CORPORATE GOVERNANCE FOR TRILLION DOLLAR OPPORTUNITIES

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Abstract

Boards of Directors will have to play a key role in the technological survival and development of companies by asking corporate executives about their plans and strategies for these emerging technological changes and challenges. Key challenges and opportunities discussed in this paper, with corresponding corporate governance implications, included Big Data, Artificial Intelligence (AI) with Industry 4.0, AI with the Internet of Things (IoT), Deep Learning, and Neural Networks. Survival should not be the goal, but it may be the necessary first step for today's companies. Potential winners seizing these trillion dollar opportunities will be company executives and Boards of Directors who can incorporate these technological changes into specific new business models, strategies, and practices. While the awareness on boards regarding risks originating from disruptive innovation, cyber threats and privacy risks has been increasing, Boards of Directors must equally be able to challenge executives and identify opportunities and threats for their companies. This shift for companies is not only about digital technology but also cultural. How can people be managed when digital, virtual ways of working are increasing? What do robotics and Big Data analysis mean for managing people? One way to accelerate the digital learning process has been advocated: the use of digital apprentices for boards. For example, Board Apprentice, a non-profit organization, has already placed digital apprentices on boards for a year-long period (which helps to educate both apprentices and boards) in five different countries. Additional plans and strategies are needed in this age of digitalization and lifelong learning. For example, cybersecurity risks are magnified by all these new technology trends, such as Big Data, AI, Industry 4.0, and IoT. Accordingly, the main findings of this paper are analysing the challenges and opportunities for corporate executives, Boards of Directors, and related corporate governance concerning the driving force of Big Data, Artificial Intelligence with Industry 4.0, Artificial Intelligence with the Internet of Things, Deep Learning, and Neural Networks.

Keywords: Technology Opportunities, Corporate Governance Implications

1. INTRODUCTION

Which person or company will become the world's first trillionaire? Mark Cuban is worth over $3 billion from his systems integration, software, internet broadcasting, distribution networking, entertainment, and media companies. He predicted that the world's first trillionaire is going to come from somebody or company who masters artificial intelligence (AI) and all its derivatives and applies it in ways never thought of yet. He said that knowledge of AI is the determining factor for future business viability and critical thinking with global perspective matters more than ever. Individuals and companies need to become knowledgeable in such technologies as AI, deep learning, and neural networks since the software will automate software, and automation will automate automation (Lui, 2017).

Similarly, Bill Gates said this work is at a really profound level with phenomenal potential and, accordingly, Microsoft is developing such technologies. Also, Google has predicted that such technology will be as transformative as the discovery of electricity. McKinsey & Co. has predicted that

such technology represents $20 trillion in business opportunities. Some Wall Street insiders are calling it bigger than the internet (Bleeker, 2017). Oxfam, an international confederation of charitable organizations, has predicted that the world could have its first trillionaire in the next 25 years with the most likely candidates being Microsoft's Bill Gates and Amazon's Jeff Bezos who just became the first world's $100 billionaire (Martin, 2017).

Technical skills will gradually get picked up and replaced by automation and computers. Thus, creative solutions are needed to mitigate job losses from such automation, especially since current governments are not going to solve that problem by bringing back factories (Lui, 2017). The following quotes dramatize these emerging challenges. "Software is eating the world," Netscape founder, Marc Andreessen (Friedman 2016). "If a board is not bothered about digital, I would sell your shares in that company!" Brian McBride, Chairman, Asos (Korn/Ferry Institute, 2013). "Society should prepare for decades of pain as the internet and automation disrupt the old economy, Cloud computing and artificial intelligence are essential for business – and if leaders don't get that, they should find young people in their companies to explain it to them," Jack Ma, Alibaba Chairman (Bloomberg News, 2017). UBS warned that if companies fail to integrate AI into their business models, they run the risk of market share losses and potential extinction. The oncoming impact of AI will exceed that of the recent technological forces of e-commerce and smart devices (UBS, 2017),

