

## SUSTAINABLE BUSINESSES ENHANCED THROUGH DIGITAL TRANSFORMATION AND ARTIFICIAL INTELLIGENCE IN THE CONTEXT OF INDUSTRY 4.0

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### Abstract

The paper analyzes the interplay between Sustainability and Digital Transformation that is happening now in businesses around the world. We look into recent developments and how businesses strive towards sustainability; we investigate how the Digital Transformation process is implemented and what are its outcomes. We outline the Sustainable Development Goals, with focus on the Digital Revolution. We note the recent rise of Artificial Intelligence(AI), and how it enables the achievement of this Digital Revolution but acknowledge that it comes with a cost, sometimes unquantifiable.

These solutions tend to provide only an incremental, cost-saving and temporary advantage, as most companies work to improve the core business. In order to improve results and be more efficient, companies have to approach automation differently, based on systems of analysis and thinking, focus on growth and enforce teams.

Digital transformation is the first step towards operational efficiency and transparency, and repetitive process automation would bring more discipline and efficiency. It is important to find out what systems are appropriate, who wants to implement digital solutions and discuss the challenges involved in transforming the business.

We end the investigation with a set of conclusions, in the context of a holistic, interconnected world, where everybody is responsible to reach sustainability.

### Keywords

Digital transformation, Sustainability, Artificial Intelligence, Sustainable Business, Change Management

### JEL Classification

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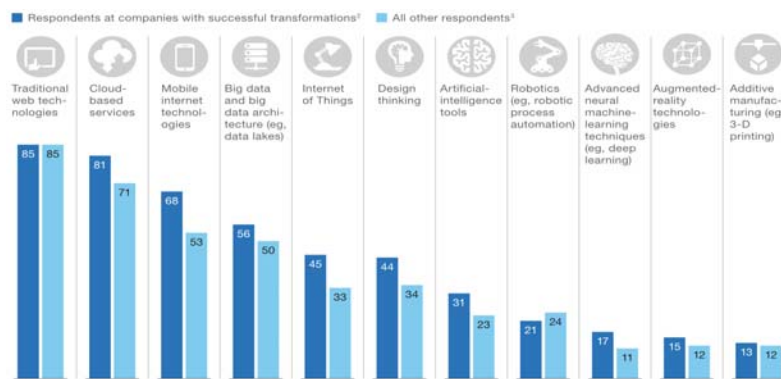
## Introduction

In the past decade Digital Transformation has become one of the key elements for businesses all over the world, this concept being embraced from the smallest companies to the most renowned multinationals. We refer to digital transformation as the integration of digital technology into all areas of a business, fundamentally changing how it operates and delivers value to customers (Grab et al., 2019).

The goal of keeping digital transformation impact on society positively motivates research in many areas, from economics and law to technical topics such as verification, validity, security and control. As digital technologies start to reshape industry after industry, companies are making efforts to keep up and benefit from these trends while also staying competitive.

According to a survey done by the McKinsey Company (Fig. no. 1) regarding digital transformation, more than 80% of the people interviewed stated that their companies have made considerable efforts in this direction in the past five years.

However, the success of these transformations has proven to be elusive. For example, previous research by McKinsey Company showed that less than a third of the companies who implemented digital transformation actually succeeded in improving performance and were able to maintain these improvements. Furthermore, their recent results proved that the success rate of digital transformation is even lower. Success rates vary depending on the company size: a small organization with less than 100 employees is more likely to report a successful digital transformation (2.7 times more) than an organization with more than 50.000 employees (McKinsey & Company, 2018).



**Fig. no. 1. Digital technologies, tools and methods currently used by organizations**

Source: McKinsey, 2018. <https://www.mckinsey.com/business-functions/organization/our-insights/unlocking-success-in-digital-transformations>

Even though digital transformation is at times difficult to achieve, in the last 10 years it has become one of the key pillars for businesses all over the world, being embraced from the smallest companies to largest multinationals (Marquardt et al., 2018). We often hear about the association between technology, transformation and artificial intelligence. Are they effective, can they help to obtain a sustainable and harmonious, long-lasting business?

