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# Can Artificial Intelligence Effectively Support Sustainable Development?

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**Abstract.** This paper describes the role AI may play in sustainability. Sustainable development is currently among the greatest challenges. Sustainability and development are apparently opposite. The current efforts to face the Planet Crisis by separate actions generate less impact than expected. The capacity of available technology and in particular Artificial Intelligence is underexplored. 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 and focus. The concepts such as Smart, Intelligent, Innovative, Green or Wise City invented to promote existing technology transform the IT market. Most of offers consist in data processing with statistical/optimization methods. This paper explains how the AI approach and techniques combined with adequate thinking may innovate the way of facing Planet Crisis and achieving some of 17 United Nations Sustainable Development Goals.

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

## 1 Introduction

Many factors affect the sustainability. One of them is quick technological progress, considered as powerful engine of economy. It provides benefits for humanity, but contributes also to Planet Crisis with waste generation, energy consumption, cooling data centers and depletion of scarce metals. The majority of computers, smartphones, IoT and other electronic devices are mostly not eco-designed and even integrate a principle of planned obsolescence. Consequently they are thrown away and replaced by the latest model. Not conceived with knowledge approach, the consecutive layers of software and frequent update for various reasons increase already existing “obesity” and creating a need for more powerful computers. The combination of various communicating software requires “up-to-date” hardware to run correctly.

Despite the large introduction of Corporate Social Responsibility, some companies still practice planned obsolescence to generate more revenues [1].

Is getting huge and quick revenue compatible with Planet protection?

Main conferences devoted to climate change blame coal and automotive industry as the biggest emitters of carbon dioxide. However, they seem forgot the other influencing factors and do not study the pollution systems as a whole.

According to [2 and 3] simple email without attachment generates equivalent of 4g CO<sub>2</sub>, annual google search 10 kg by only one person.

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, 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 triggered by marketing needs to sale more and quicker to largest public. The involved companies collect all available data in aim to elaborate the models and selected algorithms to generate “client experience” among others.

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.

Advertisement-based business model, invented by Google influences and mass media promote 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.

This trend 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. 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.

Globalization has 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. It requires transportation across the world by ships and airplanes, which increases pollution [5]. Besides, the end-buyers have to recycle products, often of poor quality, made just for sale. Repairing costs often more than new product and requires the availability of spare pieces and related expertise.

Huge global business amplifies 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 [6].

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.

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) 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 [7]. Instead of sorting, it is smarter to produce less waste. Corporate Social Responsibility aims in balancing environmental, economic and social impacts. The standards associated with product lifecycle management (PLM) software claim to manage environmental impact of the design [8].

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 [9]. 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 [10, 11, and 12].

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 [13], complex problem solving, art of choosing appropriate techniques and managing available knowledge and experience that apply.

After describing the concepts of sustainability, and sustainable development we give a short overview of AI techniques useful for sustainability management. This is following by discussion on how AI can help achieving some of the 17 goals of UN. The case of Smart City demonstrates AI applied to mastering of environmental impact.

The paper ends with some perspective on alternative way of doing and on the role of intelligent technology in the transformation of society.

## **2 Sustainability and Sustainable Development**

For many sustainability means economic health. Indeed sustainability depends on how human activities are in balance with natural ecosystems and how they affect biodiversity and our biosphere [14].

Facing the Planet Crisis requires different approach that world conferences, agreements and separate actions. By the way, participants travel mostly by planes generating CO<sub>2</sub> instead of using available teleconferencing technology. Nobody publish the “return on investment” in terms of tangible and intangible effects of such actions.

Covid 19 however, changed the way we work; many conferences went online. Remote working generates positive impact on the environment, such as but there are also few negative often forgotten. All conferences online are recorded and stored in the data centers, nevertheless these records offer the access to knowledge to large audience.

Successive lock downs have also increased shopping online and by consequence traffic on the internet and transportation of goods.

In biological systems, sustainability means long life. Systems components influence each other and the balance of the whole system is the condition to survive. Human activities and especially greedy economic system have affected the balance of natural ecosystems [14 and 15].

