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► **To cite this version:**

Eunika Mercier-Laurent. Greening and Smarting IT - Case of Digital Transformation. IFIP International Workshop on Artificial Intelligence for Knowledge Management (AI4KMES), Aug 2021, Montréal, Canada. pp.1-18, 10.1007/978-3-030-96592-1\_1 . hal-03496816

**HAL Id: hal-03496816**

**<https://hal.science/hal-03496816v1>**

Submitted on 9 Jan 2022

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# Greening and Smarting IT – Case of Digital Transformation

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**Abstract.** The recent concern about the Planet condition and climate change does not include in the debates the pollution induced by technology and innovation. Green Deal and Deep-Tech Digital Transformation (DT) are among the strategic topics of the European Union program Horizon Europe. They cover various fields that are not fully represented in the calls for proposals. Digital transformation offers a great opportunity for disruptive innovation, but consideration of the environmental aspects in the whole process may help better controlling the environmental impact. Eco-innovation actions focus mainly on smart transportation, smart use of energy and water and waste recycling but do not consider the necessary evolution of behaviors. While technology produces twofold effect – benefits and waste, the capacity of available technology and in particular Artificial Intelligence for related complex problems solving is underexplored.

The objective of this research is to provide the AI-based methodology for Smart and Green Digital Transformation. This paper explains how the knowledge-based AI and connectionist approaches and techniques combined with adequate thinking may innovate the way of managing DT in industry, administration and in other contexts and improve the effectiveness of efforts in sustaining the Planet.

**Keywords:** Artificial Intelligence, Digital Transformation, Method, Sustainability, Sustainable Development, Planet Crisis, Climate Change, Data Obesity.

## 1 Introduction

The participants of recent COP26 aim in accelerating action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change. Increasing frequency and strength of natural disasters is a complex consequence of decisions taken at governmental and other levels and of human behaviors as well.

From the beginning of intensive industrialization after the second war some alerts have been raised by among others Antonina Lenkowa [1] and Erik Eckholm [2] trying to explain to governments and people the various and heavy consequences of such intensive industrialization.

Since the world population has tripled. Globalization amplified by technological progress leads to increased transportation of goods and of persons. Many focus on business

only. Despite the large introduction of Corporate Social Responsibility, some companies still practice planned obsolescence to generate more revenues [3]. Is getting huge and quick revenue compatible with Planet protection?

Technological progress facilitates communication, sales online, but also generates lot of visible and hidden waste [4]. Numerous reports elaborated by WHO [5], OECD [6] and GIEC [7] and conferences including the recent COP26 alert again about the state of our planet Earth. Intergovernmental Panel on Climate Change (IPCC), the UN body was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation option. It is composed of several working groups including one multidisciplinary. Through its assessments, the IPCC determines the state of knowledge on climate change. It identifies where there is agreement in the scientific community on topics related to climate change, and where further research is needed [8]. However, the involved stakeholders focus mainly on carbon dioxide generation, but it is only one factor. Main conferences devoted to climate change blame coal and automotive industry as the biggest emitters of carbon dioxide. They seem ignore the other influencing factors such as globalization and miss to study the pollution systems as a whole.

In reality the addressed problem is very complex and effective solving it requires collaboration of specialists from various fields, deep understanding and actions, not only recommendation and reports.

While the information technologies including artificial intelligence are ubiquitous they are weakly considered as a source of pollution. Computers and other devices are designed to be changed often. Data centers generate heat due to increasing data obesity. There is a lack of “garbage collector” cleaning outdated, duplicated and false data.

Advertisement-based business model produces “invisible” pollution via cookies, not targeted emails, social networks influencers’ and other trends.

On the European level the program Horizon Europe addresses Digital Transformation and Green deal separately; submitted projects are evaluated by experts in related fields what limits the opportunity for disruptive innovation. The recent posts on twitter show emerging synergy between two programs [9].

After discussion on the main contribution of IT to Planet Crisis, the case of Digital Transformation and Green Deal are analyzed applying ecosystem approach. Some elements of AI-based methodology are proposed and commented before the final perspective for the future work.

## **2 Sustainability and Climate Change – Current Efforts and Influencing Factors**

In general manner sustainability is about the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. The practice of sustainability recognizes that these complex issues are interconnected and requires a systems approach. Indeed sustainability depends on how human activities are in balance with natural ecosystems and how they affect biodiversity and our biosphere [4].

The International Standard ISO 26000 provides guidelines on how businesses and organizations can operate in a socially responsible way [10]. While it constraints companies to integrate social and environmental aspects into their activities, for ex. design, they should also focus on balancing it with their economic performance. These guidelines are complex and it is very difficult for a small company to check and respect all these principles without losing business.