## Research Methodology and Paper Organization

The paper is based on qualitative research that supports an in-depth understanding of the situation investigated and the use of Artificial Intelligence in developing sustainable businesses. AI is at the forefront of today's interest in companies. The researchers' analysis is based on literature review, empirical data is collected via self-inspection and reflection of own experience, and on specialized consulting companies that promote new business sustainable development tools. Figures are given using very recent reports (2017-2019) by

large consulting companies (PWC, McKinsey) or governmental or independent agencies (European Environmental Agency, Center for Climate and Energy Solutions, etc). General guiding principles come from peer-reviewed publications (2015+). The main sustainability goals (including the Digital Revolution which is our focus) are discussed based on the reference work provided by The World in 2050 (TWI2050, 2019), a global research initiative supporting the United Nations' 2030 Agenda.

This paper defines and researches the concepts of Artificial Intelligence and Sustainability, in the context of Digital Revolution and the enablement of sustainable business development. We are focusing on the economic/sustainability cause-effect, but other aspects are briefly reviewed as well (e.g. environmental and societal issues). As the main investigation point is the effect of AI in Digital Transformation and Sustainability, both these aspects are discussed separately before analyzing them jointly. Finally, the authors draw a number of conclusions based on the investigation.

### **Digital Transformation through Artificial Intelligence**

Digital Transformation refers to the strategy adoption of digital technologies with the final purpose of improving processes and productivity, delivering better customer and employee experience, managing business risk and controlling costs. The first phase of Digital Technology journey started around the mid 20<sup>th</sup> century and lasted until the 1990's. The second phase started with the advent of the Internet Age. Today, it encompasses a variety of solutions, tools and processes that can be tailored for each company according to its needs.

Why is digital transformation important? To remain competitive on a global marketplace which changes continuously, you have to adapt and embrace new technologies in your business. IDC estimates that worldwide spending on technologies and services that enable digital transformation will reach almost \$2 trillion in 2022 (IDC, 2018).

In a report published by PWC in 2018, 80 ways were identified in which Artificial Intelligence, the latest tool in the digital transformation toolbox - can help the environment. Some of the exciting areas include energy system load prediction and distribution, smart mass transport, predictive urban planning, "hyperlocal" weather forecasting for crop management, supply chain monitoring and transparency, just to name a few (PWC, 2018).

Looking back, the first notable steps towards artificial intelligence were taken in the 1940's. Today, AI has become ubiquitous in our lives, quietly helping us in our daily routine. As Celine Herweijer (Partner, PwC UK Innovation and Sustainability Leader) and Dominic Waughray (Head of Public-Private Partnership and Member of the Executive Committee World Economic Forum) affirm in their paper (Fourth Industrial Revolution for the Earth, Harnessing Artificial Intelligence for the Earth), AI has moved from research labs (in vitro) into our everyday lives (in vivo) due to six converging factors: Big Data, Processing power, A connected globe, Open-source software and data, Improved algorithms and Accelerating returns. These preconditions were met each in its own time; this is why AI, while an old concept, is only now exploding in every field around us. For example, our phone has smart GPS navigation, AI-powered photo corrections, or tailored music and movie recommendations. One effect of this is that even non-technical executives are accustomed to it and are thus aware of its potential value (PWC, 2018).

This means that now we have networks that can automatically read house numbers in pictures, understand handwriting and drive a car on a road. Show a network examples on how to segment and parse text and it will be able to help you with grammar (Boros et al., 2018). Or, show a network the second-by-second energy demand of a country and it will be able to predict with high accuracy what demand will be in each city in the following hour, day, or even month. This is achievable now; other things, like predicting the weather, will get better as time goes by, as more data is collected and as algorithms improve.

The truly enabling power of AI is the predictive power, and this is what is the true game-changer for industry and companies in general. Before AI, companies relied on crude predictive statistical algorithms, or, in the vast majority cases, on no algorithms at all. We were reactive. In the AI-age we have access to unprecedented predictive powers – this allows us to be proactive – a game-changer moment, unique in history.

