IMPORTANCE AND CHALLENGES OF LEADERSHIP IN NURTURING THE ECOSYSTEM, FAVORABLE TO INDUSTRY 4.0

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ABSTRACT

The term "Industrie 4.0" was coined in 2011 at the Hannover Fair (Germany) to describe how entire value chains are interconnected by autonomous systems supported by intelligent networks of machines and data. We are currently living through an industrial revolution characterized by the pace of unparalleled change and catalyzed by a conglomerate of different technologies proceeding on different fronts and at different speeds. The Internet of Everything (IoE) which encompasses the Internet of Things (IoT), the Internet of Data, the Internet of Services, and the Internet of People is a key enabler in this broad and encapsulating concept of technological integration that will have far and wide-ranging impacts on how organizations do business and how people experience products. This paper will assess the importance of leadership in meeting the vision of Industry 4.0. The hypothesis that 'the people-centric approach is key to inclusive growth' will be tested. The findings will help steering organizations towards embracing this revolution by ensuring that social, legal and environmental challenges are identified, debated, and addressed for a sustainable future.

Keywords: *Internet of Everything (IoE), technological integration, inclusive growth, environmental challenges, the industrial revolution*

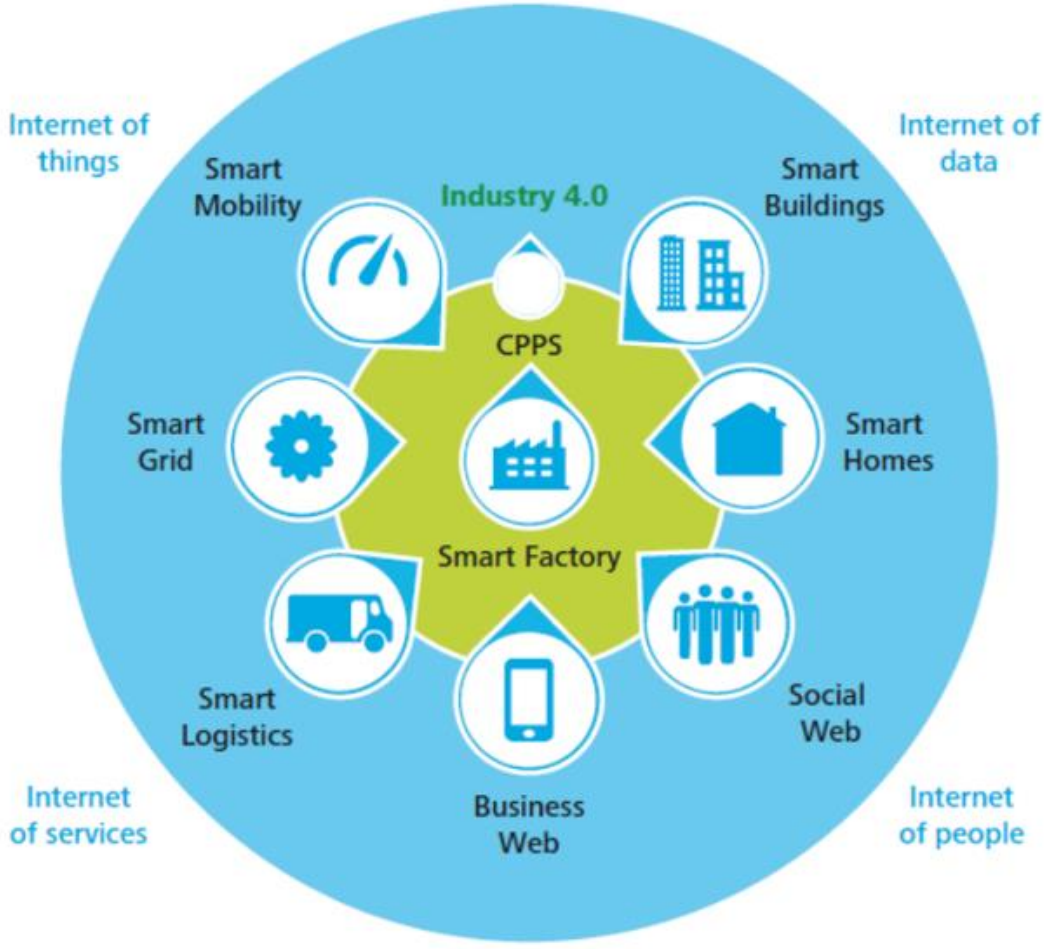
INTRODUCTION

The first industrial revolution was catalyzed by the advent of the steam engine which saw subsistence farming scaled up to large scale commercial farming. Rail and ship transport were critical drivers of that revolution. The second industrial revolution was characterized by the increasing adoption of mass production techniques such as conveyor belts and standardized lines. Electricity was essential to bring about this revolution. The third industrial revolution was galvanized by the programmable electronic chips which introduced automation to mass production lines. That era effectively marked an end to the growth in unskilled workers entering the workforce. Later, the internet introduced a new way for people to communicate and cooperate with each other. The Internet was the enabler for the information age. The fourth industrial revolution (FIR) or Industry 4.0, which we are currently experiencing, represents the next stage in the organization and control of the entire value stream along the life cycle of a product.

There are four main characteristics of Industry 4.0: vertical integration, horizontal integration, through-engineering, and integration of technologies. Vertical integration requires enhanced connectivity within the Smart Factory chain, allowing factories and manufacturing plants to react quickly and appropriately to variables, such as demand levels, stock levels, machine defects and unforeseen delays. Horizontal integration facilitates networks that create and add value, such as business partners and customers around the globe. Through-engineering is a unique aspect of FIR that focuses on the entire value chain. In other words, businesses are no longer just looking at manufacturing or an isolated aspect of the production process, but rather at a product from its inception to the final output and delivery. In other words, businesses are no longer just looking at manufacturing or an isolated aspect of the production process, but rather at a product from its inception to the final output and delivery. This is achieved with new, advanced and

