

The study of technology entrepreneurship in relation to the fourth industrial revolution provides opportunities for researchers, entrepreneurs/industrialists and policy makers to discuss concurrently the implications of this new concept of technology entrepreneurship and the fourth industrial revolution on the global economy and the frontiers of sustainable development of the human race. To researchers, technology entrepreneurship focuses on licensing their technology and/or engages in the full commercialization of their product (Gans & Stern, 2003). While, digital technology entrepreneurs are embedded in an interconnected system where they aim to commercialize their solutions; it is a context where platforms and network effects matter (Kyprianou, 2016; Srinivasan et al., 2004) and standards or dominant designs (Brem et al., 2016) can define the boundaries and scalability of products. As a result, there are opportunities to update what they know about growth patterns in technology entrepreneurship (Hesse & Sternberg, 2016) to include digital technology entrepreneurs.



In contrast, the fourth industrial revolution is a new concept or a phenomenal that is driven by digital and technology entrepreneurship. The speed at which these concepts of technology entrepreneurship and fourth industrial revolution emerged, moving and smoothly integrating the world, there is room for more research to unravel the mystery for human precautions.

To entrepreneurs/industrialists, the introduction of digital elements in the technology entrepreneurship process also reveals a bright side for entrepreneurs as it favours the adoption of born-global approaches facilitating the fourth industrial revolution (Kraus et al., 2017; Tanev, 2012). These firms quickly scale up their products and aim for a global audience. The digitization of the production processes makes it possible to be both a lean and global company at the same time (Frederiksen & Brem, 2017; Rasmussen & Tanev, 2015), blurring the traditional boundaries of technology entrepreneurship. Activities in the entrepreneurship process, such as resource acquisition and production process are also changing as digital technology entrepreneurship offer the acceleration of the fourth industrial revolution that can be used completely changing the technology innovation management process in the new firm (Giones & Oo, 2017). With so many possible futures, the ability to design and innovate the business model makes a difference (Doganova & Eyquem-Renault, 2009; Westerlund et al., 2014). This study aims to guide technology entrepreneurs as fast growth and forward leaps often mean higher failure risks for the ambitious digital technology entrepreneurs stepping into emerging ecosystems, where the role of each of the players is still unclear and the technology base is still evolving. Westerlund, Leminen, and Rajahonka (2014) describe the example of new entrants in the Internet of Things (IoT) ecosystem, where the lack of structure and solid standards (Brem et al., 2016) in the ecosystem increase the complexity of entrepreneurs' decisions.

To the policy makers, the consequence of digitization goes beyond the dynamics of the entrepreneurship process as new policy and support mechanisms is the successful-Corps program (<http://www.nsf.gov/i-corps>) run by the National Science Foundation in the United States. The digital core of new technologies makes it possible to run accelerated approaches to market validation and early-stage growth. As a result, the model of the university incubator for technology entrepreneurship (Amezcuca et al., 2013; Gerlach & Brem, 2015) no longer fits with the characteristics of digital technology entrepreneurship. Instead, the authors observe how an increasing number of research centres and universities are starting to partially or fully introduce entrepreneurship-supported models that follow the accelerator program design (Pauwels et al., 2016). The transition from incubation to acceleration models requires specific knowledge, dynamic markets, and an investor ecosystem done in isolation, it is likely to end up in the black-box of failed policies (Brown & Mason, 2014).

2. Literature Review

2.1 Technology Entrepreneurship in Perspective

Technology entrepreneurship according to Bailetti, (2012) is an investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm. To make sense of how much information communication technology has changed entrepreneurship, the authors propose to examine this topic from three different perspectives of technological opportunity, the entrepreneurship process and the resource acquisition. Previous researchers have suggested that the type and nature of a technology opportunity can be a determining factor in the activation of the entrepreneurial process (Davidson, 2015; Gruber et al., 2012). These complementary perspectives allow us to identify and describe entrepreneurship cases where we can observe how ICT has influenced technology entrepreneurship. Ferreira and colleagues (2016) assert



that it is a combination of entrepreneurship and technology-based innovation that make-up technology entrepreneurship. Similarly, Beckman and colleagues (2012) assert that technology entrepreneurship is a type of entrepreneurship that aims to exploit opportunities related to advances in science and engineering.

