

Case Studies: Sustainability 2

Proposed Answers

Case 1 - Causal Loop Diagram applied to Data Centers and Sustainability

Context

A technology company, operates a network of data centers that support its global digital infrastructure. These data centers are essential for providing cloud services, data storage, and high-performance computing to millions of customers worldwide. However, it is facing increasing investigation from regulatory bodies and the public due to the significant environmental impact of its operations. The company is committed to enhancing its sustainability practices and reducing its carbon footprint.

The company has several key components and processes within its data centers that affect its overall sustainability. These include the **energy consumption** of servers and cooling systems, the **carbon footprint** resulting from this energy use, and the efficiency with which the data centers operate. **Operational efficiency** in data centers is typically a combination of energy efficiency (reducing the energy cost of non-IT infrastructure such as cooling) and resource optimization (reducing the energy cost related to idle servers).

The company sources its energy from a mix of renewable and non-renewable sources. Partly driven by **regulatory compliance** requirements, which are becoming increasingly demanding, the company is exploring ways to increase its reliance on **renewable energy**. It is also increasing its **adoption of greener technologies** such as upgrading to more advanced cooling techniques and buying energy-efficient servers, to improve its operational efficiency. In addition, the **efficiency of its existing cooling systems** (i.e. lowering the energy per unit of heat removed) is a major investment area, as these systems are critical for preventing overheating and ensuring reliable operation. Finally, optimizing the utilization of servers is another important aspect, as higher **server utilization** can lead to greater operational efficiency. However, this must be balanced against the **risk of overloading servers**, which could lead to failures and increased energy consumption due to non-linear power draw.

Task

You have been appointed by the company to understand the complex interactions between these different elements and identify strategies to improve sustainability. Your task is to develop a causal loop diagram that maps out these interactions and answer several key questions based on this diagram.

The key variables of the diagram you are supposed to build are the following - you are expected to add the causal links:

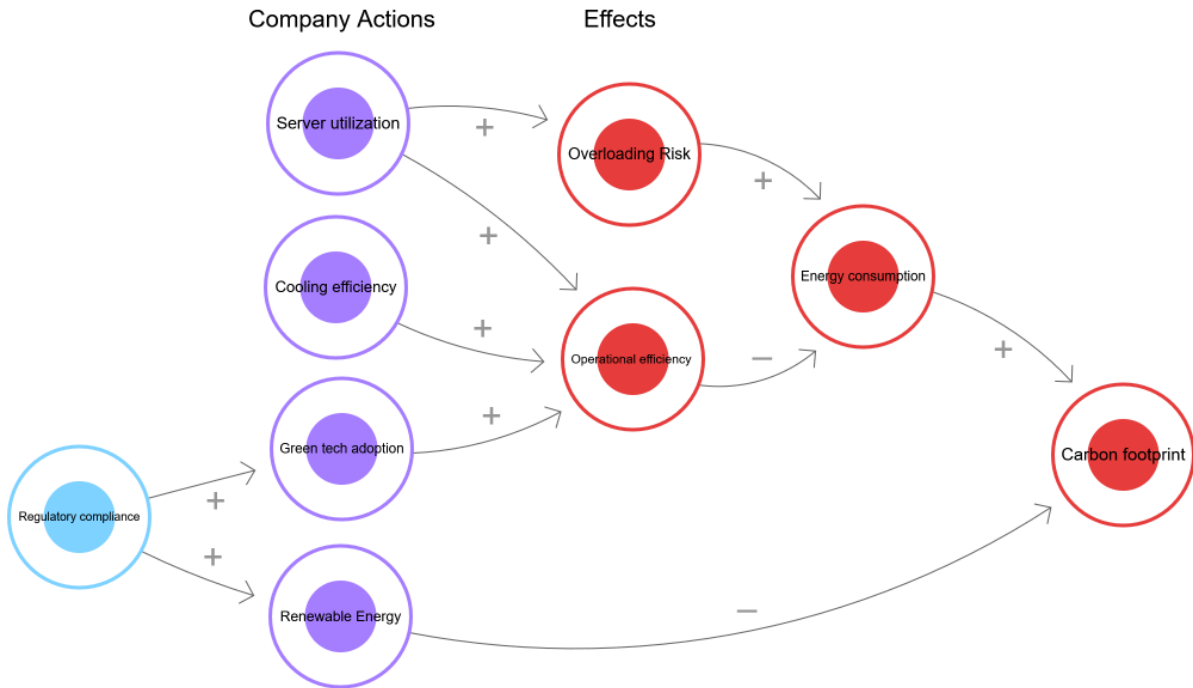
1. energy consumption
2. carbon footprint
3. operational efficiency
4. regulatory compliance
5. renewable energy use
6. adoption of green tech
7. cooling efficiency
8. server utilization
9. risk of overloading servers