"A lifelong job requires lifelong learning, especially now in the age of digitalization which had an incredible boost in 2007," Tom Friedman, author and columnist (Freidman, 2016). In 2007, Apple released its first iPhone, starting the smartphone revolution that can provide an internet-connected computer to anyone. Facebook opened itself to anyone with an email address and Twitter started to scale globally. Hadoop software expanded the ability of any company to store enormous amounts of data which helped enable "big data" and cloud computing. Palantir Technologies, the leading company using "big data," launched its first platform. Amazon released Kindle which started the e-book revolution. Google bought YouTube and introduced Android, an open-standards platform for devices that would help smartphones scale globally. AT&T invested in "software-enabled networks" to expand its capacity to handle mobile cellular traffic which then increased more than 100,000% from January 2007 through December 2014. IBM started Watson, the world's first cognitive computer, which combined machine learning and artificial intelligence (Freidman, 2016).

Also, in 2007, Intel introduced non-silicon materials into its microchip transistors, extending the duration of Moore's Law, the expectation that the power of microchips would double about every two years with the exponential growth in computer power still continuing to this day. Internet users worldwide exceeded one billion which seemed to have been a tipping point. Thus, 2007 may be viewed as one of the greatest technological inflection points in history with so many more things that could be digitalized, so much more storage for digital data, so many faster computers, so much more innovative

software, and so many more organizations and people who could access and contribute to those benefits with their handheld computers – their smartphones (Friedman, 2016).

At the 2016 World Economic Forum meeting in Davos, Switzerland, some influential leaders advocated the need to develop a digital mind which understands the potential, the disruptive nature, and the risks associated with the use of digital data. They stressed that a company's ability to harness digital data can drive profitability, offer critical insights, and open new business opportunities. At this Davos meeting, 735 board members and executives voted the speed of disruptive innovation as the fourth highest risk for business in 2017 (Amato, 2016).

The rest of this paper is divided into the following major sections which represent challenges and opportunities for corporate executives, Boards of Directors, and related corporate governance: literature review, driving force of Big Data, Artificial Intelligence with Industry 4.0, Artificial Intelligence with the Internet of Things, Deep Learning, Neural Networks, Technology Challenges and Opportunities, and Conclusions.

2. LITERATURE REVIEW

So what are companies and Board of Directors doing about these emerging digital advances and applications? Are they seizing opportunities to create competitive advantages? Are they analyzing the challenges and risks? Are they adapting their business models and strategies? Already internet-based collaborative service companies are helping companies to optimize and create new products using newer technologies. Digital opportunities include manufacturing parts with complex designs, reducing prototype and tooling costs, improving product design, and increasing customization at low cost. Digital challenges include protecting intellectual property, reskilling workers, addressing factory environmental concerns, and improving supply chains. Where is the Board of Directors' corporate governance to determine if corporate executives are creating competitive advantages with such opportunities while also dealing with the related risks? Corporate governance should play a key role in this surge in AI, software, and automation. Boards of Directors need to be asking critical questions about how their companies are taking advantage and coping with these challenges.

Peter Montagnon, Associate Director of the Institute of Business Ethics, observed that a major role of a board is to allocate capital, but how can directors fulfil this role if they do not fully understand the implications of the digital economy? Rather than treating digital knowledge as a specialist skill, he argued that such skill must be developed by all directors (Heimer and Valeur, 2016). Similarly, Shelly Palmer, the CEO of The Palmer Group, a strategic advisory, technology consulting firm, warned: "Today you are experiencing the slowest rate of technology change you will ever experience for the rest of your life. You really don't have time to wait. Adapt or Die!" (Palmer, 2017). As technology gets faster and cheaper at an accelerating rate, companies cannot wait until they are ready or until they are forced to do it, especially since the same

challenges are faced by competitors and startup companies. Palmer summarized: "It is not the strongest or the most intelligent species that survive. It is the one that is the most adaptable to change" (Palmer, 2017). Boards of Directors should play a key role in such survival for the companies by challenging corporate executives about their plans, strategies, and practices for such technological changes and challenges.