However, we're only in the early days of this age. In 2019, PWC conducted a different survey amongst global executives that showed that 54% of them were making significant investments in AI (PWC, 2019). Another analysis made by Tractica, indicates that annual revenue generated from implementations of AI software will increase from 1.4 billion in 2016 to 59.8 billion by 2025. This means that organisations that continue to invest in tools, data optimization and AI-enabled innovations have their income expected to grow. But, investments and innovations are meant to keep a business viable. A viable business is sustainable.

### **Sustainability trends**

In the last two decades the importance of sustainability defined as a business issue has grown significantly. More and more businesses have begun to understand that their success is based on three core elements and each of them must be carefully considered in relation to the others: Environmental Protection, Social Development and Economic Development.

Since sustainability problems have become significant for a business to succeed, companies are realizing that they can't „walk” alone. So it is up to each organization to address the main sustainability issues through their strategic networks. When it comes to sustainability there is no “one right solution” and the best options depend on each company's stakes and objectives. Prof. Knut Haanaes proposes eight actions for all management teams to improve sustainability practices (Haanaes, 2016). He affirms that by respecting transparency, aligning strategy and sustainability, putting compliance first then competitive advantage, being reactive to proactive, paying attention to quantity, including business case, engage the board and your ecosystem and finally - and most importantly – engaging the organization broadly, companies will be able to succeed in this major challenge called sustainability.

The good news is that lately more and more companies are beginning to adopt the idea of sustainable practices including environmental factors, worldwide, across all industries. 62% of executives consider a sustainability strategy necessary to be competitive today, while another 22% think it will be in the future (Haanaes, 2016). Given most companies' disclosures, they seem geared towards AI and the opportunities it enables. Interestingly, the vast majority does not mention any AI risk at all in their Companies Sustainability Reports.

For example, bias is a sustainability risk. Bias happens when the machine learns patterns that are based on age, race, gender: credit scoring in banks uses different levels of AI routinely to determine credit risk. Biased algorithms could lead to unfairness towards specific groups, an action that is prohibited by law and is punishable. To prevent this, companies must ensure unbiased data as well as unbiased algorithms. Furthermore, as sustainability reporting increases or even becomes mandatory, companies should be encouraged to report these extra aspects, like algorithmic fairness, third-party certifications of usage of unbiased algorithms, as well to specify what software they use and quantify energy expenditures based on it.

Taking a step back and looking at the four pillars of sustainability: Social, Human, Economic and Environmental, it is a known fact that AI will contribute significantly to the Economic pillar through improved production, maintenance and prediction (Sachs, 2015). The Environmental pillar will also benefit in mid-to-long term from AI, as prediction power and interconnected smart devices will bring a significant change in how we produce and distribute energy, on how we move, on how we treat the agricultural soil or on how we monitor and clean our water supply. Short term, the increased power consumption and unclear or non-existing policies will minimize the gains brought by AI. The Human pillar will benefit from

AI in the form of improved, tailored life-long learning (education, re-skilling) and better healthcare through personalized diagnostics or AI-enabled drugs and treatments breakthroughs. The Social pillar is not so direct; the maintaining and improving of social quality by cohesion, reciprocity, honesty could be seen as being improved by online social networks, but care must be taken as it will exact a toll on direct relationships and change the way a society feels and interacts.

Returning to the direct sustainability effects of AI, the biggest concern is that given the guaranteed production increases, this extra wealth would be distributed evenly. Unfortunately history has shown that the vast majority of businesses/governments act in direct economic self-interest: without a mindset change we shouldn't expect an AI-powered organization to give up proprietary knowledge or to invest the majority of profits into society or environment. However, there is hope. Big companies are open-sourcing (some) algorithms, NGOs are pushing towards AI transparency, accountability and fairness, all the while investors, through ESG analysis, and social pressure, through environmental and social awareness, are pushing economic entities to change this mindset and incorporate sustainability as one of their goals.