The diversity of forms that technology entrepreneurship characterized even in the extreme case of pure digital entrepreneurship, it can be argued that it rarely fits within a technology-push perspective, being instead much closer to concepts such as recombinant innovation or demand-driven approaches to technological innovation in the understanding of market-pull (Brem & Voigt, 2009; Priem et al., 2011). This is further expatiated that from a research perspective, digital entrepreneurship is much closer to the information systems concepts of artifacts, platforms, and information infrastructure. This position was supported by Giones and Brem (2017) that alternative forms of technology and digital entrepreneurship are bound in three typologies of firstly, technology entrepreneurship; this is with opportunity in new products based on breakthroughs in research such as science based advances through specific knowledge in an academic field with technology proof of concept by customer validation. Secondly, digital entrepreneurship; this is facilitated by new products and services based on the internet as the technology behind the opportunity where services are running only in the cloud using big data or artificial intelligence. This is also using technology as an input factor to stay ahead of competitors to be the dominant player in the sector or subsector; and finally, digital technology entrepreneurship; this is with specific opportunity in new products based on ICT technologies making smart devices using the possibilities of internet of things through the use of existing technologies of traction, growth and scalability.

Giones and Brem (2017) assert that the digital transformation of the input technologies that entrepreneurs use to propose their new innovative ventures has extended the types of technology entrepreneurs they can observe. Instead of proposing a clear-cut conceptualization between digital and technology entrepreneurship, they propose to describe the change in meaning of technology as a continuum between the extremes represented by the commercialization of the latest scientific breakthroughs and the latest application for smart phones. Thus, they further proposed to enrich Bailetti's (2012) definition of technology entrepreneurship to include specific aspects related to this specific form of entrepreneurship: digital technology entrepreneurship is focused on the identification and exploitation of opportunities based on scientific or technological knowledge through the creation of digital artefacts. Digital technology entrepreneurs build firms based on technologies on the one hand, and on services on the other. The extension of the definition implies that this profile of entrepreneurs do not only experience the challenges of engineering or scientific development, but also the complex dynamics of digital platforms and infrastructures (Nambisan, 2016). Digital technology entrepreneurs do not only rely on an innovation ecosystem as digital entrepreneurs do, they strategically combine technological product knowledge (technology push) with consumer know-how (market pull) to drive the fourth industrial era.

2.2 Industrial Revolution Eras

The Industrial Revolution Eras marks a major turning point in history; almost every aspect of daily life was influenced in some way. In particular, average income and population began to exhibit unprecedented sustained growth. Some economists say that the major impact of the industrial revolution is that the standard of living for the general population began to increase consistently for the first time in history, although others have said that it does not begin to meaningfully improve until the late 19th and 20th centuries (Feinstein.1998).



The Gross Domestic Product per capital according to Lucas (2003) was broadly stable before the industrial revolution and the emergence of the modern capitalist economy while the industrial revolution began an era of per-capital economic growth in capitalist economies. Economic historians are in agreement that the onset of the industrial revolution is the most important event in the history of humanity since the domestication of animals and plants.

There were also many new developments in non-industrial spheres, including the following: (1) Agricultural improvements that made possible the provision of food for a larger non-agricultural population; (2) Economic changes that resulted in a wider distribution of wealth, the decline of land as a source of wealth in the face of rising industrial production, and increased international trade; (3) Political changes reflecting the shift in economic power, as well as new State policies corresponding to the needs of an industrialized society; (4) Sweeping social changes, including the growth of cities, the development of working-class movements, and the emergence of new patterns of authority; and (5) Cultural transformations of a broad order. Workers acquired new and distinctive skills, and their relation to their tasks shifted; instead of being craftsmen working with hand tools as they became machine operators, subject to factory discipline. Finally, there was a psychological change: confidence in the ability to use resources and to master nature was heightened (Encyclopedia Britannica; www.britannica.com).