Thus, the changing technological environment will affect board best practices for carrying out its governance responsibilities. For example, with the rise of digital technologies, corporate executives and Boards of Directors must become agile, innovative and act as though they are dynamic technology companies. Ignoring the challenge of the networked age and the digital revolution is no longer an option for executives and Boards of Directors as such complacency will accelerate the decline and possible failure of such corporations (Vermeulen, 2015). For example, the emergence of blockchains has implications for corporate executives, Boards of Directors, auditors, and other parties involved in corporate governance. Blockchain technology has the potential for lower costs and more accurate recordkeeping while reducing threats of cyber attacks (Yermack, 2018).

Since almost every business now has an internet presence and is engaged in e-commerce, corporate executives and Boards of Directors must consider and deal with the risks of e-commerce, cybersecurity, information technology, and electronic payment systems (Trautman, 2016). There can be grave dangers and potential consequences of cyber attacks and there is a relative lack of computer familiarity on the part of many senior business leaders and Boards of Directors. Recent governmental policy developments and major legislative proposals and laws need to be considered and applied (Trautmen, 2015).

For example, the European Union's General Data Protection Regulation takes effect on May 25, 2018. It applies to every organization of any size, industry, and geography that processes data from EU citizens. The rule subjects a violator to a fine of up to 4% of annual global turnover and has two primary objectives. The first one is to provide EU citizens with control of their personal data and the second one is to simplify the regulatory environment by unifying regulation across the EU. The rule applies to personal data, including customer lists, contact details, genetic/biometric data, and potential online identifiers like IP addresses. The rule mandates that companies conduct privacy risk-impact assessments to analyze the risk of data breaches, including steps to minimize such risk (Kalinich, 2017).

3. DRIVING FORCE OF BIG DATA

Big Data remains the driving force behind many ongoing waves of digital transformation, including artificial intelligence, data analysis, and the Internet of Things. There continues to be an explosion of data, due to the rise of computers, the internet, and technology capable of capturing information from the real world and converting it to digital data. People generate date whenever they go online, when they carry GPS equipped smartphones, and when

they shop. People leave digital footprints with everything they do that involves a digital transaction. Also, the amount of machine-generated data is rapidly growing. This ever-growing stream of sensor information, photographs, text, voice, and video data is the foundation of Big Data (Marr, 2017).

Currently, Big Data analysis projects are helping to cure disease and prevent cancer, feed the hungry with improved agriculture, explore distant planets, predict and respond to natural and man-made disasters, prevent crime with improved policing, and make daily living easier and more convenient. Big Data works on the principle that when more is known about anything, more reliable predictions can be made. By comparing more data points, relationships will begin to emerge that were previously hidden and these relationships may contain insights into how change can be initiated. The most common process is to build models, based upon data collected, and, then, run simulations, tweaking the value of data points each time and monitoring how it impacts the results. This process is automated with advanced analytics technology that can run millions of simulations until a pattern or an insight is found to help solve the problem being analyzed. Instead of just data that can be structured into tables with rows and columns, much data today is unstructured, i.e., satellite images, videos, photographs, email, instant messenger communications, and recorded telephone calls.

To analyze all of this structured and unstructured data, Big Data projects often use artificial intelligence and machine learning to spot patterns much more quickly and reliably than humans. The recent trend is the delivery of Big Data tools and technology from third-party cloud service providers, which is making Big Data-driven discovery and transformation accessible to any organization without having to spend vast sums on hardware, software, and technical staff. Big Data concerns relate to data privacy, data security, and data discrimination. While newer technology buzzwords have emerged, such as artificial intelligence, deep learning, and neural networks, Big Data is still the driving force behind just about all of them (Marr, 2017). For example, traditionally an auditor sampled 25 to 50 transactions out of millions to look for non-compliance. However, data analytics allow auditors or machines to look at all the transactions and apply statistical and quantitative modelling and profiling to provide greater insights and more profound analyses (Vollmer, 2017).