**The Digital Transformation and Sustainability interplay**

We often hear about Sustainable Development Goals (SDG) and the impact they would have on society. When we refer to SDGs we are actually talking about six fundamental transformation ideas known as the major drivers of the future changes: Human Capacity & Demography; Consumption & Production; Decarbonization & Energy; Food, Biosphere & Water; Smart Cities; and the Digital Revolution. These are the directions identified by the TWI2050 as distinct operational areas that, if reached, would transform our society into a sustainable one, that would serve and empower both its people and the environment (TWI2050, 2019). Crucially, the path forward depends as much on policies and our will to enact them, as on the *science* that will enable true (both digital and non-digital) transformations.

Thus, digital transformation has an added goal: improve my business while, at the same time, make it more sustainable. Looking at the sixth Sustainable Development Goal, the Digital Revolution, this interplay of transformation and sustainability is clearly defined in its scope: „Science, technology and innovations are powerful drivers, but the direction of change needs to support sustainable development” (TWI2050, 2019). This Revolution embodies all the newest state-of-the-art technologies that bring true change in the world. The digital transformation however is not a holy grail that needs to be adopted at all cost; its development has to be planned, to balance out the needs of the business, employees and environment. As a quick example, supercomputer centers need a large amount of power which today comes from fossil fuels. Furthermore, making the center „smart” by implementing the latest technologies in the digital transformation toolbox (automatization, robots, predictive maintenance, etc.) will have a direct impact on the number and qualifications of the center’s employees. Do we accept that there will be fewer employees? Where is the threshold between CO<sub>2</sub> emissions and raw processing power, and, if so, who decides it?

In what follows we look into each of the top 3 sustainability problems today and analyze it from a digital transformation / AI point of view, highlighting sustainability goals.

**Table no. 1 Top sustainability problems in terms of GHG emissions**

<i>Energy</i>	Energy production (of all kinds) represents 72% of all emissions. At a global level, this energy is mainly used for direct electricity and heat (31%), agriculture (11%), transportation (15%), forestry (6%) and manufacturing (12%) (Center for Climate and Energy Solutions, 2017). Considering that ~68% of the electricity produced
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	comes from fossil fuels, looking into how we could decarbonize this industry is essential.
<i>Transport</i>	In 2017, 27 % of total EU-28 greenhouse gas (GHG) emissions came from the transport sector, and the EU is considered as one of the most pro-environment geopolitical entities. Current emissions need to fall by ~60% by 2050 to meet the long-term 60 % GHG reduction target as set in the 2011 Transport White Paper (European Environment Agency, 2019).
<i>Industry</i>	Industry consumes energy to convert raw materials into goods (cars, clothes, steel, etc.). For example, 22% of US’s GHG emissions are caused by industry (IPPC, 2014).

Source: *The Digital Revolution and Sustainable Development: Opportunities and Challenges*.  
International Institute for Applied Systems Analysis (TWI2050, 2019)

**Energy → Decarbonized, streamlined energy:** Decarbonizing the energy system is one of the main goals towards the SDSs. Though alternative sources like nuclear and solar are on the rise, they are not enough to offset the increased demand brought by the Digital Revolution, and thus GHG emissions are constantly increasing. A concerted move towards the transformation of the energy sector has to happen, and has to target both the energy source (replace fossil fuels with non-polluting alternatives), as well as the redesign of the energy field. As smaller plants appear (geothermal, hydro, down to home solar panels), the standard producer-consumer paradigm has to disappear as the roles become interchangeable. Powered by AI, the digital transformation of the energy becomes achievable: the reduction of operation and maintenance costs, improved power plant efficiency, reduced blackouts, smart demand-response of the power grid that proactively configures itself in real time. The streamlining of the energy sector is central; transport, industry as well as every other field are dependent on it – thus, digital transformation has to happen here first, guided by sustainability principles.