Figure 1 presents a systematization of Industry 4.0 environment (source: Deloitte, 2015)

enhanced data collection technology, which is the fourth and final characteristic of Industry 4.0.



Looking back historically at the past three revolutions, technology has always been a net job creator. Academics and practitioners largely agree that Industry 4.0 offers far-reaching opportunities while having a presumably disruptive impact on today's markets, business models, supply chains and the world of work in general (Evans and Annunziata, 2012). A historical perspective with learnings should serve as a guide towards making technology subservient to human needs and not the other way around. After all, men created technology to serve men. Industry 4.0 is still at its infancy and leadership from the government, public institutions, and the private sector will be critical to ensure that the overused and often ill-used adage "this time is different" is apt.

WHY INDUSTRY 4.0?

The organizations that adopt Industry 4.0 can expect to significantly improve their present competitive position, increasing value creation and minimizing risks. The adoption of more efficient and faster production systems and of innovative technologies will allow shorter operations, delivery times and faster time to market new products and services (Fonseca, Luis M., 2018).

The EU has been actively advocating for Industry 4.0 and Europe Digital transformation, according to the Strategic Policy Forum on Digital Entrepreneurship "Digital Transformation of European Industry and Enterprises" (2015) and the benefits are as follows:

1) Companies applying the new accelerating technologies are performing 10 times better than their competitors
2) A fully realized Digital Single market can generate a 6% GDP
3) The internet economy has the potential to create 1.5 million new jobs in the European Union

4) Big data technology and services are expected to represent USD 16.5 billion with a compound annual growth rate of 40%
5) Companies using Big data technology and services can become 5 – 6% more productive
6) eLearning market will grow by a factor of 15 over the next 10 years and reach 30% of the education market.

According to Klaus Schwab, the Founder and Executive Chairman of the World Economic Forum (2017), there are two primary concerns about factors that may limit the potential of the fourth industrial revolution to be effectively and cohesively realized, namely:

1) The required levels of leadership and understanding of the changes underway across all sectors are low when contrasted with the need to rethink our economic, social and political systems to respond to the fourth industrial revolution. As a result, both at the national and global levels, the requisite institutional framework to govern the diffusion of innovation and mitigate the disruption is inadequate at best and, at worst, absent altogether
2) The world lacks a consistent, positive and common narrative that outlines the opportunities and challenges of the fourth industrial revolution, a narrative that is essential if we are to empower a diverse set of individuals and communities and avoid a popular backlash against the fundamental changes underway.