Introducing the environmental principles into a design of electronic devices and related services is a step forward. However, the traditional PLM (Product Life Management) tools should evolve to take into consideration a new way of doing [11] by using alternative thinking, simulators before doing and optimizers. Future Factories are supposed to evolve in this direction [12, 13].

### **2.1 Influencing Factors**

Globalization, innovation and IT are weakly considered as strong influencing factors by all conferences and debate on Climate Change.

#### **2.1.1 Globalization**

Focus on profit “World companies” have changed the economic landscape. Opening to business and quick development of China and other Asian and South American countries offering the low labor cost increases the relocation-out from origin countries, mainly US and Europe, in search of quick and high revenues. Such business relies on not always optimized transportation across the world by ships and airplanes, which increases pollution [14]. Besides, the end-buyers have to recycle products, often of poor quality, made just for sale. Repairing them costs often more than new product and requires the availability of spare pieces and related tools and expertise. Many integrate embedded planned obsolescence.

Huge global business amplified through communication technology, e-commerce, and transportation facilities. The each day of recent Suez Canal blockage disrupted more than \$9 billion worth of goods, according to The Associated Press, citing estimates from Lloyd’s List. The large number of ships stuck in one place — at the northern end of the Suez Canal in the Mediterranean Sea — caused Sulphur emissions to spike in the region [15]. Route through North Pole will increase of ice melting.

The knowledge of adequate techniques of AI and expertise in applying them can help finding and optimizing the local resources in aim avoiding or minimizing transportation of many goods and enhance local economy. AI is also useful for optimizing logistics. Covid pandemics demonstrated clearly the need for relocation in, especially for electronic components in Europe.

### 2.1.2. Innovation

Despite the provided benefits, the innovation is among contributors to planet disaster, because the inventors and designers think mostly about the functionalities, shape, look, attractiveness, and few about minimizing the use of raw materials, reducing the energy consumption, providing the remanufacturing and recycling facilities and other ways to reduce environmental impacts. “Innovation” in packaging by reducing the quantity of a given product (food, ink) in more attractive box produces more waste.

The primary eco-innovation movement claims to generate new businesses and jobs but the use of technology in the related activities is moderate, except maybe for waste sorting [16]. Instead of sorting, it is smarter to produce less waste. The standards associated with product lifecycle management (PLM) software claim to manage environmental impact of the design [17]. Autodesk is probably among the pioneers of industrial convergence including constraints into design [18]. However, they do not consider yet the environmental and recycling constraints.

The industrial renewal in Europe called Industry 4.0, initiated by German government to face Asian competition, focuses on digitalization and optimization of related processes. Therefore, eco-design is included into Industry 4.0 [19]. Future factories, such as those at Vaudreuil of Schneider Electric and Safran in France integrate a lot of AI, preserving principle of collaboration human-machine, instead of replacing humans. Cyber physical systems allow simulate and improve maintenance of existing equipment and design [12, 13 and 12].

Technological progress, considered as powerful engine of economy produces twofold effect. It provides benefits for humanity in many fields, but contributes also to Planet Crisis with massive waste generation, energy consumption, generation of heat by data centers situated mainly in the north and depletion of scarce metals. The enthusiasm of the users for novelty and recently for AI lead to sometimes hidden waste.

## 3 Twofold effect of Information Technologies

Information technologies have provided a considerable help for humans in various contexts, such as administration, businesses, schools, research, health, cities and many others. Everything digital and connected is everywhere, even if it is not necessary. Thanks to IT many activities went online during the Covid pandemics. This experience demonstrated that it is possible to reduce traveling and optimize between telework and work in office. Although records from meeting and conferences are registered and stored contributing to data obesity.

Related to innovation, technology is able to enhance creativity (generator of ideas in [20]) and provide a considerable help in eco-design, verifying constraints before implementation, optimizing design, reparability and recyclability. However, the way of thinking compatible with such complex problem solving should combine the global, holistic and system approaches [4, 21]. For example, aerospace and automotive industries focus on lightening weight and reducing carbon footprint, while other related aspects such as route optimization for users are weakly considered. Current travel search engines works for their clients, not for travellers. The air transportation system “hub-and-spoke” in which local airports offer air transportation to a central airport where long-distance flights are available, need innovation to minimize the distance and related CO<sub>2</sub> emission. The effort can be done through better collaboration between airlines. Three main alliances Sky Team, Star Alliance and One world do not accept combining the flight tickets between them for optimizing flights distance.