**Transport → Smart transport:** A real revolution is on the horizon in transport. As vehicles become electrified, as well as interconnected, as they start to be able to drive themselves thanks to increasingly better AI computer-vision algorithms, they become controllable elements that a digital transformation can control and optimize. For example, a smart city will have a smart mass-transport system, that will adapt in real-time to passenger demand, with driverless trams, metros and buses. AI is at the core of this control system. Such a change will bring with it less emissions due to not only electrified vehicles, but less vehicles needed to move the same amount of people and goods. Looking further, at shareable self-driving cars (another answer to the overcrowding of our streets), we see that AI is essential, but not sufficient: people need to approve of the shift from self-ownership to shared-ownership, and this has to be guided by policy as well.

**Industry → Sustainable Industry 4.0:** Industry will see a major revolution as well. The digital transformation has brought many changes so far, but the biggest one will be the full integration of AI (Kiehne and Olaru, 2017). For example, most waste is generated by the supply chain. Interlinking all actors in a single framework will lead to less overproduction waste as producers would produce only what will be needed by consumers with the help of AI-powered predictive algorithms. Transporting these goods optimally would be done by AI-generated routes that would maximize load while also having the direct benefit of reducing GHG emissions (as an example, in EU it is estimated that truck load usage is 60%, and every third shipping container sails empty) (Intermodal & Logistics, 2019). Transparency in the produce-consumer chain will increase accountability and thus promote sustainable practices. Machine learning predictive algorithms would be used in all areas to increase production, cut waste, and assist in overall management and operations.

As AI is a revolutionizing force, we have to ask if, sustainable-wise, are there any downsides. These ever-more-powerful algorithms require energy (Vinuesa et al., 2020). The devices they run on become common-place and they too require energy to operate 24/7. Data Centers and networks are estimated, currently, to consume about 2% of produced energy (Grubler, et al., 2018). At present, energy efficiency improvements on devices could keep the demand stable. AI-wise, however, the situation is getting worse, at least for the short term. For example, training a current state-of-the-art Natural Language Processing model emits 87 Kg CO<sub>2</sub>, and running a single instance for a month will emit much more (UKEssays, 2020). For example, Google's search, which is used millions of times a day, is partly based on such models. As this problem is very new, only recently has AI sustainability come into focus, with attempts at creating more energy-efficient models. Overall, because AI is so novel and under constant evolution, its full impact on the SDGs is difficult to quantify and reliably predict.

### Conclusions

We have presented the Digital Transformation concept with focus on AI, and its interplay with sustainability. As we are currently experiencing the beginning of the Digital Revolution, we need to be aware that it is happening, and guide it such that it will enable, among other, our sustainability goals.

Based on the analysis presented in this paper, we recommend the following high level action items for participating entities.

For *governments*, it is essential that they streamline their decision taking process regarding targeted policies and regulations; they should provide open data; sustainability should be taken into consideration more when deciding large-scale policies. *Companies* need to integrate environmental awareness into their strategy jointly with their digital transformation and AI goals; prepare employee retraining programs to account for AI integration. *Academia and AI developers* should refocus and look at a bigger, multi-disciplinary picture; provide transparent access to data and algorithms; focus on practical applications of AI together with industry partners.

We draw the following conclusions, that executives should take into account when designing their digital transformation agenda:

- Digital Transformation is a process that will happen naturally in businesses. While difficult, this process will happen, either *proactively*, directly pushed by CxOs, or *reactively* by indirect pressure from competition and ESG-aware investors.
- Digital Transformation is *not guaranteed to succeed*. It is a difficult and constant process of change that must be handled carefully, as past history has shown.
- It is up to leaders to enact policies (both governmental and in-company) such that Digital Transformation will make a *sustainable* change.
- AI, the newest tool in the Digital Transformation toolbox, will be *disruptive*. It provides the means to achieve the Digital Revolution.
- Like any revolution, *AI comes with a cost*. Besides the direct energy costs that can be measured and contained, the changes in society will have an ethical cost, and people will have to adapt.
- Transformation towards a sustainable future is possible, but *action is required* from all stakeholders. Because everything is integrated in the connected world, the grand transformation requires a holistic perspective (TWI2050, 2019).

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