

Case Studies: Sustainability 1

Proposed Answers

Case 1: Decision matrix - Choosing an interactive voting tool

Context

A professor at EPFL is seeking to enhance interaction with students during auditorium sessions by using a new voting system. They decide to ask their TA team to help them choose wisely the system they will be using. You are working on this project and are given by the professor the three options they have already shortlisted: Kahoot! 360, Mentimeter, and SpeakUp. Each system offers unique features and benefits, and the ultimate decision will mostly take ethical considerations into account. The selected system must protect user privacy, be accessible and inclusive for all students, ensure user safety, have high sustainability standards and implement an adequate transparency level.

Exercise:

In order to select the proper platform, you and your team decide to apply the Decision Matrix strategy in two steps:

- I. **Determine at least 5 criterias** to evaluate the different options you are given and assign a weight to each of them by distributing 10 points between the different criterias. The professor will need to understand the rationale for your choices.
- II. **Complete the matrix** by rating each system from 1 to 3 for the different criteria to determine which voting system the professor should select.
In preparation for this step, you have already reviewed the terms and conditions and the privacy policies of the three systems and summarized the key points in the following tables. In addition, you can perform additional searches online as you see fit. You can use [this source](#) to evaluate the carbon intensity of the locations for hosting your software.

Summaries for the three voting apps [last updated in October 2025]:

NOTE: these summaries are provided for educational purposes only, the official terms of use and privacy and security policies provided by the vendors are the only valid reference.

1. Mentimeter: <https://www.mentimeter.com/>

Company location	Headquarters in Stockholm, Sweden
Product hosting	<ul style="list-style-type: none"> • Main data hosting: Amazon Web Services, Luxembourg • Image caching and rendering: Cloudflare, USA • Artificial Intelligence features (opt-in): OpenAI, Ireland
Legal compliance	GDPR (EU)
Data collected	<ul style="list-style-type: none"> • Account with personal data provided by user (contact info) • User-generated content, which is made publicly available except for the 'pro' and 'enterprise' paying plans which have a choice of sharing policies • Usage traces (detailed) • Information collected on third party websites and platforms as well as public information for combination
Accessibility	Mid-range (level AA on WCAG)
Protection from online risks	<ul style="list-style-type: none"> • Age limit: 13 (under 16 with parental consent) • Tool available for users to filter unwanted text from the audience for the 'pro' and 'enterprise' paying plans.

Open Source?	No
--------------	----

2. Kahoot! 360: <https://kahoot.com/schools/higher-ed/>

Company location	Headquarters in Oslo, Norway
Product hosting	<ul style="list-style-type: none"> ● Main data hosting: depends on user location For EU-located users (this list is not exhaustive): <ul style="list-style-type: none"> ○ Google Cloud EMEA, Ireland ○ Amazon Web Services, Luxembourg ○ OVH, Canada ○ Hetzner, Germany ● Artificial Intelligence features (opt-in): Microsoft Azure, Ireland
Legal compliance	GDPR (EU & UK) FERPA, COPPA and SODIPA (USA)
Data collected	<ul style="list-style-type: none"> ● Account with personal data provided by user (contact info, detailed profile) ● User-generated content, with choice of sharing policy ● Usage traces (detailed) ● Information collected on third party websites and platforms in the context of recruitment
Accessibility	Mid-range (level AA on WCAG)
Protection from online risks	<ul style="list-style-type: none"> ● Age limit: no ● Moderation team reviewing content. ● Possibility for users to flag inappropriate content for review by the moderation team.
Open Source?	No

3. SpeakUp: <https://www.speakup.info/>

Company location	University of Neuchâtel, Switzerland
Product hosting	<ul style="list-style-type: none"> ● Main data hosting: Neuchatel, Switzerland
Legal compliance	GDPR (EU) CPDT-JUNE, LPD, OLPD and LTC (Switzerland) Age limit: no
Data collected	<ul style="list-style-type: none"> ● No account/login, optional user ID for admin, optional nicknames for guests ● User-generated content ● Usage traces
Accessibility	N/A
Protection from online risks	<ul style="list-style-type: none"> ● Age limit: no ● Tool available for users to filter unwanted text from the audience
Open source?	Yes

Proposed answer:

- I. **Part I:** 5 criteria that could motivate the professor’s decision are data protection and privacy, sustainability, accessibility, level of moderation and transparency. The next step is to assign the weight of each of these criteria by distributing 10 points among them.
 - A. **Data protection and privacy (3pts):** This criterion assesses how well each system safeguards personal data and complies with data protection regulations. Protecting user privacy is crucial, especially for an academic institution like EPFL.
Note: in the context of the course, we are evaluating privacy from an ethical angle, not a legal one - you have to be aware that institutions like EPFL have mandatory legal requirements in terms of data protection regulation compliance, that we do not address here.
 - B. **Sustainability (2pts):** This criterion evaluates the carbon footprint of each system's hosting locations. EPFL's commitment to sustainability requires a voting system that minimizes its environmental impact.
 - C. **Accessibility (2pts):** This criterion assesses how well each system supports diverse users, including those with disabilities. The platform must be usable by all students, regardless of their abilities. Accessibility is essential for ensuring that all students can participate equally.
 - D. **Content moderation (2pts):** Ensuring a safe environment where students can interact without fear of encountering harmful content is important. This criterion assesses the availability and effectiveness of moderation tools in each system.
 - E. **Transparency (1pts):** This criterion evaluates the openness and transparency of each system, which is important for ethical usage. Open-source platforms allow the community to review and contribute to the system, ensuring it operates ethically and securely.

- II. **Part II:** The next step is to assign a score from 1 to 3 to each option for each criteria, to do this, you should use the information provided in the tables above.

Criterion	Weight of criterion	Mentimeter	Kahoot! 360	SpeakUp
A. Data Protection and Privacy	3	★	★★★	★★★★★
B. Sustainability	2	★★★	★	★★★★★
C. Accessibility	2	★★★	★★★	★
D. Content moderation	2	★	★★★	★
E. Transparency	1	★	★	★★★★★
Total	10 (max rating = 30)	3*1 + 2*2 + 2*2 + 2*1 + 1*1 = 14	3*2 + 2*1 + 2*2 + 2*2 + 1*1 = 17	3*3 + 2*3 + 2*1 + 2*1 + 1*3 = 22

From this you can conclude that the best option for the professor is to use Speak Up, closely followed by Kahoot.

Here is the justification for the different ratings:

A. Data protection and Privacy:

- 1. **Mentimeter (★):** Although they have compliance with GDPR, they collect extensive data and combine it with data collected from third party sources.

In addition, part of the data storage is in the USA, which has weaker data protection laws.

2. *Kahoot! 360* (★★): Although they comply with various data protection regulations, and have location-based data hosting in regions with strong privacy laws, they still collect a large quantity of data and use a wide range of service providers, increasing risks to privacy.
3. *SpeakUp* (★★★): Collects minimal data, with optional accounts, and hosts data in Switzerland.

B. Sustainability:

1. *Mentimeter* (★★): It is mainly hosted in Luxembourg, where carbon intensity of electricity generation is low. However image caching is done in the USA, which involves network data transfers. In addition, they offer AI features hosted in Ireland, which would add to the energy consumption if used.
2. *Kahoot! 360* (★): Data is hosted in multiple regions with varying carbon intensity, from low (Luxembourg, Canada) to high (Germany, Ireland). It is not clear how the hosting is done and if it involves network data transfers. In addition, they offer AI features hosted in Ireland, which would add to the energy consumption if used.
3. *SpeakUp* (★★★): Hosted in Switzerland, a country with a relatively low carbon intensity in electricity generation. Local hosting also reduces the energy necessary for network data transfers.

C. Accessibility:

1. *Mentimeter* (★★): Provides mid-range accessibility features, making it reasonably inclusive.
2. *Kahoot! 360* (★★): same as Mentimeter
3. *SpeakUp* (★): Lacks detailed accessibility information, which could limit its inclusivity.

D. Content moderation:

1. *Mentimeter* (★): Moderation tools available to users only on paying plans.
2. *Kahoot! 360* (★★): Centralized content moderation effort and tool available to users to flag inappropriate content.
3. *SpeakUp* (★): Basic moderation tool available to users.

E. Transparency:

1. *Mentimeter* (★): proprietary, limiting transparency.
2. *Kahoot! 360* (★): Same as Mentimeter
3. *SpeakUp* (★★★): Open-source, which enhances transparency and allows for community oversight.

Case 2: Stakeholders analysis - A new datacenter

Context

SuperDatacenterCorporation, a fast-growing company, decided to create a new datacenter in Iceland. Attracted by the country's cool, stable climate, ideal for the natural cooling of machines, it chose to build a vast, ultramodern data center near Reykjavik. This new facility promises optimized performance and a low carbon footprint thanks to its state-of-the-art infrastructure. The management team also sees this project as an opportunity to enhance the security and reliability of its services.

