

Technology and Sustainability

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Abstract

Sustainability has allowed discussions in different areas of study. The application of green technologies to support the new reality has grown exponentially in all sectors including finance and agriculture and the management and structure of cities. However, efficient management of green technologies and economic growth is very important. Governments with efficient management that present economic growth goals in the right measure and with proper governance can implement diverse green technologies as a way to increase the number of patents and development of new technologies that contribute significantly to the objectives of sustainable development.

Within society today, sustainability has permeated discussions in different areas of study. The three main dimensions of sustainability, environmental, social and economic, and the synergy between them is essential for a positive result from implementing sustainable practices (Thomsen, 2013). The 17 Sustainable Development Goals (SDGs) proposed by United Nations (UN) in 2015 together with 169 associated objectives are now well-established expectations in civil societies, private sector organizations and governments (UN, 2022).

Considering all the rapid changes that have been taking place in the globalized context so far, as society advances and undergoes a transformation there is a need for companies and governments to adapt with more agility. Organizational models have suffered structural impacts and companies have reformulated their concept of information exchange and capabilities they now require. The application of technologies to support this new reality has grown exponentially in virtually all sectors including finance and agriculture and the management and structure of cities (Briken, 2017; Feng, Zhang and Li, 2022).

The concept of a smart city combines social capital, human investment and infrastructure aimed at economic and sustainable development using technologies to promote sustainability (Macke et al., 2019). Such a city is considered sustainable, intelligent or 'smart', and has several technological characteristics such as renewable energy, smart housing, pollutant emission control, multimodal mobility, digital inclusion, efficient financial management, among many others (Rosales, 2011; Anand; Rajkuma; Suganthi, 2017; Li and Yi, 2020).

However, technologies can both help and hinder sustainability and so, today, we have green technologies which are described by Iravani, Akbari and Zohoori

(2017) as those that seek the improvement and application of systems and products that minimize negative effects on the environment and human health. Among its principles, green technologies seek to reduce the emission of greenhouse gases, the use of natural resources and energy in addition to promoting recycling and the use of recyclable materials.

The concept proposed by Saunila et al. (2019), with the realization of investment in green technology based in knowledge and innovation (Fernando; Jabbour; Wah, 2019), has shown an increasing trend towards having a greater contribution from companies involved with environmental sustainability. Although, Song et al. (2019) also highlights the adaptive and absorptive nature of these technologies as a way to accelerate this green growth. When compared to conventional technological alternatives, the new emerging green markets can collaborate in overcoming the disadvantages of green technology, especially when it is supported by governmental public policies (Hottenrott, Rexhäuser & Veugelers, 2016). These may also have the added effect increasing organizational profits (Song; Wang; Sun, 2018). However, Barbieri, Marzucchi and Rizzo (2020) reinforce the view that new technological developments arise from the green orientation of an invention and green technology is directly responsible for the reach of the SDGs (Guo et al., 2020).

Green technologies are those considered environmentally friendly due to their adaptation of processes that emit less pollution and more sustainable production chains using fewer resources. Yalina and Rozas (2020) explain that the concept of green computing, for example, began in 1991, during the launch of the "Green Light" program by the Environmental Protection Agency. The concept focused on the use of computers that function in an environmentally responsible manner, through the reduction in the use of energy and waste released into

the environment, namely heat from cooling systems during operation and hardware products thrown away due to the end-of-life disposal. In this context, the use of green designs, production, consumption and management methods were encouraged.

It is expected that the use of green technologies facilitates productivity and efficiency within work environments and helps in the sustainable use of resources (Yalina; Rozas, 2020). Sestino (2020) points out that devices that integrate with the Internet of Things are also great allies of the traditional digital platforms because they allow better control and monitoring of the processes under their command by continually evaluating and optimizing their performance within an organization.

Related to green technologies there is digital finance which significantly promotes the innovation in green technology. This is due to the reduction of restrictions in corporate financing and, consequently, in the modernization of the industrial structure and development of manufacturing. The effect has been greater in small-scale private companies and where local government has greater control over governance (Feng, Zhang and Li, 2022).

An efficient management of green technologies and economic growth is important. Wang and Feng (2021) evaluated the evolution of global green development from 1990 to 2017 in different countries or regions. Green development growth was remarkable, especially until the 2007 financial crisis, but slowed somewhat after that when there was a disparity in green growth in relation to income. Countries or regions with higher incomes showed a higher growth in green development. On the other hand, Shen et al. (2021) show that the adoption of higher economic growth targets inhibits innovation in green technology. In agriculture, the use of green technologies is also important. Mao et al, (2021) analyze the adoption of green technology in rice plantations and noted that large-scale farmers are more likely to adopt green farming technology than small-scale farmers.

Green technologies require specific materials to be implemented. Valero et al (2018) analyzed the supply chain for possible bottlenecks in the supply of base materials and identified 13 elements with a very high or high risk of becoming scarce and causing difficulties to other supply chains serving the green technologies. These elements are identified as cadmium, zinc, copper, barium, cobalt, indium, manganese, lithium, nickel, tellurium, silver, tin and chromium. As a way to

minimize this problem, the authors suggest precautionary measures be taken now such as:

- investment in technologies capable of obtaining these materials from unconventional sources;
- investment in geological exploration to increase the reserves and resources of these materials;
- invest in recycling technologies capable of recovering more of these critical materials;
- research in the technologies with lower requirements of these serious raw materials;
- combination of all items of above by defining eco-design strategies that reduce the use of these raw materials and improve the recovery of end-of-life materials.

Finally, it is notable that publications on sustainable green patents increased from 1996 to 2015 with the expansion of spending on research and development contributing to this effect (Fujii and Managi, 2019). When studying patent data from 63 countries, Perruchas, Consoli and Barbieri (2020) analyzed the adoption of green technology from 1970 to 2012 and found that countries diversifying toward green technologies is related to their existing competencies. Therefore, governments with an efficient management that present economic growth goals in the right measure and with proper governance (Shen et al., 2021; Feng, Zhang and Li, 2022), can implement diverse green technologies as a way to increasing the number of patents and development of new technologies that contribute significantly to the objectives of sustainable development.

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