According to an expert survey conducted by the McKinsey Industry (2016), the top 5 barriers mentioned by manufacturers with limited to no progress in Industry 4.0 were difficulty in coordinating actions across different organizational units, lack of courage to push through radical transformation, lack of necessary talent, e.g. data scientists, concerns about cybersecurity when working with third-party providers and lack of a clear business case that justifies investments in the underlying IT architecture. Additional barriers mentioned by more advanced manufacturers were concerns about data ownership when working with 3rd party providers, uncertainty about in vs. outsourcing and lack of knowledge about providers and challengers with integrating data from disparate sources in order to enable Industry 4.0 applications.

LEADERSHIP AND ITS IMPORTANCE IN THIS REVOLUTION

Leadership has a fundamental role in ensuring that change at all levels is done faster, smarter and more efficiently. The leadership role can come from different stakeholders: corporate CEOs, community leaders, heads of states, public institutions, non-governmental organizations, and concerned citizens. While leaders will want to create a sense of stability within an organization, they also have to struggle with ever-changing business environments. As business organizations face increasingly unpredictable, complex, and challenging environments, those that have the greatest hope of surviving and contributing to the world will have leaders who embrace strategic paradoxes (Smith, Wendy K. *et al*., 2016). A challenge for corporate boards is to be simultaneously responsible to key corporate stakeholders, while at the same time balancing requirements for affordability and the efficient use of resources and acting responsibly towards the environment and wider society. Too often some interests are pursued at the expense of others (Coulson-Thomas, 2019). From a traditional perspective, the duty of the board of directors (BOD) has always been to the owners and investors of the firm. With the beginning of the 21st century, a social paradigm has emerged, reflecting broader directors' responsibilities in not only fulfilling shareholders' interests but also addressing stakeholders' needs (Chams, N. & Garcia-Blandon, J., 2019). Leadership starts by creating a vision and giving meaning to that vision for each and every stakeholder. At its core, leadership is about garnering support for the realization of a common vision. As such, having a clear vision should be the starting point for a leader. Ever since the concept of 'Industry 4.0' was developed, great strides have been taken towards the realization of architecture with the intention of creating a framework from which the leadership can build upon to create a vision that fully optimizes the potential of the FIR.

The EU and other EU countries have developed major Industry 4.0 initiatives. The German Federal Government has identified Industry 4.0 as one of the 10 forward-looking projects in its "High Tech Strategy Action Plan". Plattform Industrie 4.0 and the Robot Revolution Initiative of Japan announced cooperation regarding IoT/Industrie 4.0. General Electric (GE) coined the term Industrial Internet after the U.S. government announced the "Advanced Manufacturing Partnership 1.0". China has launched China Manufacturing 2025 (CM2025). The Australian Prime Minister's Office [verb missing here..] for the Industry 4.0 taskforce in 2015. Those initiatives have trickled down to most countries.

Driving innovation requires systems thinking and executive knowledge and understanding of how all the components of a system interact to produce the results that are required. Looking at what successful cyber leaders do, mindset characteristics jump out, such as having an expansive worldview, understanding how neuroscience can improve leadership, being eager to grow others, and having a voracious hunger for learning (Doan, M., 2019).

DATA

Cyber-Physical System (CPS) is a system that can effectively integrate cyber and physical components using the modern sensor, computing and network technologies (Zeadally, S. & Jabeur, N., 2016). A new computing paradigm known as cyber-physical-social (Sheth, A. *et al.*, 2013) or physical-cyber-social computing, has been originated from CPS and cyber-social system (CSS). Cyber-physical-social systems (CPSS) expand CPSs and include social space and signs of people's participation and interaction (Zeng, J., 2016). CPSs are the basis for the development of the following areas: smart manufacturing, smart medicine, smart buildings and infrastructures, smart city, smart vehicles, wearable devices, mobile systems, defense systems, meteorology, etc. The rapid growth of CPS applications leads to a number of problems with security and confidentiality (Alguliyev, R., 2018).

