

Systems Thinking for Sustainable Development

Tomorrow University - Impact MBA

SparkCoach ✨

REPORT.

Unlocking innovative solutions for better AI-empowered Apps

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SparkCoach ✨

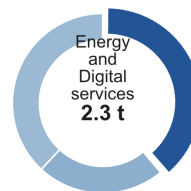
[1], is a project currently in development that aims to impact students' lives. This AI-powered web app SaaS product is designed to empower students in their educational journeys by utilizing coaching techniques with a holistic approach and personalized support.

Due to the project's yet-to-be-developed status, finding the best practices and advocating a sustainable approach are crucial in its first steps. As for the need for more information on SaaS AI educational products' sustainable practices, this report uses referential information on SaaS development and emissions impact.

1. Emissions

The first two years of SparkCoach are planned using a home office methodology for a team of three people and average data values. According to MyClimate [2], the primary emissions for the project imply a total CO₂ amount of **5.8 t**. While this does not contemplate the SaaS Operation and users' indirect usage, it does highlight the most relevant emissions on the business configuration and the one with the highest prospect of increase: **Energy and Digital Services (Fig 1)**.

There are three main areas of emissions categories in SaaS products that relate specifically to the product SparkCoach capabilities:



SparkCoach:

Energy and Digital services	2.3 t
Mobility	0.011 t
Board	0.000 t
Material and Waste	1.3 t
Home Office	2.2 t

1.1 Data Centers and Cloud Infrastructure [3]

1.1.1 Energy consumption of the cloud: Data centers that store online data consume considerable energy to power their servers and cooling systems.

1.1.2 Water usage and pollution by SaaS: SaaS-related data centers require regular cooling, usually with potable water resulting polluted.

1.1.3 Electronic waste from data centers: Disposing of computers, other electronic waste, and obsolete equipment, such as servers, contributes to environmental pollution.

1.2. Generative AI. [4]

1.2.1 Energy consumption: Gen AI requires enormous computational power to process a large amount of data and generate new information.

1.2.2 E-waste: generated at a rapid pace and improperly disposed of.

1.2.3 Hardware consumption of Natural resources: The consumption of rare minerals and metals is a complex production process in critical social and working environments.

1.3. SaaS Operation: User indirect usage

1.3.1 Device Manufacturing and Shipping: the production and distribution of devices that access SaaS contribute to emissions throughout the supply chain. [5]

1.3.2 E-waste: Cellphones and computers are quickly replaced to keep up with the latest trends, speedier software, and higher requirements. [6]

1.3.3 Network Connectivity Infrastructure, and energy: Satellites, 3G, 4G Networks [7]

Carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) are the specific types of GHGs emitted by Data Centers, cloud infrastructure, and general energy consumption in Generative AI and User Devices manufacturing. [6], [7]

Regarding e-waste, in addition to the already mentioned GHGs, there are toxic substances like **lead, critical metal cobalt, cadmium, mercury, and toxic gases**. [8]

2. Timeline Events and Impact of SaaS Industry

Year	Events	Impact
2000	The appearance of the first commercial cloud computing.	It starts a progressive reduction of servers' energy due to dematerialization, reducing energy consumption by up to 87% compared to standard software. [3]
2005	First SaaS product: Gmail - transforms how software is developed and distributed.	Cloud-based products can lead to fluctuating energy consumption, making it difficult to measure and reduce emissions accurately. [9]
	Social Media has started to become popular.	
2008 / 2009	The Great Recession pushes the fast production of SaaS against expensive traditional software.	In response to the high demand, cloud providers started investing in renewable energy and energy-efficient technologies. Google Cloud and AWS have started their path towards 100% renewable energy for their data centers. [5]
2010	Smartphones become popular and accessible.	
	Social media integration in marketing, sales, and customer services increases SaaS integration.	European Commission report published in 2020 shows an increase of 42% in energy consumption of data centers. [3] - While the direct emissions from mobile SaaS apps are low, the indirect emissions from hardware usage are significant. [3]
	API-driven platforms allow the creation of custom applications and integrations.	
2012	WEEE Directive (2012 Revision) requires producers of electrical goods in the EU to finance the collection, treatment, and recovery of e-waste.	Initially introduced in 2003, the revision (2012/19/EU) enters into force, impacting e-waste management. [10]
2018	The first data protection principles are more strongly tied to GDPR and CCPA.	Security measures involve storing large amounts of data, requiring energy-intensive data centers. Encryption algorithms are also computationally intensive, consuming energy.
	Subscription-based models become popular, generating revenue for SaaS companies. Vertical SaaS solutions have become popular.	The adoption of vertical SaaS solutions leads to increased energy consumption, at the same time as they provide efficiency in businesses' internal processes and operations. [9]
2020	COVID-19: Remote work and connectivity increases, generating a fast adoption of SaaS solutions as a business, changing remote work and digital transformation.	Remote work significantly reduced transportation-related emissions. However, the increased use of devices for remote work contributed to device manufacturing and energy consumption. [3]
2022	AI and Machine Learning become popular.	AI models require ongoing training and updates; their constant application consumes energy.
	SaaS integrates fast, personalized experiences with AI and ML, predictive analytics, and automation.	The more requirements, the more energy is consumed. On the other hand, AI and ML are also tools to optimize processes and make them more efficient. [9], [11]