Sustainable development is a principle that many people claim to have invented. The definition of the European Union [16] inspired by those of Antoine de Saint Exupéry [17] is following:

“Sustainable Development stands for meeting the needs of present generations without jeopardizing the ability of futures generations to meet their own needs – in other words, a better quality of life for everyone, now and for generations to come. It offers a vision of progress that integrates immediate and longer-term objectives, local and global action, and regards social, economic and environmental issues as inseparable and interdependent components of human progress”.

“Sustainable development will not be brought about by policies only: it must be taken up by society at large as a principle guiding the many choices each citizen makes every day, as well as the big political and economic decisions that have to be taken. This requires profound changes in thinking, in economic and social structures and in consumption and production patterns” [18].

Sustainable development can be considered as a process for meeting human development goals while maintaining the ability of natural systems to provide the required natural resources and ecosystem services upon which the current economy and society depend.

The current greedy economic system is not compatible with sustainable development. Burning forests to plant genetically modified soybeans or remove trees to build houses just for sale destroys unnecessarily biodiversity. In this context, **sustainable development is an oxymoron – it is impossible to remain sustainable without deep understanding of our natural ecosystems (multidisciplinary knowledge) and without radical change of behaviours, objectives, values, political and economic system.** Sustainable development is an attitude to learn and cultivate.

Various actions aiming in changing the way of acting and doing things have been engaged since 1960 [18]. Recently the young individuals such as for example Boyan Slat, Greta Thunberg and some NGOs are engaged in actions for planet cleaning and protection. Spreaded through social networks such actions have potential to influence behaviours. The initiatives as buy local, sharing knowledge on repairing via video and

numerous applications, such as Uber, wonolo [19] and some others, connect people offering services or jobs with those who need them. It is quick and effective, but out of the current economic practices (taxes, companies...). Sometimes this way of doing raise conflicts between “traditional” and “innovative”. Some platforms connecting offer and demand use AI techniques such as Case-based reasoning or deep learning for direct matching of offer and demand [20, 21].

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 [22].

Introducing the environmental principles into a design of products and services is a step forward. However, the traditional PLM tools should evolve to take into consideration a new way of doing [12] by using alternative thinking, simulators before doing and optimizers. Future Factories are supposed to evolve in this direction [10, 11].

Technology is able to provide a considerable help in eco-design, but the way of thinking compatible with such complex problem solving should evolve to global, holistic and system [14, 32]. 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 CO2 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. This situation my change with Covid crisis.

The International Standard ISO 26000 provides guidelines on how businesses and organizations can operate in a socially responsible way [23]. While it constraints companies to integrate social and environmental aspects into their activities, for ex. design, they should also focus on balancing 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. The AI-based simulators can help checking and optimizing things. Such system has been prototyped in the framework on French national funded project Convergence [8] that delivered a game-based guide for SMEs aiming in guiding them in applying ISO 26000 requirements related to eco-design.

To remain sustainable, 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.

### **3 Artificial Intelligence and sustainability**

Since years, researchers and practitioners of AI have demonstrated the AI has potential to provide valuable solutions for facing today challenges. Since 1980s, numerous applications in the fields of medicine, chemistry, industry, finance and others demonstrated that AI is able to help human in many situations [24].

#### **3.1 Third hype of AI**

The third hype of AI triggered by marketing needs to sale more and to more people amplified collection of multisource data. Despite of GBDR the acceptance of cookies by users is mandatory to access most of websites. Before marketing, professionals in operational safety, reliability and feedback processing applied mathematical methods based on statistical analysis to sample of data. While engineering specialists understood that it is necessary to combine “data approach” with “knowledge –based AI, those of marketing were suddenly empowered by analytics and “machine learning” algorithms. As deep-learning requires big data for more accurate results the marketing specialists 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 [25]. 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”.

While an “automated” dialog between human and machine was proposed by Turing (famous Turing test) and Weizenbaum (Eliza, 1966), 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. Main applications of chatbots are described in [26].

Some research groups still follow the old dream of AI founding fathers work on Artificial General Intelligence (AGI) – a machine able to surpass human intelligence [27].

#### **3.2 AI patrimony**

Since over 60 years, AI researchers and practitioners invented and have experimented the various approaches and techniques. The first robot Perceptron built in the late 1960s was equipped with embedded sensors, camera, and neural networks. It was able to ride on the ground and “learn” from “observation”.

