

Intelligent models for recommendation

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Today, the industries of all European countries face common challenges: improving resource efficiency, becoming more environmentally friendly, mitigating climate change, improving the digitization in all segments of the value chain and improving transparency and safety, providing consumers with detailed information and ensuring the safety and quality of the final product.

Growing concerns about environmental and social issues are pushing the demands of stakeholders (customers, workers, shareholders, consumers, etc.) and the public towards more sustainable processes and products. Sustainability is closely linked to climate change: the introduction of sustainable measures, both by consumers and producers, is inherently a measure against climate change.

Although 65% of consumers say they want to buy sustainable products, only 26% follow them. The difficulty of assessing which products are the most sustainable or correspond to customers' personal values in the field of sustainability also contributes to this. In addition, studies suggest that consumers often consider aspects of sustainability to be too complex when making purchasing decisions. To simplify decision-making, a number of sustainability labels have emerged, such as eco-labels, fair trade and environmental certification. Others have tried to come up with a sustainability assessment (e.g., ISO 21930: 2017). Although there is evidence that these brands contribute to sustainable development, further research has shown only a limited effect on consumer behavior. This is partly because it is often not clear what exactly these labels mean.

Information tools are one of the types of tools available in an effort to change consumers' perceptions, motivations, knowledge and standards. Accordingly, it is increasingly important for consumers to be able to make informed choices about the products they buy, especially in terms of sustainability.

Together with the commitment of businesses and organizations to more responsible and sustainable processes and production, the implementation of the European Green Deal and the Sustainable Development Goals is an urgent challenge to all actors in society to contribute to changing the way we meet our needs.

In one way or another, the activities of industries, be it directly or indirectly, can contribute to the achievement of all of the 17 Sustainable Development Goals. However, the goals that are most closely related to industries and that could determine the consumers' choice of a product, are discussed below:

- **Goal 3 GOOD HEALTH AND WELL-BEING:** All types of industries can have an effect on people's health on several levels. They can promote a healthy working environment, ensure the security of their workers to prevent any accidents or illnesses, as well as collaborate with their local communities to promote healthier habits. Food industries can play an extremely important role in contributing to health, by eliminating any food additives that may be harmful to health and incorporating ingredients that are beneficial for health. In addition, industrial activity is known to contribute to air, water and soil pollution. Industries which take actions to reduce the negative impact they have on the environment, will be contributing to the health of the community in which they operate.
- **Goals 4 GENDER EQUALITY:** By developing and following gender equality policies, industries contribute to creating a fairer society in which gender does not determine opportunity or lack of thereof. Letting consumers know about these policies may determine their choice of supporting one company or another. Moreover, companies can get involved with local organizations to promote gender equality within the industry in which they operate.
- **Goal 6 CLEAN WATER AND SANITATION:** Water contamination continues to be a problem in Europe today, as many industries still fail to comply with laws on sewage and sanitation, releasing harmful

chemicals into rivers. This may lead to serious illnesses, such as cancer, in the local community who use the contaminated water to bathe and drink. By implementing sensors at their water treatment plants, industries will be able to demonstrate to local consumers that they do not contaminate their water resources.

- **Goal 7 AFFORDABLE AND CLEAN ENERGY:** By updating their energy infrastructure to renewable energy, industries will be able to minimize the negative impact they have on the environment. Moreover, given that the market is becoming increasingly decentralized, industries can become prosumers and sell any extra energy they produce to local consumers.
- **Goal 8 DECENT WORK AND ECONOMIC GROWTH:** Industries can improve work and support economic growth in a number of ways. Firstly, they are important providers of jobs, and their operation helps drive the economy of the city in which they operate and beyond. Industries can gain the locals' support by informing them of the value they add to their community, in terms of job opportunities and economic growth.
- **Goal 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE:** Industries can design and deploy solutions involving disruptive technologies, capable of optimizing all the areas of industrial operation, ranging from outsourcing to product design, manufacturing, packaging, storage and logistics. The collected data can be used to make decisions in real-time which is very important in case of machine failure or accidents at work. Moreover, through industries can develop effective worker safety systems and deploy IoT Smart Personalized Protective Equipment for the real-time monitoring of the workers' health.
- **Goal 10 REDUCED INEQUALITIES:** All sorts of inequalities continue to exist across our societies. It is important that we strive for a better world where everyone receives equal opportunity and treatment. Some of these inequalities include income inequality, economic inequality, gender inequality, lack of access to education and technology, discrimination on the basis of race, age, gender, sexual orientation or religious belief. Industries must develop policies that will ensure inclusion and equal treatment in the workplace. Moreover, they can implement technologies to continually monitor the employees' perception of the work environment, so that any incidents of discrimination are rapidly identified and resolved. Moreover, companies can create educational opportunities for their employees. Ensuring a workplace in which everyone feels welcome contributes to the good image of a company.
- **Goal 11 SUSTAINABLE CITIES AND COMMUNITIES:** Industries are an inseparable and very important part of any city. Therefore, the sustainability of industries has a general effect on the city in which it is located, contributing to lower contamination levels and better logistics within the city, for example. To make their processes sustainable, industries must turn to new technologies, such as Artificial Intelligence, Machine Learning, Internet of Things, Cloud Computing, Edge Computing and Blockchain.
- **Goal 12 RESPONSIBLE CONSUMPTION AND PRODUCTION:** Technologies can help industries become greener measuring their waste generation and emissions in all their processes. Technologies such as Machine Learning and Deep Learning can be used to analyze the processes taking place in an industry and make any changes that may cause unnecessary loss of resources, contamination or that take too long. Moreover, industries can play an active role in their communities by informing consumers of the importance of choosing products that were made sustainably and in environments which ensure equality, inclusion and safety of the workers. Moreover, industries can implement technologies such as Blockchain and Edge Computing to ensure the security of their data while being transparent to consumers about their production processes.
- **Goals 13&14&15 CLIMATE ACTION, LIFE BELOW WATER, AND LIFE ON LAND:** According to the United Nations Development Programme, greenhouse gas emissions are 50 percent higher than they were in 1990. Industries can use disruptive technologies to monitor their greenhouse emissions. There are Artificial Intelligence models that are capable of analyzing the data and making recommendations to users regarding actions that will decrease their energy use and emissions. Moreover, the Internet of Things, in combination with other Artificial Intelligence techniques, can be used on industrial ships to prevent oil spills and therefore help protect marine life in the ocean.