The first industrial revolution period according to Lucas (2003) took place approximately from 1760 to 1840 and saw to the rapid industrial development through machines, steam engines and weaving looms. The first industrial revolution was largely centered on Britain and parts of the Northeastern United States. The second industrial revolution era which last between 1870 to 1914 also known as the technological revolution was a phase of rapid industrialization characterized with mass production, assembly line and electric energy. The second industrial revolution was a great leap forward for society as it fast track steel production from iron casting, fossil energy/petroleum discovery and hydro-electricity which led to the introduction of public automobile and airplanes. The second industrial revolution laid the foundation for globalization and created a rough draft of today's world (Gustavo 2016). The third industrial revolution according to Rifkin (2011) emerged by 1969 and was characterized by main frame computer (ICT), electronic (internet), green electricity and 3-D printing. The third industrial revolution era led to fundamental economic change that occurs when new communication technologies converge with new energy regimes mainly renewable electricity and linking economy globally.

2.3 The Fourth Industrial Revolution Era

The fourth industrial revolution according to Klaus (2016) is building on the third, the digital revolution that has been occurring since the middle of the last century approximately (2005). It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. There are three reasons why today's transformations represent not merely a prolongation of the third industrial revolution but rather the arrival of a fourth and distinct one: velocity, scope and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the fourth is evolving at an exponential rather than a linear pace. It is disrupting almost every industry in every country. The breadth and depth of these changes herald the transformation of entire systems of production, management and governance. The fourth industrial revolution is mainly characterized by artificial intelligence, self-driving cars, drones for virtual assistance, robotics, iCloud computing, digital fabrication, additive manufacturing, materials engineering, and synthetic biology pioneering a symbiosis between microorganisms, our bodies, products we consume and even the buildings we inhabit (Klaus, 2016).



The fourth industrial revolution according to Schwab (2015) has the potential to raise global income levels and improve the quality of life for populations around the world. To date, those who have gained the most from it have been consumers able to afford and access the digital world; technology has made possible new products and services that increase the efficiency and pleasure of our personal lives. Ordering a cab, booking a flight, buying a product, making a payment, listening to music, watching a film, or playing a game—any of these can now be done remotely. In the future, technological innovation will also lead to a supply-side miracle, with long-term gains in efficiency and productivity. Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which will open new markets and drive economic growth.

Anderson (2012) predicts that the fourth industrial revolution is likely to reduce barriers between inventors and markets due to new technologies such as 3D printing for prototyping. Anderson (2012) further predicts tissue engineers use rapid prototyping techniques to produce 3D porous scaffolds. The 3D printing technique fabricates scaffolds with a novel micro- and macro-architecture and these in turn help shape the new tissue as it regenerates. New technologies, like this 3D printing, allow entrepreneurs with new ideas to establish small companies with lower start-up costs. The entrepreneur can bring the product to reality with 3D printing without the traditional time constraints often encountered with traditional prototyping methods. The typical barriers to entry are removed from the marketing equations.

Increasing trends in artificial intelligence point to significant economic disruptions in the coming years. Artificial systems that rationally solve complex problems pose a threat to many kinds of employment, but also offer new avenues to economic growth. A report by McKinsey & Company found that half of all existing work activities would be automated by currently existing technologies, thereby enabling companies to save billions of dollars and to create new types of jobs. Driverless cars may modestly replace tax and Uber drivers, but autonomous trucks may radically transform shipping with far fewer jobs for truck drivers (Manyika et al. 2017).

Innovative technologies try to integrate different scientific and technical disciplines. Key forces will come together in a fusion of technologies that is blurring the lines between physical, digital, and biological spheres. This fusion of technologies goes beyond mere combination. Fusion is more than complementary technology, because it creates new markets and new growth opportunities for each participant in the innovation. It blends incremental improvements from several often previously separated fields to create a product (Schwab, 2015). Robotics can and will change our lives in the near future. Technically robots are automated motorized tools. They cook food, play our music, record our shows, and even run our cars according to Schwab (2015). Meanwhile, we just do not see it because robots do not have a face to whom we can talk or a butt we can kick. Consequently, robots have the potential to improve the quality of our lives at home, work, and many other places. Customized robots will create new jobs, improve the quality of existing jobs, and give people more time to focus on what they want to do (Schwab 2015).

The Internet of things (IoT) is the internetworking of physical devices. Typically, the IoT is expected to offer advanced connectivity of devices, systems and services that goes beyond machine-to-machine (M₂M) communications and covers a variety of protocols, domains and applications (Holler et al., 2014). The interconnection of these embedded devices is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid, and expanding to areas such as smart cities. The revolution of the connected life came about thanks to the advance of the Internet. In 1969, the first data was transmitted over the internet and linked two main frame



computers. Now, the internet is connecting personal computers and mobile devices. By 2010, the number of computers on the internet had surpassed the number of people on the earth (Gershenfeld and Vasseur, 2014) and (Schwab, 2015).