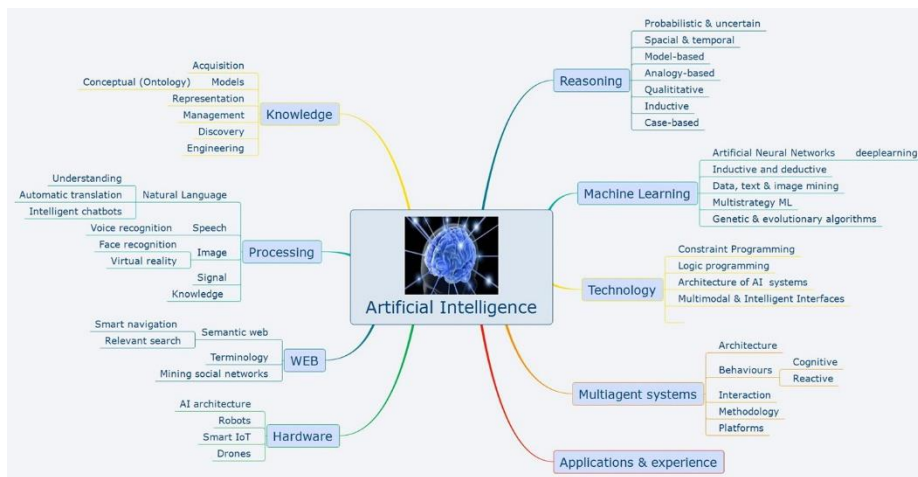


The knowledge-based AI introduced object programming, expert systems, natural language understanding and processing. After neural networks (1943) other machine learning approaches has been invented, such as automated generation of decision tree (ID3, 1970), Star methodology (Michalski, 1969) implemented in AQ [27]. All existing ML methods were grouped in Multi-Strategy Machine Learning (MSML) toolbox [28]. ID3 laid the foundation for data mining.

Case-based reasoning developed from the works of Roger Shank and Janet Kolodner in 1982 was latter improved by adding ID3 algorithm and dynamic induction combining the best from induction and nearest neighbors' algorithms.

Voice recognition and latter face recognition (image mining) are not new neither. Virtual reality implemented the principles of image processing in the middle of the 1990s.

The Figure 1 presents an overview of main AI fields and available techniques.



**Fig. 1.** Overview of main AI fields and techniques [30]

All techniques shown in Figure 1 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.

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. The approach such as KADS [31] comb-

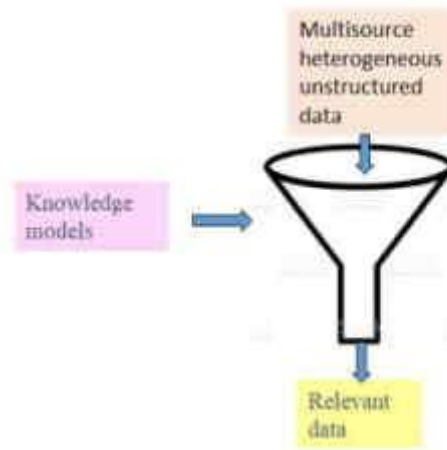
ing Newell knowledge level, Chandrasekeran interaction hypothesis and Clancey generalization, requires defining of a goal and decomposing it into the tasks; each tasks corresponds to a specific reasoning model that will use available knowledge and consider the context to achieve a given goal.

Deep problem understanding (global, holistic and system thinking) facilitates the choice of right technique or combination of them in hybrid systems [32, 33]. For example, we can use constraint programming for optimizing, planning and scheduling, artificial neural networks 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) [34]. 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.

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 [35] 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.

### **3.3 AI and sustainability**

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 2) and for guidance in “learning”.



**Fig. 2.** Collection of data guided by knowledge models

According to Eric Thivant [36] 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. Since over five years now, French company called Back Market has been working on revaluation of apparently outdated smartphones [37]. Repair cafés multiplies connecting people that need a service or learn reparation [38]. 3D printer services provide spare pieces if not available for sale (old equipment). Sweden government offers the tax reduction for repairing goods.

The United Nations defined the 17 Sustainable Development Goals presented in Fig. 3. Some of them can be achieved with the help of adequate AI approach and techniques.