The AI-based simulators can help checking and optimizing things. Such system has been prototyped in the framework on French national funded project Convergence [17] that delivered a game-based guide for SMEs aiming in guiding them in applying ISO 26000 requirements related to eco-design.

Amazon claims reducing carbon dioxide emission by using technology in the whole cycle of sales [22]. Although, they also contribute to CO<sub>2</sub> generation. Total balance is not published.

The initiatives as buy local, sharing knowledge on repairing via video and numerous applications, such as Uber, wonolo [23] and some others, connect people offering services or jobs with those who need them. It is quick and effective. Some platforms connecting offer and demand use AI techniques such as Case-based reasoning or deep learning for direct matching (e-commerce, job finding, talent finding, travel, help desk) [24,25].

Games and serious games (with AI) have also potential to encourage people to think and act differently. For example, the game Nega-water developed by association Du Flocon à la Vague calculates the use of water when doing daily activities [26].

However, the majority of computers, smartphones, IoT and other electronic devices are mostly not eco-designed, except Xiaomi Modular smart phone (see Fig. 2) and even integrate a principle of planned obsolescence. Consequently they are thrown away and replaced by the latest models. Not conceived with knowledge approach, the consecutive layers of software and frequent update for various reasons increase already existing “obesity” and generate a need for more powerful computers, smartphones and other devices. The combination of various communicating software requires “up-to-date” hardware to run correctly. Software is so complex that it is impossible to remove not-used parts (ex.Windows).

While web 2.0 brought useful services, the massive appropriation of social networks and various applications produce an exponential amount of data stored in data centers that need cooling. Fortunately, few apply circular energy to reduce environmental impact [30], but still those in Scandinavian countries and North America clearly contribute to the rise of temperature and melting of ice [4].

The third hype of AI has been mostly triggered by marketing needs to sale more and quicker to largest public. The involved companies collect all available data in aim to elaborate models and selected algorithms to support the whole acceleration and amplification of business including “client experience”. Covid 19 pandemics amplified also online shopping...and need for transportation.

The advertisement companies explore the navigation data and “client experience” in aim pushing not always targeted advertisement to large population of the Internet users. It generates not only carbon footprint, but also visual pollution and certainly influence concentration. According to [27 and 28] simple email without attachment generates equivalent of 4g CO<sub>2</sub>, annual google search 10 kg by only one person.

Advertisement-based business model, invented by Google influences and mass media promotes the “buy more” and “to have more and to show” mentality. “Buy more, throw away and buy new” are the engines of today business. The demand for data scientists, especially in marketing is increasing, which is good for employment.

The trend of “Data and machine learning” affected also the problem solving capacity among the AI programmers to the point that many apply Big Data + machine learning principle to solve all kind of problems even if the alternative methods, greener and smarter are available. Collection of data became a prerequisite. However, their quality should be adapted to the expected results without cheating aiming in influencing the results and producing the famous bias. Raw data need “cleaning” before processing.

In fact, the quality of data is not controlled – there is not “garbage collector” for outdated data, no verification of consistency, and no selection in function of target. For example, many organizations collect our personal data that are in various database instead of having just one (identity). By consequence the same data may be registered a dozen of times, contributing again to data obesity.

Artificial Intelligence plays already a significant role in decision support systems, optimization, simulation, but can do better at the condition to consider the mentioned elements as an ecosystem. It requires a capacity of different thinking without the barriers between fields [31], complex problem solving, art of choosing appropriate techniques and managing available knowledge and experience that apply.

Digital Transformation and Green Deal European programs provide an opportunity to do things differently.



## 4 Digital Transformation and Green Deal

European Union strategy includes two ambitious programs: Digital transformation [32] and Green Deal [33]. The first includes Industry 4.0, next generation of aircraft, transformation in design, manufacturing, integration and maintenance. Green Deal focus mainly on energy, water, transportation, among others. However these two topics are interrelated.

### 4.1 Digital transformation

According to IT businesses Digital transformation is the process of using digital technologies to create new — or modify existing — **business processes, culture, and customer experiences** to meet changing business and market requirements. This definition clearly focus on business and lacks of considering environmental aspects.

Oracle mentions five large fields concerned by digital transformation: manufacturing, retail, healthcare industry and smart cities.

“In manufacturing, IoT can improve efficiency and profitability by enabling predictive maintenance and process improvements that reduce downtime and scrap while ensuring the production of high-quality goods. Augmented reality solutions enable superior and less-costly training and can bring expertise from afar directly into the factory.