Exercise

- a. Identify at least 8 **stakeholders** and describe briefly why they are stakeholders in this scenario.
- b. From the 8 stakeholders of the previous question, identify at least 3 who are **negatively affected** by the project, and describe how they are impacted.
- c. Fill out the direct/indirect table below and provide a **justification** for your **direct/indirect** classification.

- d. Describe how a **rebound effect** can occur in this context.

Proposed answer:

a. and b. You can find various stakeholders by answering the questions proposed in the cheatsheet (you can also use the [questions from the Markkula Center for Applied Ethics](#)):

1. Who will use the product daily?

- Internal IT Teams: These employees will monitor, maintain, and ensure the smooth operation of the data center's infrastructure.
- Corporate Clients: organizations using SuperDatacenterCorporation's data storage and cloud services will access the servers daily for data management and cloud computing.
- Application Users: People using software and platforms hosted by these servers, whether employees or customers of corporate clients.
- Technicians and Engineers: Working to maintain hardware, troubleshoot issues, and manage upgrades.

2. Who is in geographical proximity to the users of the product?

- Local Population (Reykjavik): The new facility in Reykjavik could have environmental and social impacts on the local community.
Impacts: The positive impacts may be economic (e.g. jobs), the negative impacts may be noise, environmental pollution, increase of energy prices.
- Icelandic Government: Involved through regulations and environmental policies regarding data centers.
- Local Utility Companies: Companies providing renewable energy (geothermal, hydroelectric) for cooling and powering the data center will be key stakeholders.
Impacts: Most impacts would probably be positive (e.g. economic, with new demand), but negative impacts can arise e.g. if the demand of the new facility is too high for the local resources (electricity, water).
- Local Ecosystem: The data center will affect the surrounding ecosystem.
Impacts: The creation of the data center will require land transformation, and its operation may contribute to localized noise and warming of air and water in the surrounding area, affecting animals and plants (as well as people).

3. Who is in social proximity with the users of the product?

- Investors: Shareholders and financial backers of SuperDatacenterCorporation who will track the company's expansion and profitability, closely tied to the success of the Icelandic facility.
- Employees' families: Workers at the new facility have families, who may benefit from their work.

4. Who is involved in the maintenance of the product?

- IT Maintenance Teams: These teams handle server operations, repairs, and preventive maintenance.
- Infrastructure Service Providers: Third-party contractors responsible for maintaining the physical infrastructure, including electricity and cooling systems, as well as building integrity.
- Software Developers: They maintain the software that powers and monitors the data center's internal operations and security.

5. Who provides services that are needed to run the product?

- Energy Providers: Iceland's geothermal and hydroelectric energy companies will be central stakeholders, providing the necessary power to run the data center.

- Equipment Providers: Managing the supply chain for hardware, parts, and materials needed for the data center.

6. Who provides funding?

- Investors and Shareholders: Providing the financial capital necessary to build and expand the new data center.
- Banking Institutions: Offering loans or financial services required for the relocation project and future expansion efforts.

7. Which communities are active in the application domain?

- Environmental NGOs: Organizations focused on the environmental impact of energy consumption and sustainability practices may take interest in the center’s operations.
- Technology Communities: developers and software engineers may interact with or rely on the cloud infrastructure of the data center.
- Data Security Forums: Online communities concerned with data security practices, monitoring the implementation of privacy and security measures.

c. Here are some of the stakeholders we identified above with their direct/indirect categorization - the justification is what is important here:

Stakeholders	Direct	Indirect	Justification
Internal IT teams	✓		These employees will directly interact with the servers, monitoring and maintaining them daily
Corporate clients	✓		Corporate clients directly access and rely on the data center’s services for cloud computing and data management
Application users	✓	✓	Users of hosted platforms interact with the services provided by the data center. However this interaction may not be apparent to them and, in some cases, it might also be beyond their control (i.e. they do not explicitly choose to use this data center instead of another). For this reason, application users could eventually be considered indirect stakeholders instead of direct stakeholders. That’s a “gray zone”.
Technicians and Engineers	✓		They will be physically working on-site or remotely to maintain and repair the data center’s hardware and software.
Local population		✓	The local population is indirectly impacted by environmental and social factors due to the presence of the data center
Local ecosystem		✓	The local ecosystem is indirectly impacted by the presence of the data center through land transformation, heat and noise emissions
Icelandic Government		✓	The government oversees the data center’s compliance with regulations but does not interact with it directly
Local utility companies	✓	✓	Companies that provide the power (geothermal, hydroelectric) necessary for running the data center will