According to ISO/IEC 27001:2013, information security is the preservation of confidentiality, integrity, and availability of information. The Implementation Strategy Plattform Industrie 4.0 Results Reports (2016) has identified the following Current protection targets within the production realm[not clear here..] have the same high priority within Industrie 4.0: 1) Availability 2) Integrity 3) Protection of expertise/confidentiality 4) Authenticity 5) Integrity of time, particularly with respect to value networks that extend beyond company limits 6) Traceability and 7) Legal security.

Cyber-threats affect the confidentiality, integrity, and availability of data. Data protection is an important consideration for manufacturers facing pressure for customer, employee and partner data protection (Barrios, R.M. *et al.*, 2019). According to Howell, C. & Agarwal, P. (2016), the manufacturing industry is one of the most infiltrated industries from a cybersecurity point of view. Working with large groups of devices can cause some of them to be compromised. CPS security raised a number of new challenges (Liu, C.H. & Zhang, Y., 2016):

- The rising number of IoT devices leads to increasing vulnerability of such systems to cyber-attacks;
- Security threats modeling;
- Development of a formal approach to CPS vulnerabilities assessment;
- Designing reliable and fault-tolerant architectures for the processing of rapidly developing cyber and physical threats.

It is of paramount importance that leaders should restructure their Information Security function. Cyber-physical threats are threats that originate in cyberspace and have an impact on the physical space of the system. Data protection starts from the way the cyber-security function is structured within the hierarchy of the organization. The latter function cannot be treated simply as an IT problem since data protection should be the concern of all stakeholders in the value chain. Attacks on data could have negative impacts on the reputation, efficiency, effectiveness, and, in some cases, legality of operations. With IoE, gathering data raises important issues of privacy. The EU's General Data Protection Regulation (GDPR) took effect in 2018 and covers the personal data of any EU resident. It is a comprehensive people of legislation that concerns "Any company that has employees, suppliers or customers in Europe." Data has no borders, private and public stakeholders from all around the world should work together to embed legal requirements in their data acquisition, storage and processing processes.

SOCIAL

A slew of technologies working together can for the 1st time in history, influence human behavior autonomously. CPS can now collect data from sensors and process the data through intelligent analytics and algorithms in real-time and carve customized outcomes that play into the gullibility and biased inclined nature of individuals. Hence, beyond the benefits determined by technological innovations, there are also theoretical and practical challenges, and sometimes threats, that need to be addressed to ensure that technological innovation goes hand in hand with societal needs, beliefs, and expectations (D'Agostina, M. & Durante, M., 2018). On the one hand, algorithms are invoked as powerful entities

that govern, judge, sort, regulate, classify, influence, or otherwise discipline the world. On the other hand, algorithms are portrayed as strangely elusive and inscrutable, or in fact as virtually unexplorable (Barocas et al., 2013). As algorithms increasingly play a vital role in our information societies, leaders will need to surround themselves with a team of multi-disciplinary experts and drive the discussion and implementation of measures to address the following issues: 1) A "delegation problem": how are algorithmic procedures and applications governed once we delegate to them the solution of problems? and 2) a "standard problem": by which standards or indicators are the relevance and the timeliness of problems as weak as the efficiency and the fairness of solution brought about by algorithmic procedures and applications to be measured? (D'Agostina, M. & Durante, M., 2018).