In the retail environment, digitalization leverages devices, channels, and platforms to create seamless customer experiences tailored to specific customer needs. Chatbots, AI, and sophisticated data analytics are helping retailers develop and deliver personalized recommendations to successfully appeal to an audience of one. Digitalization is transforming the in-store experience as well, creating an engaging interactive environment and more convenient customer service processes.

The healthcare industry is leveraging a variety of digital capabilities to create patient-centric and value-based outcomes that benefit patients, providers, and payers—while reducing costs at the same time. Virtual doctor visits and networked electronic medical records are just two modes of digitalization that are transforming healthcare.

Digital-enabled “smart cities” that blend existing physical infrastructures with cutting-edge digital technologies are becoming more efficient while providing a safer and better quality of life for their citizens. From utility monitoring to public safety to environmental sustainability, technologies such as sensors, AI, and video analytics are helping the public sector transform the way it provides essential services to achieve greater efficiency, lower costs, and a higher level of citizen engagement” [34].

Such an approach leads to more IT waste and certainly to energy waste. Everything is based on data business.

MIT limits Digital transformation to block chain, IOT, cloud and cybersecurity [35] **MIT]**

European Union elaborated Digital Europe Program designed to bridge the gap between digital technology research and market deployment. It aims in bringing benefit to Europe's citizens and businesses, especially SMEs. Investment under the Digital Europe Program supports the European Union's twin objectives of a green transition and digital transformation while strengthening the Union's resilience and digital sovereignty [36].

The special focus is on Industry 4.0 (digital twins), next generation aircraft, digital transformation in design, manufacturing, integration and maintenance.

Public administration seems to be forgotten, while there are a lot to do including the way of thinking. Usually people has adapt to existing software, "fat" for the most. The smart and green transformation requires evolving the traditional way of thinking and designing application in collaboration with the users [37, 20, 38, and 39].

The current call for proposals The Digital Europe Program [40] provides funding for projects in five crucial areas:

- supercomputing
- artificial intelligence
- cybersecurity
- advanced digital skills
- ensuring the wide use of digital technologies across the economy and society

Supercomputing is necessary because of massive generation of multimedia data. Artificial Intelligence is not a topic per se, but AI approaches and techniques should be integrated in all above points. Cybersecurity requires also AI thinking in terms of understanding hackers methods and maybe modifying their bad attitudes for ex. via games.

Related to skills, the first thing to do is to know what we have and what we need and plan training and education accordingly [41].

While health systems are absent in this call for proposals digitalization and the use of digital technologies is already an important and growing part of most health systems. However, national governments and international health partners are not yet fully unlocking the potential of digital health to scale up access to primary health care services as a pathway to achieve UHC" [42]. The strategy for prevention is also missing.

All mentioned requires "*smart & green IT*" thinking [43]

## 4.2 Green Deal

Another EU program: Green Deal is represented in Figure 1.

It covers nine areas: climate ambition, clean and secure energy, industry and circular economy, efficient buildings, mobility, agriculture, biodiversity and very ambitious

zero pollution. Three horizontal areas are: strengthening of knowledge to support the 9 areas, empowering citizens in transition to climate neutral sustainable Europe and international cooperation with Africa and Mediterranean.



**Fig. 1.** Source [33]

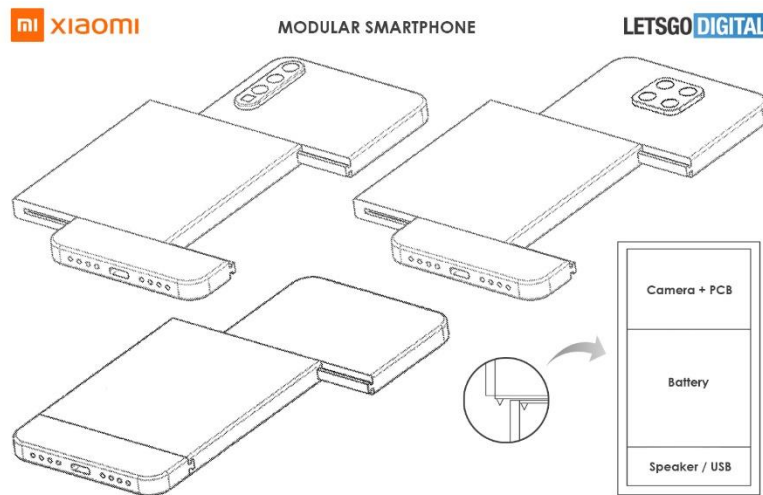
The program ambitions in “transforming the EU into a modern, resource-efficient and competitive economy, ensuring: no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use, no person and no place left behind”.