It must be considered that different consumers have different priorities due to their personal situation and preferences. For example, while some prefer to reduce CO₂ emissions, others prefer to minimize plastic waste or obtain local products with a clear origin. There are inevitably trade-offs between these goals. While uniform assessment or labeling may allow for direct product comparisons, it does not take into account individual preferences and multiple dimensions of sustainability, which could lead to a loss of motivation for individuals to change their behavior towards more sustainable consumption. In addition, individual circumstances may play a role. For example, those who live close to a certain store would produce less CO₂ emissions on the way to the store than those who live further.

Another important point to consider are local policies (environmental, social, mobility, transport, etc.) that can influence purchasing scenarios / behaviors. For example, some municipalities allow for the recycling of plastics, while others do not or limit recycling to only a few types of plastics, which affects the sustainability of the product that the consumer buys. The availability, collection and integration of the vast amount of data needed to make decisions based on sustainability is a limiting factor that negatively influences consumer behavior towards more sustainable products.

New technologies, such as the Internet of Things, Big Data and Cloud Computing, make it easier to collect large amounts of data from all processes in the value chain and maintain product traceability from origin to consumer. On the other hand, distributed ledger technologies, such as blockchain, enable food and other goods manufacturers to guarantee the origin of the products and the means used to produce, store and transport them. It is also possible to use hybrid algorithms of ethical and eXplainable artificial intelligence based on machine learning, specifically on Deep Neuro-Symbolic Learning models, which provide recommendations to end consumers, regarding purchasing decisions, based on parameters such as sustainability or the health benefits of products. Last but not least, the contextual awareness provided by sensor-equipped smartphones enables the timely and relevant provision of information, while in-device computer vision algorithms allow in-situ examination of products, thus maximizing the transformational impact of purchasing decisions on consumer behavior. Several existing projects have used a technical approach to address sustainable consumption. Automated referral systems to support consumers in making sustainable purchasing decisions have been introduced, in another example, a harmonized food ontology has been introduced to increase global food traceability, quality control and data integration.

The H2020 ASSET Consumerism project develops an application for smartphones using Internet of Things technology that promotes sustainable shopping based on personal preferences and leads to the emergence of collective political consumerism. However, these projects take into account a limited amount of data, focus only on factors related to individual products and only allow comparisons of similar products from the same store. In addition, existing applications, such as the standalone Yuka application, are limited by their data, but also offer a better range of services through their paid version of the application, which excludes a large part of the population. In addition, there is currently no system to help consumers make decisions about their purchasing decisions as a whole, such as whether it is better to buy organic products on the spot than to order organic products online, even with regard to the individual situation of the consumer. The narrow definition of "consumer" is, in addition to the previously elaborated problems with quality and access to data, the main limitations of existing sustainable consumption solutions. It is becoming increasingly clear that a wide range of stakeholders in the supply chain need to be involved for sustainability to emerge.

In this regard, the targeted consumers can be not only individuals sensitive to environmental and sustainable consumption issues, but also communities, small businesses (e.g., local coffee shop, school, sports club) that share the same concerns as their customers or are just trying to better address their needs. In addition, this tool is designed to assist decision-makers in companies (e.g., supply chain and purchasing managers) as well as policy makers in assessing the overall sustainability of products. Likewise, the tool can provide valuable information to manufacturers who, based on the "sustainable market momentum" gained, could innovate their products and their approach to improving sustainability, thus differentiating themselves from the competition.

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