The system of technologies working in unison means that many functions that previously required manpower, will be partially and even completely taken by machines and a significant portion of the workforce will be negatively impacted. Because of the overwhelming positive changes that Industry 4.0 will bring to humanity, it is impossible and, would arguably be, immoral to try and stop progress. The world economic forum estimates that 65% of children entering primary schools now will grow up to work in jobs that do not yet exist (Nature, 2017). According to the International Labour Office (ILO), the debate on the future of work is crucial because of: (i) changes associated with the world of work, which are explained by causes such as technology, demographic challenges (with the emphasis on aging, which puts social protection systems under pressure), persistent globalization, migratory processes (and growing obstacles to them) or climate change; (ii) the inability of ordinary citizens to influence the ongoing changes; and (iii) it is crucial 'to meet the criteria and the imperatives of social justice' since the world of work is becoming more unfair and more unequal (ILO, 2008). This is where leadership in employee recycling and even total educational reform is fundamental. The 2014 Conference Board International survey of challenges facing CEOs identified "human capital as an enterprise-wide driver" as the top-ranked challenge globally and also highlighted the extent to which "a talented, engaged, and properly motivated workforce is critical to success" in addressing this issue and also the next three issues in order of priority, namely, "customer relationships, innovation and operational excellence" (Mitchell *et al.*, 2014). More highly skilled IT professionals are needed. Reskilling and upskilling personnel whose skills will potentially become obsolete should be done incrementally and ahead of time so as to avoid 'change fatigue'. At the same time, history teaches us that relying significantly on algorithms can have unforeseen and unplanned consequences should they fail. As a failsafe, present industrial know-how painstakingly accumulated through thousands of hours should be preserved. Governments, corporations and members of the workforce should all be involved equally. At the government level, the leadership should create the right environment through tax incentives, labor laws, etc. for corporations and individuals to take advantage.

One of the key components and enablers of smart industries is connectivity through the Internet. Without access to the Internet, people and small businesses cannot participate fully in the third industrial revolution let alone the fourth. Yet some 3.4 billion people – about 50% of the world's population are still not online. Closing this digital divide remains overwhelming, complex and multidimensional. This has exacerbated the economic inequality in some countries and even led to unrest and a refugee crisis. Leaders will have to ensure that a collaborative, multistakeholder approach is taken to overcome the following barriers: internet inclusion, infrastructure, affordability, skills, awareness, and cultural acceptance and relevant content.

ENVIRONMENT

Social responsibility in the context of environmental sustainability has become a buzzword in the last decade. Most countries have now passed the point whereby sustainability is seen as a painful and not urgent goal to one which promises a better quality of life, prosperity and well-being. It has now been widely admitted by economists and social scientists that the critical goal of sustainable society should be achieved for humanity's ultimate welfare via resource-sustainable, eco-sustainable, and welfare-sustainable development paths (Meng, J., 2015). World leaders are now directly involved in the fight against climate change and have signed commitments to reduce their greenhouse gases. What makes environmental sustainability even more important in the Industry 4.0 is the fact that the last three industrial revolutions were possible because the world did not have to worry about sustainability. Essentially the world's resources subsidized the past three industrial revolutions. Huang & Li (2018) identified three concepts which will require the urgent attention of corporate and supply chain leaders namely:

1) Environmental innovation strategy: this concerns the development of green products and/or processes, and identifies strategic decisions related to environmental management. This kind of strategy should reduce any negative impact on the environment while increasing the competitive advantage if firms

2) Green innovation performance: This is the extent to which green products or processes compete in the marketplace as a result of a firm reducing its overall environmental impact

3) Resource alignment: This aspect of business administration relates to the extent to which a firm's own resources are compatible with that of its partners along its supply chain.

Society is now counting on the very same systems enabling Industry 4.0 to solve our sustainability problems. Innovations in the fields of renewables, agrarian engineering, recyclables/materials science, greenhouse gas reduction/conversation, biodiversity preservation, to name just a few, will be necessary to not only reduce/eliminate the destructive effects of industrialization to the environment but also, rejuvenate/repair nature's ecosystem.

CONCLUSION

Leaders with and without titles stand to play a key role in the journey of adopting the technologies that Industry 4.0 brings to the table. Sustainability consists of three dimensions: economic, social inclusiveness and environment. The economic aspect of business strategy was traditionally seen as being in direct competition with the two other dimensions. This paradigm has changed, and leadership is key to drive those mindset and operational changes. There are several critical challenges that should be addressed before FIR can be certified sustainable. In this age of rapid change, no one can predict what the future reserves for us, except for the fact that change will remain a constant.

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