Expected benefits:

- fresh air, clean water, healthy soil and biodiversity
- renovated, energy efficient buildings
- healthy and affordable food
- more public transport
- cleaner energy and cutting-edge clean technological innovation
- longer lasting products that can be repaired, recycled and re-used
- future-proof jobs and skills training for the transition
- globally competitive and resilient industry

These are just wishful thinking. The actions mentioned on GD website are all connected. Technology is supporting all these areas, but technology is not represented as area [44].

Effectiveness of circular economy is related to eco-design, packaging and depends on business model. Reusing the components requires adequate design. For ex Xiaomi elaborated a “lego-like” smartphone, shown in Fig 2.



**Fig. 2.** source

European eco-design preparatory study on mobile phones, smartphones and tablets proposes a methodology for their eco-design [45].

Extending the principle of circular energy to data centers will be certainly beneficial for Planet and energy users.

Clean energy and water, efficient building houses, public transportation are already considered in Smart City programs and offers [43].

The smart use of AI approaches and techniques may help achieving some of above mentioned objectives.

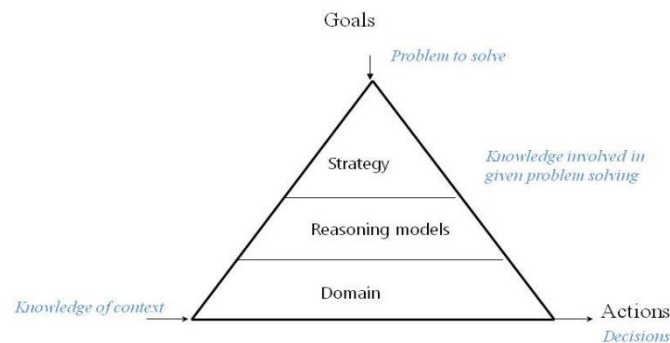
## 5 Contribution of Artificial Intelligence to Smart and Green Digital Transformation

Since its beginning AI researchers and practitioners invented and experimented various AI approaches and techniques for solving complex problems. Most of these techniques shown in Fig 1 in [43] have been successfully experimented for various applications in many fields around the globe. Decision support systems, diagnosis and many others

are now embedded in larger applications such as automated pilot, autonomous car, intelligent building, in drones, translation systems, personal assistants, security and many others.

Knowledge-based AI introduced specific way of thinking and problem solving which is different from those related to exploring databases. For example, managing sustainability requires deep understanding of all influencing factors, relations between them and elements of context, such as policies and human behaviors. Applied to Digital Transformation such approach will be very helpful in smarting and greening IT.

The approach such as KADS [46] combing Newell’s knowledge level, Chandrasekaran’s interaction hypothesis and Clancey generalization, requires defining of a goal and decomposing it into the tasks; each tasks corresponds to a specific reasoning model that will use available knowledge and consider the context to achieve a given goal, see Fig 3.



**Fig. 3.** Source [4]

Building a conceptual knowledge model consists in elaborating related ontology representing concepts and relations between them and reasoning models needed for given problem solving. Such models can be generalized and reused for other applications. It is similar to building a toy from Lego blocks. Modularity, genericity and reusability are 3 pillars of green and smart programming.

Although the third hype of AI is a comeback to data analytics that has been applied for years in industrial safety and reliability [47]. It consists in collecting data first and applying statistics or suited algorithms to “make data talk”. Specialists in marketing were suddenly empowered by analytics and “machine learning” algorithms. As deep-learning requires big data for more accurate results they focus mainly on gathering more data from various available sources about customers to push them more products and services. Collected data is mined using analytics and deep learning software and the results explored commercially. This approach is not sustainable, because it requires a huge amount of data (data obesity) and consequently their storage and cooling, as well as energy for processing.

Third generation of AI includes also evolution of robots – now robots are deployed in many contexts without necessarily having a need for robot capacities. Currently many various robots replace humans including military robots and drones what raise ethical questions [48]. Very few is wondering about sustainability, eco-designing of robots, their recyclability and reparability, availability of raw materials and of electronic components to build “super-robots”.

An “automated” dialog between human and machine was proposed by Turing (famous Turing test) and Weizenbaum (Eliza, 1966) [49], today there is a trend for having a chatbot able to answer the questions of clients and visitors. The designers of “intelligent” assistants implemented this principle. The majority of chatbots explore the ready answers recorded in (again) database, however the smarter chatbots, based on text mining or dialog understanding are coming [50].