	Low-code and no-code platforms: democratization of software development.	While platforms can accelerate development, they still require energy-consuming infrastructure, and the proliferation of applications also increases energy consumption. Increased CAGR of 32.0% during the forecast period (2024-2032). [13]
	5.3 billion mobile phones become e-waste [12]	
	A focus on sustainability appears in the software development market. Focusing on ESG, AI analyzes trends, reports, and metrics for businesses.	The Corporate Sustainability Reporting Directive (CSRD) adopted in the EU is expected to reach 50,000 companies by 2024, with a CAGR of 29,5% (2024-2032). [11]
2024	Governments have started AI regulations for transparency, data ethics, and bias mitigation.	Training large AI models consumes significant energy, leading to increased carbon emissions.

3. Feedback Loops and interactions

It's crucial to understand how feedback loops and interactions work in SaaS products when it comes to sustainability: at the same time, as the app improves AI capabilities and user experience, it generates even more usage, leading to a reinforcing loop of greater energy consumption.

Increased App Usage → More AI Model Usage and Cloud Processing → More Data Center Operations → Higher Emissions.

3.1 Data Centers Operation: As SparkCoach usage increases, more students will require more AI interactions with a more significant amount of data operation, which also implies more data storage. This means higher cloud infrastructure, leading to higher electricity consumption (higher emissions and cooling services water pollution) and faster and upgraded hardware (adding up e-waste generation).

3.2 AI Model Training and Processing Generative AI models require massive data and processing power, mainly during the initial training. Accurate complexity models require higher amounts of energy and hardware. Managing more data and optimizing AI performance requires developers to train larger models, generating more emissions. Another factor to consider is the frequency of training.

3.3 End-User Device Energy Consumption

As students use the SparkCoach app on their devices, it continuously processes data, including AI-powered recommendations. The more users engage with the app, the more processing occurs, which consumes energy on both the server side and the user's device and Network requirements.

High user engagement generates feedback on the AI's effectiveness, leading developers to optimize or expand features—the app's complexity when using AI queries in real-time demands more frequent server access.

4. Mental Models

Understanding the existing mental models of users and the industry helps to get a better picture and find solutions aligned with a shift in beliefs that can impact better.

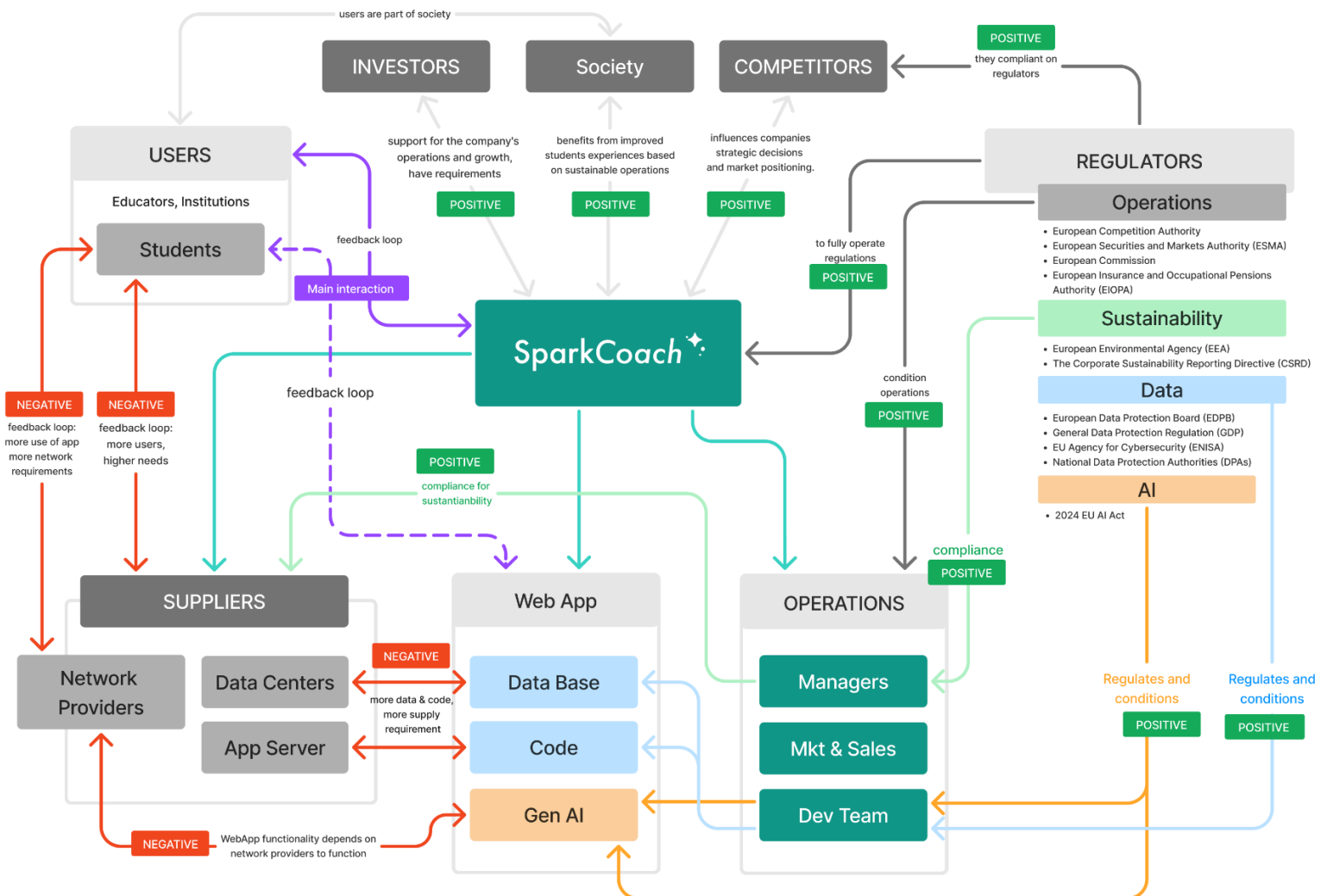
4.1 Distance mental model: According to LeMonde [14], *many people believe mobile phones do not generate significant emissions, and their disposal is underestimated.* According to McKinsey [15], “End-user devices—laptops, tablets, smartphones, and printers—generate 1.5 to 2.0 times more carbon globally than data centers... the devices typically are replaced much more often: smartphones have an