After creating your diagram (you can do it on paper or use [LOOPY](#)), answer the following questions:

1. How would a significant improvement in the efficiency of existing cooling systems affect the energy consumption?
2. What happens to operational efficiency if the server utilization decreases?

3. What happens to the energy consumption if the carbon footprint increases?
4. Which type of actions from the company could decrease the overall carbon footprint?
5. What is the effect of stricter regulatory compliance on the adoption of greener technologies and renewable energy use?
6. What is an important downside of adopting greener technologies in a datacenter as a strategy to improve sustainability?

Proposed answer:



Here is the [animated version of the diagram](#), which you can use to visualize the impact of various modifications on the entire system.

1. How would a significant improvement in the efficiency of existing cooling systems affect the energy consumption?

Solution: A significant improvement in the efficiency of existing cooling systems would enhance operational efficiency and reduce energy consumption, which leads to a lower carbon footprint. Therefore, improving the efficiency of existing cooling systems has a substantial positive impact on the sustainability practices of the company.

2. What happens to operational efficiency if the server utilization decreases?

Solution: Higher server utilization is linked to better resource optimization, resulting in greater operational efficiency as more tasks are completed per unit of energy consumed. If server utilization decreases, operational efficiency would likely decline because servers would be underutilized, leading to higher relative energy consumption and increased costs per task. Thus, reduced server utilization results in less efficient use of resources, thereby lowering overall operational efficiency.

3. What happens to the energy consumption if the carbon footprint increases?

Solution: In this model, energy consumption drives the carbon footprint, but an increase in the carbon footprint itself does not directly affect any other variables within the system's boundaries. There are no causal links from the carbon footprint to other nodes, indicating that the carbon footprint is a result rather than a driver of changes in this context (which clearly shows that the model we are using is a simplification of reality!).

4. Which type of actions from the company could decrease the overall carbon footprint?

Solution: To decrease the overall carbon footprint, our model suggests two primary approaches: increasing the use of renewable energy and lowering energy consumption. From our model, enhancing the operational efficiency is an effective way to reduce energy consumption. Thus, focusing on improving operational efficiency and shifting to renewable energy sources are key actions to reduce the carbon footprint.

5. What is the effect of stricter regulatory compliance on the adoption of greener technologies and renewable energy use?

Solution: Stricter regulatory compliance would likely push the company to increase its share of renewable energy and increase its adoption of greener technologies. Increasing renewable energy use directly reduces the carbon footprint, while a higher adoption of greener technologies leads to an increase in operational efficiency and a lower energy consumption, reducing the carbon footprint too. Therefore, stricter regulations can drive significant improvements in sustainability practices.

6. What is an important downside of adopting greener technologies in a datacenter as a strategy to improve sustainability?

Solution: Adopting greener technologies can mean either replacing existing systems with newer ones or adding newer systems to the datacenter. A major downside of this approach is that it requires the manufacturing of new systems, with an associated embodied footprint. In the case where the new systems replace older ones, the decommissioning of the old systems will result in waste. In the case where the new systems come in addition to the old ones, it potentially results in an overall increase of the datacenter capacity, leading to an increase in the overall energy consumption instead of a decrease. We have not modelled these interactions in our causal loop diagram.

Case 2 - Ethical Decision Making: where to train my AI model?

EthicModSolutions is a tech company which is developing an AI model designed to moderate online content for several large social media platforms. The goal is to create a model that minimizes harmful content while allowing for free expression.

The company faces a tough decision about where to train the AI model:

Option 1: Train the Model in India

- **Pros:** Training the AI model in India is significantly more cost-effective due to lower electricity and operational costs. This allows the company to allocate more resources to training, such as using larger and more diverse datasets, running more extensive experiments, and fine-tuning the model for better accuracy. The result would be a more sophisticated and reliable AI model that performs better in content moderation.
- **Cons:** However, India's electricity grid relies heavily on coal, resulting in high levels of sulfur and particle pollution, generating [some of the worst air pollution in the world](#). The local environmental impact is significant, having important consequences on the health of local communities.