Increasing computer power and on cloud storage facilities makes people recklessly producing large amounts of data. Only trendy techniques are used to solve every kind of problems, but the connectionist AI exploring data bases is not sufficient for smarting and greening IT. With main focus on prediction this approach is characterized by ignorance of past knowledge and experience for the quality of obtained results.

Since years, researchers and practitioners of AI have demonstrated the AI has potential to provide valuable solutions for facing today challenges. Since the 1980s, numerous applications in the fields of medicine, chemistry, industry, finance and others demonstrated that AI is able to help human in many situations [51].

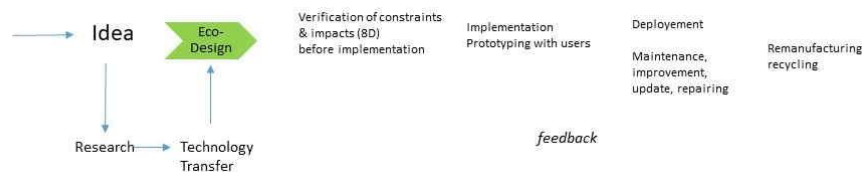
The engineering specialists understood that in many cases it is necessary to combine “data approach” with “knowledge –based” AI for more accurate results.

## 5.1 What AI can do

Knowing the available AI “toolbox” and deep problem understanding combining KADS and global, holistic and system thinking facilitates modularity and reusability and the choice of right technique or combination of them in hybrid systems [20, 53]. For example, using constraint programming for optimizing, planning and scheduling is smarter and more effective than trying to solve it with other techniques. Artificial neural networks are effective to find similar pattern in images, text or in audio file, case-based reasoning for matching local offers of jobs and competency and in intelligent e-commerce application. Some of mentioned techniques are integrated in multi-agents systems (MAS) [52]. They have been used to study and to simulate complex systems in different application domains where physical factor are present for energy minimizing, where physical objects tend to reach the lowest energy consumption possible within the physically constrained world. Furthermore, MAS have been intensively exploited for the analysis through simulation of biological and chemical systems.

Achieving the ambitious goal of greening and smarting IT requires covering the whole cycle of live of devices and software. AI can support all steps of this cycle.

## Hardware

Education  
Training

**Fig. 4.** Device lifecycle (Eunika Mercier-Laurent)

The Fig 4 represents a lifecycle of green and smart hardware.

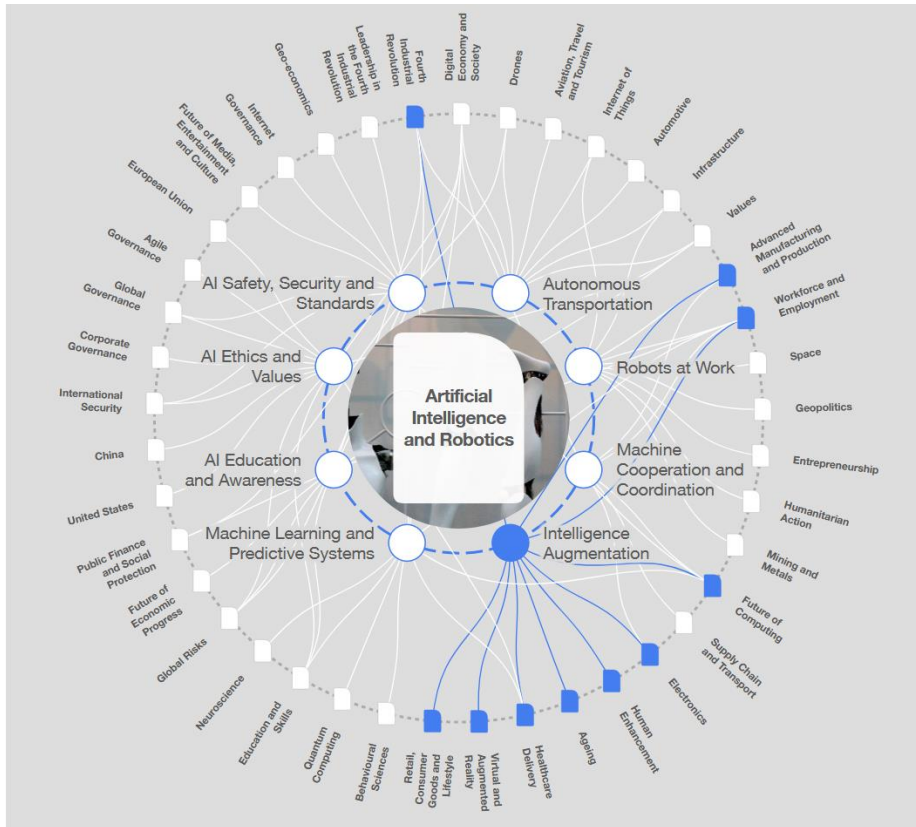
The process begin with an idea: new architecture, shape and miniaturization. In the case of research in general technology transfer of research results to industry is necessary. The next step is eco-design of architecture. The constraints such as market, feasibility, upgradeability, materials (easy recycling), environmental impact and some others have to be verified before implementation. Next steps are prototyping and deployment. It includes also maintenance and improvement in function of feedback provided. The eco-design has to include the end of life: remanufacturing or recycling.