average refresh cycle of two years, laptops four years... servers are replaced every five years, though 19 percent of organizations wait longer”, and continues “... end-user devices are much bigger emitter of carbon than data centers”.

4.2 Dissonance mental model: Rod Istrate [16] implies that *digital technologies do not have environmental implications*. Capgemini's research [17] states, "Global email usage generates as much CO₂ as having 7 million extra cars on the road. If each email user in the UK sent 1 less email per day, we could reduce emissions by 16,433 tonnes of CO₂; the equivalent of 81,152 flights from London to Madrid."

4.3 Denial mental model: AI does not hurt the environment [18]. Kanungo presents a study conducted by researchers at the University of Massachusetts, where they determine the energy needed to train specific popular large AI models. “According to the results, training can produce about 626,000 pounds of carbon dioxide, or the equivalent of around 300 round-trip flights between New York and San Francisco – nearly 5 times the lifetime emissions of the average car.”

5. Systems and structures



CONCLUSION AND INSIGHTS

Generating Impact

Following the En-ROADs Climate Scenario [19], the main levers associated with a SaaS AI-empowered web app are initially “**Renewable usage of energy supply**” and “**Improving Energy Efficiency in Buildings and Industry.**” Both levers are connected to Data Centers and Cloud Infrastructure energy consumption (**Emissions 1.1.1**), vast amounts of power required for Generative AI (**1.2.1**), and finally, the emissions produced by indirect usage of users on device manufacturing (**1.3.1**), and network Connectivity Infrastructure, and energy (**1.3.3**). The final and third lever is “**Reducing Waste and Leakage,**” related to electronic waste from data centers (**1.1.3**), water pollution (**1.1.2**), e-waste from Generative AI (**1.2.2**), and SaaS Operation (**1.3.2**).

To help reduce emissions, an ethical and moral approach should be taken.

Understanding a multi-solving approach implies that different stakeholders must agree to find a model that unifies action. Following the model of doughnut economics, using the planetary boundaries and social foundation limits, and maximizing resource efficiency in circular economy models, some actions can generate impact. As SparkCoach is in its initial state of development, can help make the right decisions:

App Development:

Usage Patterns: The frequency and duration of app usage can affect device battery consumption and overall emissions. Generating user experiences that help students minimize unnecessary usage or optimize settings can reduce emissions.

Device Efficiency: The energy efficiency of students' devices can influence emissions. Promoting the use of energy-efficient devices can help reduce the environmental impact.

Software development: Optimizing code is essential. Using AI design standards, including avoiding pointless data collection

Suppliers

Cloud Provider Efficiency: More efficient cloud providers can reduce emissions associated with data center operations.

Data Storage and Retrieval: The amount and type of data stored and retrieved can affect energy consumption. Optimizing data storage and retrieval processes can help reduce emissions.

SparkCoach Mission:

The web app promotes students' productivity and well-being with a holistic approach. As an education ally, its purpose is to prepare humans for the future and help them reach their fullest potential as lifelong learners. Psychologist Nathaniel Branden said, “The first step toward change is awareness.”

It's fundamental for **SparkCoach** to align its AI training models with a sustainability content approach to live up to its promise of a better future.

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