Jack Ma, the Alibaba chairman said: "machines should only do what humans cannot. Only in this way can we have the opportunities to keep machines as working partners with humans, rather than as a replacement," (Bloomberg News, 2017). Similarly, John Kelly, senior vice president at IBM, calls AI systems like Watson, "Cognitive computing because unlike artificial intelligence, which connotes a machine replacing human intelligence, our vision is that these systems will work in partnership with people. When we think of AI, we consider it augmented intelligence or man plus machine," He provided examples of Watson partnering with H&R Block, Quest Diagnostics, Sloan Kettering Cancer Center, the Manipal Hospital system in India, and the Gachon University Gil Medical Center in Korea. In

addition to these augmented intelligence examples, Watson can help Fortune 500 and other companies by ingesting an extraordinary amount of unstructured data, like social media posts, newspaper articles, financial reports, and medical journals to develop intelligence based on such data for professionals to use in making better decisions. Watson is even available on the cloud now. Thus, there is emerging demand for "new-collar" jobs, like data scientists, app developers, and data labellers who teach AI systems by feeding them relevant, big data (UBS, 2017).

4. ARTIFICIAL INTELLIGENCE WITH INDUSTRY 4.0

Concerning trillion dollar opportunities, executive managers and boards of directors need to urge Individuals and companies to become knowledgeable in artificial intelligence, deep learning, and neural networks for future business viability and critical thinking with a global perspective. Artificial intelligence is analyzed here with Industry 4.0.

Industry 4.0 is a current trend of automation and data exchange in manufacturing technologies, which started with the high-tech strategy of the German government. It includes artificial intelligence, cyber-physical systems, the Internet of Things or IoT, and cloud computing, using SCADA protocols (Supervisory Control and Data Acquisition). It creates a "smart factory" where cyber-physical systems monitor physical processes, create a virtual copy of the physical world, and make decentralized decisions. Over the IoT, cyber-systems communicate and cooperate with each other and with humans in real time, and via the Internet of Services, internal and cross-organizational services are offered and used by participants of the value chain (Hermann, 2016).

In a McKinsey & Company study, a German software consultant, Siegfried Dais, was quoted: "It is highly likely that the world of production will become more and more networked until everything is interlinked with everything else." While this assumption is a driving force behind the Internet of Things, it also means that the complexity of the value chain will grow significantly versus the current limitation of networks and processes to a single factory. In an Industry 4.0 scenario, individual factory boundaries will no longer exist as multiple factories or even geographical regions are interconnected (Liffler and Tschiesner, 2013). However, cybersecurity issues are magnified by this Industry 4.0 need to open up previously closed production shops. Reliability and stability are needed for critical machine-to-machine communication (M2M), especially to maintain the integrity of production processes. Cybersecurity also is needed to protect industrial know-how and control files (BIBB, 2015). The speed of manufacturing enterprises adapting to use the digital potential for efficiency, such as a programmer from the US changing in real time production lines in China or accessing a water turbine in Alaska, will help decide their survival. Warren Bennis predicted: "The factory of the future will have only two employees, a man and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment" (Bennis, 2014).

5. ARTIFICIAL INTELLIGENCE WITH THE INTERNET OF THINGS

Another example of artificial intelligence is the Internet of Things (IoT). IoT is made up of billions of everyday wireless devices that communicate with each other over the internet and send useful information to businesses and consumers, i.e. digitizing the physical world. For example, radio-frequency identification tags will replace the need for physical inventory counts and automated systems can detect, predict, and prevent potential errors (Ng, 2016). McKinsey & Company (2015) estimated the IoT economic benefits could accumulate between \$4 to \$11 trillion per year by 2025 in the following nine settings: 1) Factories: operations and equipment optimization, 2) Cities: public health and transportation, 3) Humans: health and fitness, 4) Retail Environments: automated checkout, 5) Worksites: operations optimization/health and safety, 6) Outside: logistics and navigation, 7) Vehicles: automated vehicles and condition-based maintenance, 8) Home: chore automation and security, and 9) Offices: security and energy.

McKinsey & Company (2015) also concluded that interoperability between IoT systems is critically important to capturing maximum value and that, on average, it is required to capture 40% of total potential value across IoT applications. Also, less than 1% of IoT data are currently used, primarily for alarms or real-time control, and more data can be used for optimization and prediction. Furthermore, business-to-business (B2B) applications can create two times more value than pure consumer applications or 70 percent of potential value enabled by IoT and digitalization blurs the lines between technology companies and other types of companies.