The authors stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate with one another. In its scale, scope and complexity, the transformation is unlike anything humankind has experienced before. We do not yet know just how it will unfold, but one thing is clear: the response to it must be integrated and comprehensive; involving all stakeholders of the global polity, from the public and private sectors to academic and civil society. This gives us some idea of the challenges surrounding the fourth industrial revolution. The enormity of the challenges and the breadth required of the response are reinforced accordingly (Peters, 2017).

The evolution of global industries in the fourth industrial revolution is both exciting and scary. Life will change with the 3D printing, the IoT, and the fusion of technologies. The fourth industrial revolution can raise income levels by allowing entrepreneurs to run with their new ideas. It will improve the quality of life for many people around the world (Jee, 2017). Consumers are likely to gain the most from the fourth industrial revolution. Technological innovation will also lead to a supply-side miracle, with long-term gains in efficiency and productivity. Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which will open new markets and drive economic growth (Schwab, 2015).

While there are many benefits of the fourth industrial revolution, there are several key challenges that lie ahead. At the same time, the revolution could yield greater inequality, particularly in its potential to disrupt labor markets. As automation substitutes for labor across the entire economy, the net displacement of workers by machines might exacerbate the gap between returns to capital and returns to labor. The scarcest and most valuable resource in an era driven by digital technologies will be neither ordinary labor nor ordinary capital; rather it will be those people who can create new ideas and innovations. In the future, talent, more than capital, will represent the critical factor of production. People with ideas, not workers or investors, will be the scarcest resource (Brynjolfsson, McAfee, and Spence, 2014). In 2017 Bloomberg Global Business Forum, Apple CEO Tim Cook commented; if I were a country leader, my goal would be to monopolize the world's talent (Leswing, 2017). The quest for talent will give rise to a job market that may become increasingly segregated. Low skilled and low wage jobs will be replaced by computers and digitization. The higher paid jobs requiring more skills are less likely to be replaced. This increased dichotomization can lead to an increase in social tensions (Wolf, 2015).

In addition to the threat of massive job displacement under the ongoing fourth industrial revolution, there are a variety of challenges, such as cybersecurity, hacking, risk assessment, and others (Lambert, 2017). A higher level of alert is raised up when our lives become extensively connected to various devices, from our cell phones, cars, and light switches to our home security cameras, and smart speakers. One of the biggest trends in 2018 consumer electronics show that everything is connected and there is no going back (Goode, 2018).

Having everything attached to everything else in the IoT is going to monumentally increase the vulnerabilities present in any given network. Connections and burden of connectivity, systems are going to have to be more secure. The fourth industrial revolution calls for greater cybersecurity. Companies will need to map their networks, assessing the risk and critical factors relating to security. Such an assessment should examine accessibility to systems, such as possible threats from internal



sources, from disgruntled employees to internal human error, and external sources including hackers and cyber terrorists. Furthermore, companies must assess risk and determine if these risks will be accepted, reduced, shared via insurance or other vehicles, or rejected. Risks can be from both intentional and unintentional sources. If your house lights turn on via your computer, but you have lost the wireless connection to your house, you may be living in the dark. Unintentional sources of risk can include errors promulgated by company employees or nature itself such as storms causing disruptions in connectivity. Individuals too should assess their risks, just as companies will. It may come that the Internet will have more information about individuals than the family, friends, and colleagues of the individuals. Certainly, the ability of data to be processed and the speed in which it can be done surpasses the ability and speed of individuals. It is necessary to examine the value of processes and assets, from machinery to intellectual property, ensuring that there is insurance, security measures and that any vulnerability is sufficiently identified.

When the authors consider the changing nature of security threats from employees connecting personal devices to company networks to brute force attacks from hackers the situation is further complicated. The sophistication in risk identification and neutralization has to change with it. While data can be lost or stolen by employees, either inadvertently or intentionally, the biggest attacks in recent years have been external malicious attacks, collectively or commonly referred to as hacking. These could be hacking to move money around, such as when Russian hackers stole \$10 million from Citibank customer accounts, Internet terrorism, such as the \$2 million damages caused to WeaKnees.com over a six week botnet attack, Internet pump-and-dump fraud where hackers take advantage of manipulating stock prices, or software piracy which is estimated to cost over \$50 billion a year (Romney and Steinhart, 2018).