			contract with the SuperDatacenterCorporation and the resources they provide will influence the operations of the center (e.g. a power cut would result in the partial shut down of the facility). However it could be argued that they do not directly interact with the data center itself so the direct/indirect classification is not obvious.
Environmental NGOs		✓	These organizations focus on the environmental impact of energy consumption, influenced by the data center.
Investors and Shareholders	✓	✓	Investors are financially impacted by the data center's performance, even though they do not interact with its services directly. In this sense they can be considered indirect stakeholders. However if the investors have a say in the management and operational decisions, then they have a direct influence on the data center's business and can be considered direct stakeholders. That can be considered a "gray zone" too.
Infrastructure Service Providers	✓		Directly involved in maintaining the physical infrastructure of the data center.
Banking Institutions		✓	Provide financial support (e.g. loans) for the data center but do not directly influence the management or operation of the services.
Data Security Forums		✓	Focused on data security practices and regulations, indirectly influencing the data center's operations.

d. Describe how a **rebound effect** can occur in this context.

With the creation of the new datacenter, SuperDatacenterCorporation will be able to advertise its services as more sustainable. It can be expected that this will attract new clients, with a growth of the usage of the new datacenter. This may lower the operation prices for SuperDatacenterCorporation, who may decide to lower its selling prices, which could lead to an additional increase in client base. As a result, the savings done on the environmental footprint of the datacenter services could be overcome by the increased number of clients (demand).

Case 3: Edge Cases - Health Monitoring App

Context

You are a software engineer working on a Health Monitoring App designed to help users track their physical activity, diet, and overall well-being. The app integrates with wearable devices to provide real-time data on metrics such as heart rate, steps taken, calories burned, and sleep quality. The goal is to promote healthier lifestyles while also considering the app's sustainability.

Exercise

Apply the edge case analysis to anticipate challenges across global reach, mass adoption, and longevity, to be sure that your design of this app will have sustainability as a central focus. For each edge case, propose a design change that would mitigate the issue.

Proposed answer:

I. Mass Adoption

- A. Scaling the app to millions of users would mean a significant increase in the environmental impacts because of the number of wearable devices involved

(embodied emissions, resource exploitation, electronic waste) and the energy consumption related to back-end servers in the data center(s) as well as network data transfers.

Design Change: Ensure interoperability with a range of wearable devices, preferably those with a long lifespan or those which can be easily repaired. Ensure backward compatibility with older devices to avoid forcing users to replace their device. Implement energy-efficient algorithms and data storage solutions on the server side, and minimize network data transfers. Prioritize cloud providers that rely on renewable energy sources and have a good (=low) PUE.

- B. Used at large scale, the app could lead to a change in social norms both on what is “normal” health based on the app metrics and on how acceptable/desirable constant monitoring of health is.

Design Change: The app could include ways to personalize the type of tracking and/or the health metrics with input from each user, to be able to account for various body types, diets or cultural habits as well as personal goals. From time to time, the app could encourage users to take a break from tracking their health, which would also have a positive effect on the environmental impact.

II. Global reach

- A. Developing an app that has the exact same features everywhere in the world might lead to challenges in regions with different technological capabilities and climates.

Design Change: Develop the app with a modular architecture, adapting to regional constraints. This includes optimizing the app for low-bandwidth environments, reducing unnecessary features in regions with limited energy, and ensuring that the app respects local environmental norms and data usage policies.

- B. The accuracy of health monitoring on wearable devices may vary based on skin color and other physiological differences across diverse populations.

Design Change: Evaluate the accuracy and fairness of the health monitoring input provided by the devices and how that might affect the performance and services provided by your app.

III. Longevity

- A. Over time, users might become overly dependent on the app, leading to an increase in unnecessary interactions or overuse (like checking the app excessively), leading to higher energy consumption on the user devices.

Design Change: Design the app to promote mindful usage, encouraging users to interact with the app only when necessary. Implement features like weekly summaries rather than constant updates, reducing the frequency of user interaction. This approach not only reduces energy consumption but also helps prevent users from becoming overly fixated on checking information and results, thereby supporting better mental well-being.

- B. As new devices and operating systems are released, older hardware may no longer support the latest versions of the app, leading to electronic waste.

Design Change: Design the app to ensure backward compatibility and optimize it to run even on older devices with more limited computational resources. Prioritize lightweight design and avoid unnecessary feature bloat that could render the app incompatible with older hardware. This helps extend the life of both the app and user devices, reducing electronic waste.

Except where otherwise noted, the content of this document is licensed under a Creative Commons Attribution 4.0 International License (CC BY)

<http://creativecommons.org/licenses/by/4.0/>