Option 2: Train the Model in Switzerland

- **Pros:** Switzerland offers a much cleaner energy grid, relying heavily on renewable energy sources such as hydroelectric power. Training the model in Switzerland would result in significantly lower pollution, aligning with the company's commitment to sustainability and reducing the negative impact on the environment and public health.
- **Cons:** However, the higher costs associated with electricity and operational expenses in Switzerland would limit the resources available for training the AI model, and this would result in a less accurate model. As a result, the AI model might not perform as well in content moderation, leading to potential issues such as the exposure of users to harmful content or unjust censorship, placing a greater burden on human moderators.

To arrive at a decision in such a dilemma, you can use the Ethical Decision Making strategy. Look at the problem through **four ethical lenses: Rights, Justice, Utilitarian, and Common Good**, and write down your analysis for each lens. The final choice does not really matter, what is important is the different points of view that the ethical lenses can bring to the decision.

Fill out the following table:

Proposed answer:

Lens	Justification	Option chosen
Rights	<p>Focusing on the right to freedom of expression and freedom from physical and psychological harm, training the AI model in India could be considered more ethical: a more accurate model would better protect users' freedom of expression by preventing over-censorship and avoiding exposure to harmful content, thus protecting their mental well-being.</p> <p>However, balancing this with the right to a clean environment (officially recognized by the UNHRC in 2021) presents a dilemma. If we prioritize environmental rights using a strong sustainability framework, where environmental concerns outweigh societal benefits, then Switzerland would be the better option. But from the strong sustainability point of view, we should probably question more broadly the overall environmental impact of the large social media platforms as a whole instead of focusing solely on the content moderation component...</p>	India
Justice	<p>In this lens, the principle of distributive justice demands that the harms (i.e., pollution) and benefits (i.e., improved content moderation) be more fairly distributed across society. From this perspective, training the model in India means that the burden is disproportionately on the local communities in India, especially those who don't have access to healthcare, whereas global users (especially in wealthier nations) benefit from a more accurate AI model.</p> <p>Training the model in Switzerland is more equitable as global communities (including India) avoid the pollution burden. While EthicModSolutions faces higher costs and global users face a higher risk of inaccurate moderation, this burden is more widely distributed and affects actors who have more agency and choice compared to the Indian communities.</p>	Switzerland
Utilitarian	<p>From a utilitarian perspective, training the AI model in India could be seen as more ethical because it allows for a more accurate model that protects a very large number of global users from harmful content. Although it increases local environmental harm, the overall benefit to a larger population can be seen as outweighing the negative impact on the smaller group affected directly by the air pollution.</p> <p>Note: Now if we take into consideration that using coal for the electricity contributes to global warming, then potentially the number of people who are negatively impacted is much larger (i.e. all of planet Earth's inhabitants) and some could consider that then training the model in Switzerland would be the more ethical option.</p>	India
Common Good	<p>There are two communities to consider in this case: the community of users of the social media platforms, and the communities in India affected by the air pollution, and we should consider the conditions that are important to the</p>	Switzerland

	<p>welfare of these communities. Here again we are in a dilemma as one option harms one community and the other option harms the other community. With the view of protecting the most vulnerable in these communities, in this case people affected by important health issues without access to healthcare, we could consider that training the AI model in Switzerland is the most ethical option.</p> <p>Note: Here again, if we consider global warming impacts, the community impacted is the entire planet, including very vulnerable people.</p>	
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What option would you choose? Why?

With the analysis we have done, the ethical decision remains unresolved, as two ethical lenses, **Utilitarian** and **Rights**, support training the model in **India**, while the other two, **Justice** and **Common Good**, favor **Switzerland**. This exercise, however, allows us to explore various perspectives and recognize that the final decision depends on which ethical considerations the decision-maker prioritizes. Ultimately, it is up to the person making the decision to judge which points of view seem the most valid in the context of their goals and values. Additionally, two other ethical lenses, **Virtue Ethics** and **Care Ethics**, could be considered to provide further clarity and guidance.

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