The fourth industrial revolution is more than just technology-driven change. Rather, it is powered with disruptive innovation to positively impact our core industries and sectors, such as education, health and business. In education, with the previous industrial revolutions, the focus of education changed. During the first industrial revolution, education was focused on standard modes of learning, such as the McGuffey reader. As we move toward mass production in the second industrial revolution and standardized testing. Education is service oriented and with the move into the third industrial revolution we come to see students under a customer learning model. Now in the fourth industrial revolution, technologies really blur the lines between physical, digital and biological spheres. Disruptive innovation makes its way into higher education in which it redefines the conventional ways universities deliver their content to students. New modes of curriculum and teaching arise, and the focus changes from modes of teaching to modes of learning. Alternative curriculums are being constantly developed. Disruptive innovation also reshapes how businesses operate. Thinking has really moved outside the box. New markets are created and new products are defined. Netflix is competing with traditional television. Taxis must compete against Uber and Lyft. These offered similar product offered to customers in new ways. You could watch your shows from your home or get a ride somewhere. With the Airbnb alternative overnight accommodations are competing against traditional hotels and motels (Jules 2017).

3. Methodology

The study is an exploratory study, as suggested by Cooper and Schindler (2003), exploratory research uses secondary data from extant literature to underpin the theoretical and contextual frameworks of technology business incubator. This is also predicated upon the lack of adequate information on the procedure for the establishment, development and management of technology business incubators in Nigeria. The authors rely heavily on wealth of knowledge and experience on technology business



incubation programme to elicit information on technology entrepreneurship and the fourth industrial revolution era. Besides, the authors intend to use qualitative reasoning to draw up conclusion, which is the hallmark of exploratory case studies methodology. This is a position supported by many other researchers (Page & Meyer, 2000; Saunders et al., 1997).

4. Result

4.1 Discussion of Findings

From the data elicited from various sources, the following technologies are identified to be the driving forces behind the fourth industrial revolution era. Thus: The Internet of things (IoT) is the Internetworking of physical devices. The IoT is expected to offer advanced connectivity of devices, systems and services that goes beyond machine-to-machine (M₂M) communications and covers a variety of protocols, domains, and applications. This position is equally supported by Holler, et al. (2014) in their study. Robotics; technically, robots are automated motorized tools. They cook food, play music, record cinemas and shows, and even run cars. The finding is supported by Schwab (2015). 3D printing for prototyping. Anderson (2012) said that tissue engineers use rapid prototyping techniques to produce 3D porous scaffolds. The 3D printing technique fabricates scaffolds with a novel micro- and macro-architecture and these in turn help shape the new tissue as it regenerates. New technologies, like this 3D printing, allow entrepreneurs with new ideas to establish small companies with lower start-up costs. 3D printing will be of immense contribution to printing industry in the 21st industry as stated by Anderson (2012). Artificial intelligence point to significant economic disruptions in the coming years. Artificial systems that rationally solve complex problems pose a threat to many kinds of employment, but also offer new avenues to economic growth. Driverless vehicles may modestly replace taxi and Uber drivers, but autonomous trucks may radically transform shipping with far fewer jobs for truck drivers. This finding is equally supported by Manyika et al. (2017); and the study reveals that technology entrepreneurship will be a good technological vehicle to drive the fourth industrial revolution. Few among these technological vehicles are: Samsung, Apple incorporated, tesla, Google, Amazon etc.

5. Conclusion and Recommendation

The study concludes that technologies driving the fourth industrial revolution era are digital technology, internet of things, robotics, 3D printing, artificial intelligence, drones, driverless vehicles etc. and identified technology enterprises pivoting the fourth industrial revolution among others to include; Samsung, Apple incorporated, Tesla, Google, Amazon, etc.

The study therefore, recommends that the promoters of technologies and technology enterprises driving and pivoting the fourth industrial revolution era to assist the developing countries by leap frogging into the fourth industrial revolution era to avoid large scale global differential catastrophe of system collapse and high level technology and development dichotomy through technology complementarity approach.