For example the Goal 1 – “No poverty” can be partially achieved by better management of talents – from education to employment and entrepreneurship [39]. However it is related to human behaviors.

The Goal 2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”. AI can bring a contribution here by smart agriculture, combining past knowledge on crop rotation, natural fertilization and symbiosis between plants with various optimization techniques, forecasting, smart use of water, optimal gathering and distribution (local). French Research Center on Agriculture CIRAD initiated agroecology [40] that addresses this goal by combining Knowledge Management and selected AI techniques.

We have also avoid the food waste, especially in developed countries, pushed by business. Again behaviors plays a role here – it is better to explain how to do instead of giving ready food, as says an old proverb “Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime”.



Fig. 3. United Nations Sustainability goals, source <http://www.gogeometry.com/mindmap/sdg-sustainable-development-goals-mind-map-10.jpg>

Achieving of Goal 3 “Ensure healthy lives and promote well-being for all at all ages” requires education on how our body works and nutrition. Access to Knowledge base on healthy cooking (not just to multitude of recipes) with available local ingredients, the basic phytotherapy, gymnastic may help achieving this goal. It can be done through games combining knowledge and fun. AI brought significant contribution in health systems – early detection of serious diseases, robot surgery, diagnosis (expert systems), elaboration of vaccines and other. Artificial human “spare pieces” such as artificial pancreas [41] are already available and research on it progresses.

The well-being strongly depends on environment; it is linked with goals 11, 13 and 15.

The Goal 4 “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” involves the distribution of knowledge via technology. While AI-supported online learning has been practiced from the late 1990s and many MOOCs are available, the Covid pandemics accelerated massive use of technology in education. Many conferences on various topics are online and often for free. What should be better developed is the early evaluation of talents via dialogue with intelligent systems, interaction human-machine during learning and adaptation of the program to the students’ level. An advice system for matching talents and interests with the range of occupational possibilities including new professions created by AI may help young

people selecting their dream education leading to this job. Education influences the results in achieving the other goals.

The contribution of AI to the achievement of the Goal 5 “Achieve gender equality and empower all women and girls” can be done through access to education and better management of talents, independently of gender. However, the biggest challenge here is to make evolve mentalities, accept and develop the women talents, attract girls to scientific and technical study and professions. Social networks and other communication media has a significant role to play in achieving this goal.

The Goal 6 “Ensure availability and sustainable management of water and sanitation for all” can be partially achieved by optimized use of water. There are the similarity with achieving of the Goal 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”. The IBM offer Smarter Planet launched in 2010 contains few optimizing tools, however it addresses the energy, water and transportation providers. Kayakutlu and Mercier-Laurent [30] addresses the energy users and propose applying of AI techniques for optimized combining of natural and fossil energy, but also making citizens aware about energy waste. The trend of bitcoin, of collecting data, posting on social networks and recent recording of conferences online is energy consuming. The addressing of this two goals requires critical thinking and capacity of finding the smartest way of performing our activities. For example a leaf blower is energy consuming, polluting and not effective.

The Goal 8 “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” remains very difficult to achieve. The biggest barrier here is human greed, desire to become rich and powerful at the expense of others and by exploring cheap workforce and people in the need. This attitude can be “corrected” by games and social networks. This goal is related to the goal 10.

The Goal 9 “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation” is rather easy but requires better organization of innovation ecosystems and again management of talents, promoting “local”. Digital transformation has a significant role to play at the condition of innovating the whole process. AI way of thinking helps organizing and implementing it using the suited techniques. At this stage the evaluation of impacts should be considered.

The Goal 10 “Reduce inequality within and among countries” is very ambitious and requires other organization then those by countries. It is connected to the goal 8 and requires wisening and humility of the world leaders or emergence of new leaders before applying AI for global optimization. Achieving this goal requires having an effective global governance. Some examples of societal innovation are given in [43].

The Goal 11 “Make cities and human settlements inclusive, safe, resilient and sustainable” will be discussed in the point 4 on Smart City. This goal is linked with the goals 3, 6, 7 and 13.

The achievement of the Goal 12 “Ensure sustainable consumption and production patterns” again AI can help preventing various impacts. Eco-innovation and eco-design approaches [42] 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.