For example, an oil industry vice-president said: "We're heading toward artificial intelligence and machine learning, analyzing thousands of algorithms. Through repetitive operations, you learn the patterns and through patterns, you learn to make automated decisions." These algorithms can duplicate the design of the most productive wells and can repair values and other parts on a preventive maintenance basis. Wireless technology allows a handful of geoscientists and engineers to monitor the drilling and completion of multiple wells at one time, either onshore of out at sea, and supervise immediate fixes when something goes wrong, all from a control center. Thus, technology has improved oil production and operations but with a far smaller workforce which is increasingly changing from muscle to brain power (Krauss, 2017).

6. DEEP LEARNING

Another aspect of trillion dollar opportunities was the recommendation, which executive managers and Boards of Directors need to consider, to develop deep learning for future business viability and critical thinking with a global perspective. Deep learning is also known as deep structured learning, hierarchical learning or deep machine learning. It is a class of machine learning algorithms that use a cascade of many layers of nonlinear processing units for feature extraction and transformation. Each

successive layer uses the output from the previous layer as input. The algorithms may be supervised or unsupervised with applications that include classification (supervised) and pattern analysis (unsupervised). One of the promises of deep learning is replacing handcrafted features with efficient algorithms for unsupervised or semi-supervised feature learning and hierarchical feature extraction (Deng and Yu, 2014; Schmidhuber, 2015).

Concerning applications, speech recognition has been revolutionized by deep learning. In 2015, Google's large-scale speech recognition suddenly almost doubled its performance through Connectionist Temporal Classification (CTC)-trained long and short-term memory (LSTM). This application is now available to all smartphone users. All major commercial speech recognition systems are based on deep learning methods: Google Now, Microsoft Cortana, Xbox, Skype Translator, Amazon Alexa, Apple Siri, Baidu, and iFlyTek. By the early 2000s, image recognition deep learning had already processed 10% to 20% of the checks written in the U.S. Other applications are the analysis of large medical images for cancer detection and automatic image captioning. A further application is a car computer trained with deep learning which may enable cars to interpret 360-degree camera views.

The pharmaceutical industry faces the problem where many candidate drugs fail to reach the market, due to failures of chemical compounds or unanticipated toxic effects. Deep learning has been used to detect off-target and toxic effects of candidate drugs. In 2015, Atomwise introduced AtomNet, the first deep learning neural networks for structure-based rational drug design. It has been used to predict treatments for the Ebola virus and multiple sclerosis. For customer relationship management, deep reinforcement learnings were used to approximate the value of direct marketing actions over the customer state space. The estimated value function was shown to have a natural interpretation of customer lifetime value. The most powerful AI systems, like IBM's Watson, use deep learning techniques as just one element in a very complicated ensemble of techniques, ranging from the statistical technique of Bayesian inference to deductive reasoning (Goodfellow, Bengio and Courville, 2016).

7. NEURAL NETWORKS

Another aspect of trillion dollar opportunities was the recommendation, which executive managers and Boards of Directors need to consider, to develop neural networks for future business viability and critical thinking with a global perspective. Neural networks or connectionist systems are a computational model used in computer science and other research disciplines, based on a large collection of simple neural units (artificial neurons), loosely analogous to the observed behaviour of a biological brain's axons. Each neural unit is connected with many others and links can enhance or inhibit the activation state of adjoining neural units. Each individual unit computes using summation function and there may be a threshold function or a limiting function on each connection and on the unit itself. These systems are self-learning and self-trained, rather than explicitly programmed and excel in areas where the solution or feature detection is difficult to express in a traditional computer program. The use of neural networks shifted in the late eighties from high-level (symbolic) artificial intelligence, characterized by expert systems with knowledge embodied in if-then rules, to low-level (sub0symbolic) machine learning, characterized by knowledge embodied in the parameters of a cognitive model with some dynamical system (Ojha, Abraham and Snasel, 2017).

