Sustainability Impact Analysis for Intel

Introduction

Intel is committed to reducing its carbon footprint and improving the sustainability of its products across the entire device lifecycle from manufacturing through end-of-life management. A key component of this strategy is extending the useful life of devices through repurposing and recycling initiatives.

Repurposing programs reduce electronic waste, lower energy consumption, and minimize carbon dioxide (CO_2) emissions by decreasing the demand for new device manufacturing. Many households retain multiple functional devices that are no longer actively used, creating significant opportunities for environmental impact through reuse.

This project evaluates the effectiveness of Intel's current repurposing strategy using data-driven analysis and provides actionable recommendations to maximize sustainability outcomes, energy savings, and CO_2 reductions.

Data Description

This analysis is based on two structured datasets representing Intel's device repurposing activities and associated environmental impact metrics. The datasets were joined using a common device identifier to enable integrated analysis across device characteristics and sustainability outcomes.

Dataset 1: intel.device_data

- device_id: Unique identifier for each repurposed device
- device_type: Device category (Laptop or Desktop)
- model_year: Year the device was manufactured

Dataset 2: intel.impact_data

- impact_id: Unique identifier for each device impact record
- device_id: Foreign key linking impact records to devices
- usage_purpose: Intended repurposing use (e.g., Education, Corporate, Government, Non-Profit)
- power_consumption: Average power consumption during use (watts)
- energy_savings_yr: Estimated annual energy savings compared to a new device (kWh)
- co2_saved_kg_yr: Estimated annual CO_2 emissions avoided through repurposing (kg)
- recycling_rate: Percentage of device materials that are recyclable
- region: Geographic region where the device was repurposed (North America, Europe, Asia)

Organizing and Understanding the Data

This section focuses on integrating device-level and impact-level data to enable a comprehensive analysis of device characteristics, repurposing patterns, and sustainability outcomes.

A. The device and impact datasets were joined using the device_id column to create a unified dataset containing both device characteristics and sustainability impact metrics.

```
SELECT
  *
FROM intel.device_data AS d
JOIN intel.impact_data AS i
  ON d.device_id = i.device_id;
```

B. A new column, device_age, was created by subtracting the device model year from 2024 to represent the age of each repurposed device.

```
SELECT
  *,
  (2024 - d.model_year) AS device_age
FROM intel.device_data AS d
JOIN intel.impact_data AS i
  ON d.device_id = i.device_id;
```

C. The joined dataset was ordered by model_year (from oldest to newest) to examine whether older or newer devices were more frequently repurposed and to assess potential implications for sustainability outcomes.

> This indicates that Intel is prioritizing the repurposing of older, underutilized devices, which helps reduce electronic waste and maximize overall sustainability benefits.

D. To analyze trends in energy savings and CO_2 reductions more effectively, devices were grouped into age-based categories. A categorical variable (device_age_bucket) was created using a CASE statement to classify devices as newer, mid-age, or older based on calculated device age.

```
SELECT
  *,
  (2024 - d.model_year) AS device_age,
  CASE
    WHEN (2024 - d.model_year) <= 3 THEN 'newer'
    WHEN (2024 - d.model_year) <= 6 THEN 'mid-age'
    ELSE 'older'
  END AS device_age_bucket
FROM intel.device_data AS d
JOIN intel.impact_data AS i
  ON d.device_id = i.device_id;
```

Key Insights

A. Total Devices Repurposed in 2024:

The total number of devices repurposed in 2024 was calculated by counting all records in the joined dataset.

```
Total devices repurposed in 2024: 601,740
```

B. Aggregate Sustainability Metrics (2024):

To evaluate the overall impact of Intel's repurposing program in 2024, key aggregate metrics were calculated, including total devices repurposed, average device age, average annual energy savings, and total CO_2 emissions avoided.

```
SELECT
    COUNT(*) AS total_devices,
    ROUND(AVG(2024 - d.model_year), 2) AS avg_device_age,
    ROUND(AVG(i.energy_savings_yr), 2) AS avg_energy_saved_kwh,
    SUM(i.co2_saved_kg_yr) / 1000 AS total_co2_saved_tons
FROM intel.device_data d
JOIN intel.impact_data i ON d.device_id = i.device_id;
```

C. Environmental Impact in Context:

Intel's repurposing program avoided approximately **6,768 metric tons of CO_2 emissions** in 2024, comparable to removing **over 1,400 cars** from the road. Each repurposed device saved an average of **25.74 kWh of energy annually**, demonstrating the environmental value of extending device lifecycles and reducing e-waste.

Identifying Trends & Maximizing Sustainability

By grouping devices by key attributes, this analysis identifies patterns in energy savings and CO_2 reductions. These insights help determine which device categories contribute most to sustainability outcomes and where Intel should prioritize repurposing efforts.