The Goal 13 “Take urgent action to combat climate change and its impacts” addresses a very complex and interconnected problems. Dealing with this challenge requires a deep understanding and modeling of impacting components and their interrelations, before planning the actions. As in constraint programming the priority of the actions and elaboration of adequate metrics to be implemented will determine the effectiveness of footprint reduction. Complex system approach [44] and AI-powered simulator may help in global governance of climate change. This goal is interlinked with the goals 3, 6, 7, 9, 14, 15 and 17.

The Goal 14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development”. This challenge is also complex, as the ocean life that should remain sustainable is. Taking care of the oceans requires combining knowledge and expertise from related fields. It covers many actions such as removing plastic (Boyan Slat), absorbing harmful fish using robots [45] or preserving spaces actions. Fishing is regulated however, this can be managed by AI, not on the country or European level, but for each sea and ocean. Transportation amplified by globalization try to shorten the roads despite pollution and heat generated. This problem can be solved by influencing mentality (as Goal 10), producing and buying local sustainable goods. Researchers deploy other robots to understand the sea life in aim preserving the balance. The European initiative OceanGov addresses 7 components in the related multidisciplinary working groups [46].

Achieving of the Goal 15 “Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” depends again of the way of doing business and searching for quick profit. AI may help in urbanization planning and optimizing. Desertification depends on managing local talents and increase the attractiveness. For example today the only way of getting benefits in France is investment into houses and buildings. Investors purchase the land for low prices and build houses or buildings for sale destroying biodiversity. If only we could change the innovation policies and make investment in innovation more attractive than investment in buildings, not always necessary. Again the AI based simulators have the potential to demonstrate such impacts.

Goal 16 “Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels”. Achieving this goal require the change of behaviors at all levels and restoring the lost respect. Games may help, but it should be connected to politics, education and amplified by mass media.

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. Global partnership has been already tried by various conference but without significant results. Interesting initiatives such as Earth Planet, agro ecology of CIRAD [40], numerous projects on preserving biodiversity and other prototyping actions [may serve as inspiration for the next. Knowledge base BC3 [36] was designed to group such experiences.

Smart city can be a playground for prototyping of sustainable development of not only cities but applying holistic approach – smart and autonomous villages, small and bigger cities and regions. Well defined and conceived such way of doing may help achieving several UN goals.

#### **4 Contribution of AI - Case of Smart City**

All concepts - Smart City, Intelligent City, Green and Wise City - aim in providing services to citizens of quickly growing cities. The citizens can be individual or a part of organization or company that is why holistic approach is appropriate. Actually, the reasons of this growth are job offer, access to services, to culture or immigration or search for better social conditions. Based on linear approximation in 2050 70% of world population will be living in the Megapolis [48, 49].

Another influencing factor to take into consideration is the ambition of politicians to grow their territory, to attract companies and capital in aim increasing their power and show it up. As consequence, regional economy collapses in many cases and should be reinvented using local talents and resources.

The concept of Smart City was probably born in early 2000s pushed by technology with Cisco as network provider, IBM and some others. In 2010, IBM introduced a new slogan “Smarter Planet” combining their current offer to various elements related with water, energy and transportation management.

Intelligent City tries to be different and defines integrated model of intelligent economy, green transportation, environment, governance and services for citizens [49].