The tasks applied by artificial neural networks (ANN) tend to fall within the following broad categories; fitness approximation and modelling, sequential decision making, data processing, robotics, and control, including computer numerical control. Application areas include the system identification and control (vehicle control, trajectory prediction, process control, natural resources management), quantum chemistry, game playing and decision making, pattern recognition (radar systems, face identification, object recognition), sequence recognition (gesture, speech handwritten text recognition) medical diagnosis, financial applications (automated trading systems), data mining or knowledge discovery in databases, visualization and e-mail spam filtering. ANNs have been used to diagnose several types of cancers, such as lung, prostate, colorectal cancers, and have predicted the outcome for patients with colorectal cancer with more accuracy than current clinical methods. An ANN team won a recent contest sponsored by Merck to design software to help find molecules that might lead to new drugs. A memory network developed by Facebook has been applied to question answering (Q&A) and a Neural Turing Machine developed by Google can infer simple algorithms, such as copying, sorting, and associative recall from input and output examples (Ganesan, 2013).

8. TECHNOLOGY CHALLENGES AND OPPORTUNITIES

Steven Mnunchin, a former Hollywood producer and former Goldman Sachs banker, was recently appointed U.S. Treasury Secretary by President Trump. Mnunchin commented that he wasn't worried at all about advancing artificial intelligence taking over jobs anytime soon. He said in 2017: "We shouldn't be worried about it for another 50 to 100 years" (White 2017). Discussing aircraft carriers continuing to use digital electromagnetic aircraft launchers, instead of the old steam aircraft catapults, President Trump said: "It sounded bad to me. Digital. They have digital. What is digital? And it's very complicated, you have to be Albert Einstein to figure it out" (North, 2017). These quotes appear to be examples of Bozone: the substance surrounding stupid people which stops bright ideas from penetrating. This bozone layer, unfortunately, shows little sign of breaking down the near future (Washington Post, 2013).

In contrast, Yogi Berra, the Hall of Fame baseball player, said in 1998: "The future ain't what it used to be." One significant change is that the push from the old to the new economy is reflected in the global average of services contributing 68% to Gross Domestic Product with developed economies averaging an even higher 80%, per the World Bank. The risk of AI-related job losses is higher in

traditional industries, like manufacturing, retail, and transportation, especially those jobs with predictable and routine tasks (UBS, 2017).

However, AI threatens jobs even in the services industries. For example, in March 2017, BlackRock, the world's largest money manager with $5 trillion in assets, announced that it is relying more on computers to pick stocks with data-mining and other technology-driven investing approaches. More than 40 employees, including seven traditional portfolio managers, are being laid off. BlackRock will also expand its investments in data-mining and other technology techniques to improve investment performance (Thomson/Reuters 2017). In recent studies, McKinsey & Company estimated that 45% of current jobs could be automated in the near future and the World Bank estimated that 57% of current jobs could be automated within the next 20 years (White, 2017).

To enhance corporate governance and help protect investors, corporate executives and Boards of Directors need to develop plans and strategies for oncoming digital technology changes. For example, concerning business opportunities, corporate executives and Boards of Directors should first ask: "In the future, do I think we will have that? If the answer is yes, how can we make that happen sooner? If it doesn't work with your phone, forget the idea" (Aplanetruth, 2017). Accordingly, Apple, inventor of the iPhone, is the single largest U.S. corporation by market capitalization as of January 30, 2017 at $672 billion (Online Investor, 2017).

Software technology will disrupt most traditional industries in the next 5 to 10 years. With artificial intelligence, computers are becoming exponentially better in understanding the world. For example, in the U.S., many young and talented lawyers don't get jobs because of IBM's Watson. It provides basic legal advice within seconds with 90% accuracy, compared with much slower 70% accuracy by humans. Facebook now has pattern recognition software that can recognize faces better than humans. By 2030, computers will become more intelligent than humans (Aplanetruth, 2017).

The following digital technology predictions (Aplanetruth, 2017) are organized by major U.S. business sectors. Many of these predictions are already starting to happen as a McKinsey Global Institute analysis of U.S. Bureau of Labor statistics listed technical potential for automation and potential related disruption across these sectors. These automation predictions will bring tremendous economic dislocations as employees are replaced or retrained and the leading technology companies have been encouraged to retrain and reposition displaced workers (Saper, 2017).