A. Device Type Analysis:

This query aggregates the total number of devices, average energy savings, and average CO_2 emissions saved (in tons) by device type.

```
SELECT
  d.device_type,
  COUNT(*) AS total_devices,
  ROUND(AVG(i.energy_savings_yr), 2) AS avg_energy_savings,
  ROUND(AVG(i.co2_saved_kg_yr) / 1000, 2) AS avg_co2_saved_tons
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
GROUP BY
  d.device_type
```

B. Device Type Impact:

Laptops contribute more to overall energy savings and CO_2 reductions than desktops, primarily because they are repurposed in higher volumes and typically consume less power per device.

C. Analyze sustainability metrics by device age group.

```
SELECT
  CASE
    WHEN (2024 - d.model_year) <= 3 THEN 'newer'
    WHEN (2024 - d.model_year) <= 6 THEN 'mid-age'
    ELSE 'older'
  END AS device_age_bucket,
  COUNT(*) AS total_devices,
  ROUND(AVG(i.energy_savings_yr), 2) AS avg_energy_savings,
  ROUND(AVG(i.co2_saved_kg_yr) / 1000, 2) AS avg_co2_saved_tons
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
GROUP BY
  device_age_bucket
```

D. Device Age vs. Repurposing Volume and Energy Savings.

Older devices deliver the highest average energy and CO_2 savings per device, but are repurposed least often. Newer devices are repurposed more frequently yet provide lower per-device impact, suggesting greater sustainability gains by prioritizing mid-age and older devices.

E. Regional Sustainability Impact:

```
SELECT
  i.region,
  COUNT(*) AS total_devices,
  ROUND(AVG(i.energy_savings_yr), 2) AS avg_energy_savings,
  ROUND(AVG(i.co2_saved_kg_yr) / 1000, 2) AS avg_co2_saved_tons
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
GROUP BY
  i.region
```

F. How does the carbon intensity of electricity in each region impact the total CO_2 savings from repurposed devices? Are there regions where repurposing leads to significantly higher environmental benefits? Why might that be?

> Regions with higher electricity carbon intensity generate greater CO_2 reductions from repurposing. While average energy savings per device are similar across regions, Asia shows nearly double the CO_2 savings per device compared to Europe and North America. This indicates that energy savings in higher-carbon grids translate into larger environmental benefits, suggesting that prioritizing repurposing efforts in such regions can maximize impact.

Optimizing Repurposing Strategy for Maximum Impact:

A. This analysis calculates each device type's percentage contribution to regional energy savings and CO_2 reductions to identify high-impact repurposing opportunities.

```
WITH regional_totals AS (
  SELECT
    region,
    SUM(energy_savings_yr) AS total_energy_region,
```

```
    SUM(co2_saved_kg_yr) AS total_co2_region
  FROM
    intel.impact_data
  GROUP BY
    region
)
SELECT
  i.region,
  d.device_type,
  COUNT(*) AS total_devices,
  SUM(i.energy_savings_yr) AS total_energy_savings,
  ROUND(SUM(i.co2_saved_kg_yr) / 1000, 2) AS total_co2_saved_tons,
  ROUND(
    (
      SUM(i.energy_savings_yr) / rt.total_energy_region
    ) * 100,
    2
  ) AS pct_energy_region,
  ROUND(
    (SUM(i.co2_saved_kg_yr) / rt.total_co2_region) * 100,
    2
  ) AS pct_co2_region
FROM
  intel.device_data d
  JOIN intel.impact_data i ON d.device_id = i.device_id
  JOIN regional_totals rt ON i.region = rt.region
GROUP BY
  i.region,
  d.device_type,
  rt.total_energy_region,
  rt.total_co2_region
ORDER BY
  i.region,
  pct_energy_region DESC
```

B. Device Type and Regional Impact Analysis

Across all regions (Asia, Europe, and North America), laptops account for the majority of energy savings and CO_2 reductions approximately 68% despite similar per-device impacts to desktops. This indicates that prioritizing laptop repurposing yields the greatest overall sustainability benefit across regions.

Data-Driven Recommendations:
This analysis highlights key insights used to guide Intel's device repurposing strategy.

A. Key Takeaways

- Most repurposed devices are over five years old, indicating that Intel's program effectively reduces e-waste by extending device lifecycles.
- Laptops contribute the largest share of total energy and CO_2 savings, largely due to their higher repurposing volume and lower power consumption.
- Mid-age devices provide the strongest balance between usability and sustainability impact, offering meaningful savings while remaining practical to repurpose.
- Repurposing devices in regions with higher carbon-intensity electricity results in greater CO_2 reductions per unit of energy saved.

B. Recommendation

Based on these findings, Intel should prioritize the repurposing of mid-age and older laptops, particularly in regions with higher carbon intensity. Focusing efforts on these devices maximizes energy savings, CO_2 reductions, and overall sustainability impact while ensuring efficient use of repurposing resources.