References

- Amezcuca, A. S., Grimes, M. G., Bradley, S. W., & Wiklund, J. (2013). Organizational sponsorship and founding environments: A contingency view on the survival of business-incubated firms, 1994-2007. *Academy of Management Journal*, 56(6): 1628–1654.
- Anderson, C. (2012). *Makers: The new industrial revolution*. New York: Crown Publishing.
- Bailletti, T. (2012). Technology entrepreneurship: Overview, definition and distinctive aspects. *Technology Innovation Management Review*, 2(2): 5–12.



- Beckman, C. M., Eisenhardt, K., Kotha, S., Meyer, A., & Rajagopalan, N. (2012). Technology entrepreneurship. *Strategic Entrepreneurship Journal*, 6(2): 89–93.
- Brem, A., Nylund, P. A., & Schuster, G. (2016). Innovation and de facto standardization: The influence of dominant design on innovative performance, radical innovation, and process innovation. *Technovation*, 50–51: 79–88.
- Brem, A., & Voigt, K.-I. (2009). Integration of market pull and technology push in the corporate front end and innovation management—insights from the German software industry. *Technovation*, 29(5): 351–367.
- Brown, R., & Mason, C. (2014). Inside the high-tech black box: A critique of technology entrepreneurship policy. *Technovation*, 34(12): 773–784.
- Brynjolfsson, E., McAfee, A., & Spence, M. (2014). New world order: Labor, capital, and ideas in the power law economy.
- Cooper, D. R & Schindler, P. S. (2003). Business research methods (8th ed.), New York: McGraw Hill.
- Davidson, P. (2015). Entrepreneurial opportunities and the entrepreneurship nexus: A re-conceptualization. *Journal of Business Venturing*, 30(5): 674–695.
- Doganova, L., & Eyquem-Renault, M. (2009). What do business models do? *Research Policy*, 38(10): 1559–1570.
- Encyclopedia Britannica; www.britannica.com.
- Entrepreneur (2017). Definitions of technopreneurship and technopreneurs, www.entrepreneur.org.
- Feinstein Charles (1998). Pessimism perpetuated: Real wages and the standard of living in Britain during and after the industrial revolution. *Journal of Economic History*, 3: 58.
- Ferreira, J. J. M., Ferreira, F. A. F., Fernandes, C. I. M. A. S., Jalali, M. S., Raposo, M. L., & Marques, C. S. (2016). What do we [not] know about technology entrepreneurship research? *International Entrepreneurship and Management Journal*, 12(3): 713–733.
- Frederiksen, D. L., & Brem, A. (2017). How do entrepreneurs think they create value? A scientific reflection Of Eric Ries’ leanstartup approach. *International Entrepreneurship and Management Journal*, 13(1): 169–189.
- Gans, J. S., & Stern, S. (2003). The product market and the market or “Ideas”: commercialization strategies for technology entrepreneurs. *Research Policy*, 32(2): 333–350.
- Gershenfeld, N., & Vasseur, J. P. (2014). As objects go online: The promise (and Pitfalls) of the internet of things. Retrieved from <https://www.foreignaffairs.com/articles/2014-02-12/objects-go-online>.
- Giones, F., & Oo, P. (2017). How crowd sourcing and crowd funding are redefining innovation management. In A. Brem & E. Viardot (Eds.). *Revolution of Innovation Management: 43–70*.
- Giones, F., & Brem A. (2017). Digital technology entrepreneurship: A definition and research agenda. *Technology Innovation Management Review*, 7(5):44–51.
- Goode, L. (2018). Everything is connected, and there's no going back. The verge. retrieved from <https://www.theverge.com/2018/1/17/16898728/ces-2018-tech-trade-shows-gadgets-iot>
- Gruber, M., MacMillan, I. C., & Thompson, J. D. (2012). From minds to markets: How human capital endowments shape market opportunity identification of technology start-ups. *Journal of Management*, 38(5): 1421–1449.
- Gustavo, N. (2016) Second industrial revolution: The technological revolution; Richmondvale Academy Chateaubelair, St. Vincent. www.richmondvale.org.