8.1. Defense and aerospace

The U.S. military currently operates over 11,000 unmanned aerial systems (UAS). UAS have expanded from just intelligence, surveillance, and reconnaissance missions to include electronic attack, strike missions, suppression or destruction of enemy air defence, network node or communications relay, combat search and rescue and derivations of these functions. UAS range in cost from a few thousand dollars to multi-millions and range in weight from less than one pound to over 40,000 pounds. In 2012 for the first time, the U.S.

Air Force trained more UAV pilots than ordinary jet fighters and UAV pilots now represent about 10% of total U.S. Air Force pilots. There are also thousands of civilian UAV operators (Hoagland, 2013). The space station now has a 3D printer that eliminated the need for a large amount of spare parts which were carried on board and some spare airplane parts are already 3D-printed in airports.

On January 8, 2017, there was a public demonstration of future combat by the U.S. military on the 60 Minutes News Hour. 100 light-weight (a few pounds), autonomous drones, named the Perdix, were launched from three F-18 jet fighters. These Perdix fly 40 to 50 miles per hour, are self-directed with Artificial Intelligence (AI), and communicate Machine to Machine (M2M). In this demonstration, they autonomously performed a complicated swarm maneuver. They have the capacity to launch their own weapons but are currently supervised by military personnel who approve any kill shots. A U.S. military technology expert in charge of this demonstration said that such drone capabilities are the most significant advance in military technology since the atomic bomb! The five most deadly drone powers in the world (in power order) are United States, Israel, China, Iran, and Russia (Farley, 2015). Automation potential to disrupt workers' tasks in this information sector is predicted to be 36%.

8.2. Automotive

In a prediction for 2018, the first self-driving cars will be publicly available. People probably will not want to own a car but instead call for a car with their phones. Thus, people will not need to park their cars but just pay for the driven distance while also being productive during their journeys. Although 1.2 million people die annually in car accidents worldwide, with autonomous driving, that number is estimated to drop by one million lives annually. Since many people will never own a car or need a driver's license, there will be 90% to 95% fewer cars. Cities will evolve as parking lots will be changed to housing and parks. While traditional car companies are trying to build a better car, tech companies, such as Tesla, Apple, and Google, are building a computer on wheels. The car insurance business line of insurance companies will all but disappear. Automation potential to disrupt workers' tasks in this automotive sector is predicted to be 57%.

8.3. Medical

IBM's Watson already helps diagnose cancer and it is four times more accurate than human nurses. Coming within a year, The Tricorder X medical device works with a phone. It will scan your retina, sample your blood, and when you breathe into it, it will analyze 54 biomarkers that can identify nearly any disease with amazing accuracy. In a few years, everyone could have access to world-class medical analysis with Tricorder for next to nothing, compared to the current cost of healthcare. There is already a software app called "moodies" that can tell what kind of mood you are in and by 2020 there will be apps that can tell by your facial expressions whether you are being truthful or lying. Automation potential to disrupt workers' tasks in this health care sector is predicted to be 36%.

8.4. Individual customer

Uber and Airbnb are more than just digital tools. Even though Uber doesn't own any cars, it is now the largest taxi company in the world. Even though Airbnb doesn't own any hotel properties, it is now the biggest hotel company in the world. Some shoe companies already are making 3D-printed shoes, rather than manufacturing shoes the old-fashioned way. Smartphones will soon have 3D scanning capabilities. Consumers can then 3D scan their own feet and 3D print the perfect pair of shoes in the comfort of their own homes. Automation potential to disrupt workers' tasks in the accommodation and food services sector and the retail sector are predicted to be 73% and 53%, respectively.

8.5. Supply chain

Electricity will become incredibly cheap and clean. In 2016, more solar energy was installed worldwide than fossil fuel systems. Home solar installations will also increase the availability of electricity. With cheap electricity comes cheap and abundant water. Desalination of salt water now only needs 2kWh per cubic meter (at 0.25 cents per kWh). In most places, there is only scarce drinking water, not scarce water. Thus, there will be abundant clean water for a very cheap price. Israel already has five operational desalination plants. Automation potential to disrupt workers' tasks in the utilities sector is predicted to be 44%.