A similar approach can be applied to AI software.

According to El Fallah Segrouchni [54], the AI lifecycle is composed of following steps: research, design, development, deployment, use, maintenance, conversion, dismantling and disabling. Applying of principle modularity, genericity and reusability makes the cycle smarter. Using the right tool from the AI Toolbox contributes to greening. For example, constraint programming is very useful for optimization, scheduling, resource or frequency allocation, timetable and logistics at the condition to know the constraints and the values they can take. It facilitates a real time reprogramming in case of new, strong constraint.

Education plays an important role in optimizing the whole process. Education and continuous learning are the basis for smarting and greening IT. Education should include very early the various ways of thinking and problem solving including finding alternative solution. As IT and AI are everywhere these approaches should be learned from small school. Followed latter by deep-understanding of complex problems and smart problem solving including considering alternative solutions.

AI-based simulation in VR environment effectively support quick prototyping. Simulation helps evaluation of impacts before implementation. An example of such simulation available on World Economic Forum website [55] is presented in Fig. 5.



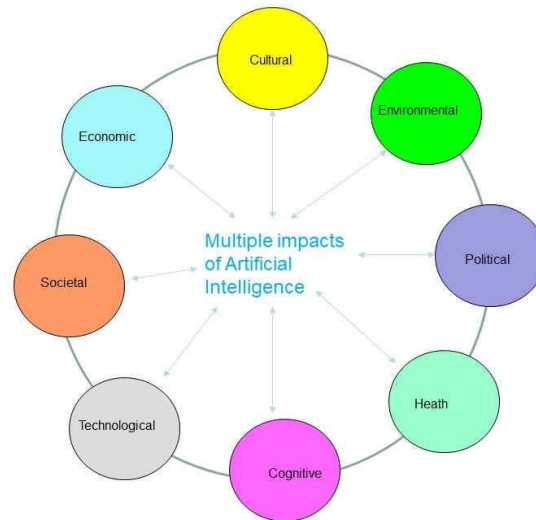
**Fig. 5.** Simulation of impacts, source

<https://intelligence.weforum.org/topics/a1Gb0000000pTDREA2?tab=publications>

This kind of simulation should be applied in many decision support systems. It will be especially useful for decision making at governmental level.

The main impacts of IT and AI are represented in Fig. 6. All are interrelated.





**Fig. 6.** Impacts of IT and AI, source [4]

In the case of sustainability the contextual knowledge on policies in a given country, base of available actions and practice/prototyping should be considered. Taking inspiration from games [56] we can imagine building a Sustainability Support System as a simulator containing various interrelated components to evaluate the impact of decisions for policy makers, planners, organizations and companies. It can be conceived as a toolbox allowing easy configuration in function of the needs and allowing verifying various constraints before doing.

### Reusing

Some of Smart cities opened their data to large public, what is a data recycling for various applications and data-based business. The EU Cordis offer the access to research results [57]; it can provide inspiration for digital transformation in various fields.

Re-using past knowledge and experience seems to be forgotten with ML approaches, thought it could help agricultures and achieving the UN SD goal nb 2 [58]. Technology is not included in 17 goals, but it can help achieving quite all of them [43].

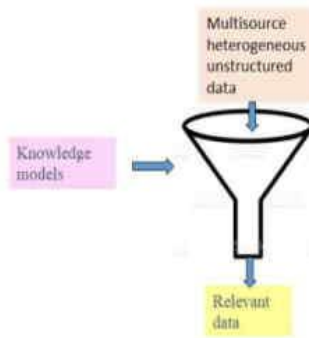
According to Eric Thivart [59] all outdated electronic devices can be partially recycled or reused in the developing countries that lacks computers.