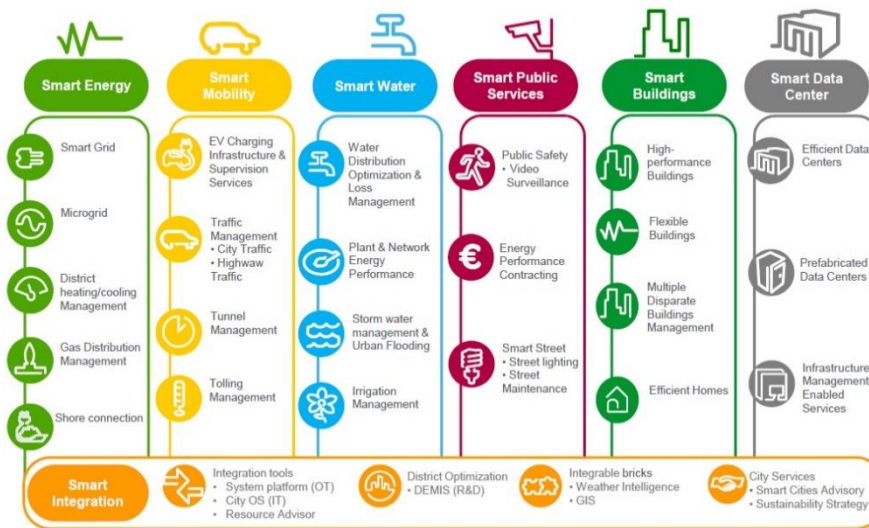
The city of Nice (French Riviera) runs annually a conference on Innovative City [50]. This year AI and its benefits for the city is on the program. The other topics discussed are more traditional - mobility, energy, recycling, urbanism, wellbeing and specificities of Euro-Mediterranean area to explore. Technology is behind all items, but it lacks an overall approach for better optimization of efforts and investment.

Growing cities want to attract people and companies by offering wellbeing to citizens. Green City combines architecture, gardening and social cohesion [51, 52]. The topic of societal innovation is timely in the current changing context [43].

The Wise City of Hong Kong in collaboration with French Chamber of Commerce brings together large companies - Schneider Electric, Alstom, Veolia, Thales and KPMG - no room for small ones. KPMG claims to be integrator of all offers. They

focus on improvement of living conditions: pollution, access to clean water, waste treatment, etc. Hong Kong with over 7 million of habitants produces 15,000 tons of waste daily and uses 60% more water than New York. Buildings are heavy consumers and air pollution is 53% local [53].

Schneider Electric being a partner of Wise City proposes an integrated offer, shown in Fig. 3.



**Fig. 4.** Integrated services for Smart City (source <https://www.slideshare.net/SchneiderElectric/schneider-electric-smart-cities-hannover-v3>)

The presented offer, elaborated as a whole, improved though deployment in over hundred targeted cities includes the following components: smart energy, smart mobility, smart water, smart public services, smart buildings, smart data centers and smart integration. These components represent also the areas of Schneider expertise. Several AI techniques, for optimization, maintenance, decision support and others facilities are embedded in this offer to provide solutions tailored for the city. For example, mobility module provides the real-time monitoring of system performance and detection of problems that may occur (predictive maintenance). The collected feedback allows reducing traffic and improving the network.

The energy module is in charge of providing continuous service. In the case that apply the energy offer is composed also with available sources of renewable energy.

Another module is in charge of water management and supply. Improving public safety is possible thanks to real-time analysis of video cameras (using deeplearning).



We can notice that the offers for energy and water are a part of smart buildings. Smart buildings, IoT and home automation systems helps managing machine-to-machine connections, detection of incidents, water and energy supply and optimized use of resources.

Healthcare management includes, among others AI-bases planning and scheduling of staff and devices for better service offered to patients.

Environmental footprint assessment application collects the environmental data. After validation, they are explored for improvement of performances. Data related to “users’ experience” are also collected and explored for continuous improvement.

Data Center is certainly associated with city management system and we hope there is only one for all applications proposed by partners.

This integrated city management platform designed using Knowledge Management principle connects all elements and allow information and knowledge sharing, the observation of world best practices, provides decision support and incidents management. This platform communicates with city management and citizens.

The city is also in charge of the other services that citizens may need but the above system does not allow expressing the citizen (consider in holistic perspective) ideas for new services. Considering holistic approach a Future factory is a part of the city or of the region.

AI plays multiple role in Smart city – in the above-integrated offer the optimization techniques are used to manage water and energy distribution and consumption, other techniques for diagnosis, maintenance, business intelligence, optimizing transportation, collection of garbage, planning works, meetings, events and other city activities.

However, the smart city has to be managed as the whole ecosystem in its environment and not by separate modules. Cities are concerned by economic development, but also pandemics, biodiversity, climate change, pollution, education, poverty and other UN goals.

We suggest to improve this concept by connecting several UN goals and prototyping in selected region. Some examples of such prototyping are already available, but in various context, that makes difficult finding similar example [43]. The project B3C [36] ambitions in building collaborative knowledge base of best world practices.

## **5 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.

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

The presented example demonstrated that 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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