8.6. Commercial

China has already 3D-printed and built a complete 6-story office building. By 2027, at least 10% of everything that is being manufactured will be 3D-printed. In the next 20 years, 70% to 80% of jobs will disappear. Self-driving trucks will displace more than 3,000,000 drivers just in the U.S. Think tanks are looking at how a Universal Basic Income (UBI) system would work as there will be millions fewer jobs than workers just in the U.S. On January 2, 2017, Finland began a UBI trial with 2,000 unemployed workers. They will continue to receive UBI even if they find work as the government does not want to disincentive anyone. Automation potential to disrupt workers' tasks in the manufacturing sector is predicted to be 60%.

8.7. Agriculture

There will be a $100 agricultural robot in the future. Farmers will then become managers of their fields, rather than labouring in them all day. Aeroponics will need much less water. The first Petri dish-produced veal is now available and will be cheaper that calf-produced veal by 2018. Since 30% of all agricultural acreage is now used for cattle, what will become of cows and land values? Several startup companies are planning to bring insect protein to the market. Pound for pound, insects contain more bioavailable protein than traditional meats but such products will initially be labelled as "alternative protein source" since most people currently reject the idea of eating bugs.

Digital technology is already facilitating both crop management and livestock management. Precision crop management techniques are using real-time data on weather, soil quality, and plant maturity to make decisions on planting, fertilizing, and harvesting crops. Precision livestock management techniques are using biometric ear tags, basically a Fitbit for cows (starter kit costs $500 and comes with 25 tags and a reader). The ear tags monitor each cow, recording its heart rate, body temperature, and location, and they store other information, such as the animal's date of birth and vaccination history. A rancher can access this data, using Bluetooth-enabled devices with a smartphone app, essentially creating smart cows. Obtaining data on how much a cow ate or drank allows correlations to be calculated with production or yield (Worthington, 2017). Automation potential to disrupt workers' tasks in this sector is predicted to be 58%.

9. CONCLUSIONS

Boards of Directors will have to play a key role in the technological survival and development of companies by asking corporate executives about their plans and strategies for these emerging technological changes and challenges. Key challenges and opportunities discussed in this paper, with corresponding corporate governance implications, included Big Data, Artificial Intelligence (AI) with Industry 4.0, AI with the Internet of Things (IoT), Deep Learning, and Neural Networks. Survival should not be the goal, but it may be the necessary first step for today's companies. Potential winners seizing these trillion dollar opportunities will be company executives and Boards of Directors who can incorporate these technological changes into specific new business models, strategies, and practices.

While the awareness on boards regarding risks originating from disruptive innovation, cyber threats and privacy risks has been increasing, Boards of Directors must equally be able to challenge executives and identify opportunities and threats for their companies. This shift for companies is not only about digital technology but also cultural. How can people be managed when digital, virtual ways of working are increasing? What do robotics and Big Data analysis mean for managing people? One way to accelerate the digital learning process has been advocated: the use of digital apprentices for boards. For example, Board Apprentice, a non-profit organization, has already placed digital apprentices on boards for a year-long period (which helps to educate both apprentices and boards) in five different countries (Heimer and Valeur, 2016). Additional plans and strategies are needed in this age of digitalization and lifelong learning. For example, cybersecurity risks are magnified by all these new technology trends, such as Big Data, AI, Industry 4.0, and IoT. Accordingly, the main findings of this paper represent the challenges and opportunities for corporate executives, Board of Directors, and related corporate governance, concerning the driving force of Big Data, Artificial Intelligence with Industry 4.0, Artificial Intelligence

with the Internet of Things, Deep Learning, and Neural Networks.

Since an observer claimed that today is the slowest that technology will ever change in your lifetime, future research could do field studies and business cases to determine how businesses and their Boards of Directors are rising to these technology changes, challenges, and opportunities, as lessons learned and to be learned for corporate governance. Limitations of this research are the focus on just these emerging technology developments without analyzing how specific companies and their Boards of Directors are handling such challenges and opportunities, especially for corporate governance.

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