**Repairing** is a key when it is possible. However, it requires expertise and can be supported by videos or AI applications. This aspect has to be considered in the eco-design phase. Since over five years now, French company called Back Market has been working on revaluation of apparently outdated smartphones [60]. Repair cafés multiplies connecting people that need a service or learn reparation [61]. 3D printer services

provide spare pieces if not available for sale (old equipment). Sweden government was probably the first offering the tax reduction for repairing goods.

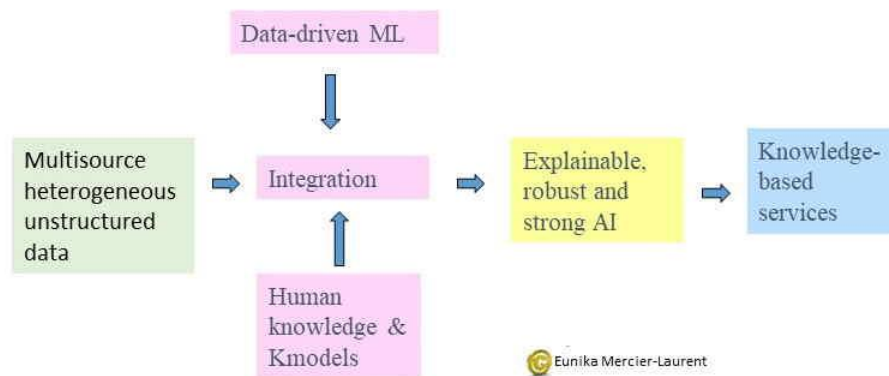
## 5.2 Two tips for greening and sliming data base

AI affects the sustainability. Two aspects of AI should be investigated: negative and positive. Negative consists in being dependent of all forms of computers and of software sometimes unnecessarily complicated; the both quickly evolving for many reasons including planned obsolescence. Collecting and storing exponentially growing data related to web services, for marketing and other purposes can be optimized by alternative green and smart approach to programming, using the suited knowledge models, both for collecting relevant data (Fig 7) and for guidance in “learning”.



**Fig. 7.** Collection of data guided by knowledge models (Eunika Mercier-Laurent)

Another possibility is to combine DL with knowledge, as shown in Fig 8, in aim providing explanations and offer knowledge-based services.



**Fig. 8.** Combining DL and K-based AI

The achievement of the UN SD Goal 12 “Ensure sustainable consumption and production patterns” again AI can help preventing various impacts. Eco-innovation and eco-design approaches powered by AI and alternative thinking may lead to wise exploring of raw materials, even avoid using them, especially in electronic devices. Planned obsolescence has to be replaced by sustainable products and services.

Goal 17 “Strengthen the means of implementation and revitalize the global partnership for sustainable development” can be achieved by incentives such as investment in sustainable innovation applied to Digital transformation connected with Green Deal. Global partnership has been already tried by various conference but without significant results. Interesting initiatives such as Earth Planet, agro ecology of CIRAD [64], numerous projects on preserving biodiversity and other prototyping actions [may serve as inspiration for the next. Knowledge base BC3 [59] was designed to group such experiences.

Digital transformation can be a playground for prototyping of sustainable development of not only industry but also all fields concerned by Digital transformation.

Knowledge Management principle may evolving the way of thinking by asking the right questions: who are the contributors and users, how to organize whole process of data, information and knowledge collection, how to help connecting all elements and allow information and knowledge sharing, the observation of world best practices.

## 6 Conclusion and Perspective

Humans are the greater generators of disasters. In the context of Planet Emergency, sustainability and sustainable development is still a big challenge for humanity. Before applying technology this complex problem requires awareness about our impact and evolution of individual and companies behaviors, radical change of focus from having more to living better in harmony with nature.

To remain sustainable, the IT development requires a smart use of available AI techniques, not only trendy ones but also those effective for a given case. Combined with intensive use of available knowledge – individual and collective, from related domains, from the past and currently gained from experience such systems can really help minimizing impact of human activity.

AI way of thinking helps understanding better such a complex problem, finding alternative solutions. The better use of our brain capacity is mandatory.

AI is useful in many situations if we apply appropriate method and techniques.

AI can help managing many aspects when used appropriately, but we still need to define the right metrics for correct evaluation of the effects of our actions – individual and collective. Simulators can help evaluating the situation, testing effect of influencing factors and consequence of decisions to take before doing. It applies in industry, city and in our lives.

The balance between the use of technology and human capacity should be preserved. Technology producers have tendency to produce software and devices that think instead of the human and take decisions for him/her. This kind of applications may replace human at the long run and reduce his cognitive capacity. That is why we have to design applications able to enhance human intelligence without switching it off.

Technology alone cannot save Planet, but can help us to be smarter.

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