- Hesse, N., & Sternberg, R. (2016). Alternative growth patterns of University spin-offs: Why so many remain small? *International Entrepreneurship and Management Journal*, 1–32.
- Höller, J., et al.. (2014). From machine-to-machine to the internet of things: Introduction to a new age of intelligence. *International Journal of Financial Research*, 9(2), 95.
- Jee, Y. S (2017). Exercise rehabilitation in the fourth industrial revolution. *Journal of Exercise Rehabilitation*, 13(3) 255-256.
- Jules, T. D. (2017). Public policy and governance in the fourth industrial revolution: Gate, regulated and governed. United Kingdom: Emerald Group Publishing Limited.
- Knight, F. (1921). Risk, uncertainty and profit. Boston, MA: Houghton Mifflin.
- Kraus, S., Brem, A., Schuessler, M., Schuessler, F., & Niemand, T. (2017). Innovative born global: Investigating the influence of their business models on international performance. *International Journal of Innovation Management*, 21(1), 103.
- Kyprianou, C. (2016). Getting to network effects: Social club and open door Strategies in two-sided market places. *Academy of Management Proceedings*. Anaheim, CA.
- Lambert, L. (2017). The four challenges of the fourth industrial revolution. Market mogul. Retrieved from <https://themarketmogul.com/industry-4-0-challenges/?hvid=2Gt2CE>
- Leswing, K. (2017). Apple CEO Tim cook: 'If I were a country leader, my goal would be to monopolize the world's talent'. Business Insider. Retrieved from <http://www.businessinsider.com/apple-ceo-tim-cook-if-i-were-world-leader-my-goal-monopolize-talent-2017-9>
- Manyika, J., et al., (2017). Harnessing automation for a future that works. Report by McKinsey Global Retrieved from <http://www.mckinsey.com/global-themes/digital-disruption/harnessing-automation-for-a-future-that-works>.
- Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science*, 29, 770-791.
- Nambisan, S. (2016). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, (414): 1–27.
- Page, C. & Meyer, D. (2000). Applied and research design for business and Management. Sydney: Irwin/McGraw-Hill.
- Pauwels, C., Clarysse, B., Wright, M., & Van Hove, J. (2016). Understanding a new generation incubation model: The accelerator. *Technovation*, 50–51: 13–24.
- Peters, M. A. (2017). Technological unemployment: Educating for the fourth industrial revolution. *Journal of Self-Governance and Management Economics*, 5(1), 25-33.
- Priem, R. L., Li, S. & Carr, J. C. (2011). Insights and new directions from demand-side approaches to technology innovation, entrepreneurship and strategic management research. *Journal of Management*, 38(1):346–374.
- Rasmussen, E. S., & Tanev, S. (2015). The emergence of the Lean Global Startup as a new type of firm. *Technology Innovation Management Review*, 5(11): 12–19.
- Robert Lucas (2003). The industrial revolution; Federal Reserve Bank of Minneapolis, Annual Report.
- Romney, M. B., & Steinhart, P. J. (2018). Accounting information systems (14th ed.). New York: Pearson.
- Rifkin J (2011). The third industrial revolution. How lateral power is transforming energy, the economy, and the world. New York: Palgrave MacMillan.
- Saunders M., Lewis P. & Thornhill A. (1997). Research methods for business students. (3rd Ed.). London: Pitman Publishing.



- Schumpeter, J.A. (1934). *The theory of economic development*. Cambridge: Harvard University Press.
- Schumpeter, J.A. (1942). *Capitalism, socialism and democracy*. New York: Harper.
- Schwab, K. (2015). *The fourth industrial revolution: What it means and how to respond*. Retrieved from <https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution>.
- Schwab, K. (2016). *The fourth industrial revolution*; World Economic Forum, 91-93 route de la capite, Cologny Geneva, Switzerland.
- Srinivasan, R., Lilien, G., & Rangaswamy, A. (2004). First in, First out? The effects of network externalities on pioneer survival. *Journal of Marketing*, 68(1): 41–58.
- Tanev, S. (2012). Global from the start: The characteristics of born-global firms in the technology sector. *Technology Innovation Management Review*, 2(3): 5–8.
- Westerlund, M., Leminen, S., & Rajahonka, M. (2014). Designing business models for the internet of things. *Technology Innovation Management Review*, 4(7): 5–14.