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**2025-HX05-COS30045-Data Visualisation (HCMC)**

**Visualisation Assignment (Week 5)**

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# **PART A - VISUALISATION CRITIQUE**

## **Introduction**

Environmental innovation, particularly through green technology patents, serves as a key indicator of a nation’s progress toward sustainable development. These patents not only reflect technological capabilities but also highlight economic potential and policy intentions. The OECD’s patent statistics offer a reliable basis for analyzing such trends, especially in tracking environmental innovation across various countries and timeframes.

This critique evaluates three distinct visualisations that utilize OECD data to depict aspects of green innovation. Each visualisation caters to a specific audience and employs a different visual strategy: one maps green patents across Nordic countries, another presents a global scatter plot illustrating innovation trends, and the third features a time series comparison across multiple nations. The primary aim is to assess how effectively each chart communicates insights, using established principles of data visualisation such as clarity, accuracy, perceptual design (including Gestalt principles), accessibility, and ethical representation.

Drawing upon critical visualisation frameworks like Munzner’s design triangle, the Gestalt laws of perception, and Cleveland & McGill’s hierarchy of graphical effectiveness, this critique explores the strengths and limitations of each visualisation. The analysis considers how visual encoding, contextual framing, and communication strategies affect the viewer’s ability to interpret and use complex environmental innovation data for informed decision-making.

## **Visualisation 1: Green Patents in the Nordic Region (2006–2011)**

A map of europe with different colored areas

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Figure 1: Regional Innovation in Green Technologies

* **Source:** Nordregio (https://nordregio.org)
* **Target Audience:** Policymakers, regional planners, innovation agencies in Nordic countries
* **Purpose:** Show spatial and thematic distribution of green patents by region, category, and growth rate

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| **Data Representation** | This visualisation integrates multiple data elements, including:   * Patent counts for the year 2011 * Average annual growth rates from 2006 to 2011 * Regional breakdown at the sub-national level * Technological composition displayed through pie charts |
| **Visualisation Type & Encoding Techniques** | The visualisation combines several graphical methods:   * A choropleth map uses color gradients to indicate regional growth rates * Proportional circles reflect total patent volumes based on their size * Embedded pie charts within each circle represent the share of different green technology categories through segmented color coding |
| **Strengths** | * ***High Information Density:*** The integration of spatial, numerical, and categorical data provides a multidimensional perspective on innovation. * ***Clear Geographic Context:*** The regional mapping effectively identifies areas with concentrated green technology development. * ***Effective Legend Usage:*** The legend clearly supports all encoding types, aiding interpretation. * ***Color Gradient Intuition:*** The use of light-to-dark shading to represent growth levels is visually intuitive and aids rapid understanding. |
| **Weaknesses** | * ***Visual Overload:*** The use of multiple encoding techniques—color, size, and pie segmentation—can overwhelm viewers and increase cognitive effort. * ***Unreadable Small Pie Charts:*** In regions with limited space, pie charts become too small to discern individual segments, reducing the effectiveness of categorical data representation. * ***Color Interference:*** The background map shading can clash with pie chart colors, which may reduce clarity—especially for color-blind viewers. * ***Unclear Scaling:*** The proportional size of the circles does not convey quantitative differences clearly without referring back to the legend. |
| **Application of Gestalt Principles** | * ***Proximity:*** The alignment of pie charts with proportional circles strengthens the connection between quantity and composition. * ***Similarity:*** Consistent use of color within pie segments supports recognition of shared technology types. * ***Figure-Ground Separation:*** While the base map and overlays are distinguishable, visual clarity could be enhanced through improved layering or contrast adjustments. |

* **Overall Evaluation**

This visualisation delivers a rich and sophisticated portrayal of environmental innovation patterns suitable for expert analysis. However, the simultaneous use of multiple encoding dimensions may reduce accessibility for non-expert audiences. Adding interactive features (such as zoom or filtering) or simplifying the number of visual elements could significantly improve user engagement and comprehension without sacrificing analytical depth.

## **Visualisation 2: Green and Inventive – Technology Growth by Country (2000–2011)**

A graph of green and inventive technology development

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* **Source**: OECD Green Growth Indicators
* **Intended Audience**: Policy analysts, researchers in comparative innovation
* **Objective**: To assess and compare national growth trends in environmental technologies relative to overall technological development

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| **Data Representation** | This chart visualizes four key data elements:   * The growth rate of environmental technologies (positioned along the X-axis) * The growth rate of total technological innovation (Y-axis) * Country identifiers displayed as text labels * A visual emphasis on nations where environmental innovation exceeds general technological growth |
| **Visualisation Type & Encoding Techniques** | The visualisation uses a scatter plot format to depict two-dimensional growth comparisons:   * Lightbulb icons serve as data markers, symbolising technological innovation * Color coding: Green icons indicate countries where green technology growth is higher than total innovation growth * Labels: Country names are added to identify each data point |
| **Strengths** | * ***Effective Quantitative Comparison***: The scatter plot structure is highly appropriate for visualising relationships between two continuous variables. * ***Thematic Symbolism***: The use of lightbulb symbols reinforces the central theme of innovation, making the visual more engaging. * ***Visual Emphasis***: Green-colored icons quickly draw the viewer’s attention to countries leading in green innovation. * ***Supportive Annotation***: Explanatory text or captions clearly outline the purpose and findings, aiding comprehension. |
| **Weaknesses** | * ***Label Clutter:*** In areas where data points are densely clustered—especially within Europe—overlapping labels reduce readability and visual clarity. * ***Poor Alignment:*** The positioning of country names often fails to clearly correspond to their respective data points. * ***Imbalanced Axis Scaling:*** The uneven scale between the X and Y axes may lead to distorted interpretations of comparative growth. * ***Lack of Interactivity:*** While interactive features like tooltips or filters are suggested, the static design limits deeper exploration of the data. |
| **Design Principles in Practice** | * ***Accuracy:*** The chart communicates its core message accurately but suffers from reduced interpretability due to label congestion. * ***Preattentive Processing:*** Use of color and iconography enables rapid identification of key patterns and outliers. * ***Visual Aesthetics:*** The overall design maintains a clean layout and adequate white space but lacks interactive or dynamic elements to improve user engagement. |

* **Overall Evaluation**

This visualisation demonstrates a clear and conceptually strong design for comparing national innovation trends. Its thematic consistency and use of visual cues are commendable. However, the execution is hindered by practical usability issues, particularly label overcrowding. Enhancing the chart with interactive elements (e.g., tooltips, zooming) or applying label decluttering strategies (such as grouping or toggles) would greatly improve its readability and usefulness for policy decision-making.

## **Visualisation 3: Share of Environmental Patents (2000–2017)**

A graph of different colored lines and numbers

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* **Source:** MDPI, Technological Eco-Innovation (<https://www.mdpi.com>)
* **Target Audience:** Researchers in innovation, economists, and policy advisors
* **Purpose:** To illustrate the evolution of the share of environmental patents over time in five major economies

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| **Data Representation** | This visualisation encompasses the following key elements:   * A time span covering the years 2000 to 2017 * Five countries: Germany, Japan, South Korea, the United States, and China * The core metric displayed is the percentage share of environmental patents * A supplemental data table beneath the chart provides exact numerical values for each year and country |
| **Visualisation Type & Encoding Techniques** | The visualisation uses a scatter plot format to depict two-dimensional growth comparisons:   * Line chart: Tracks annual trends in environmental patent shares across countries * Color-coded lines: Each country is represented by a distinct line color * Legend: Identifies each country's line via color association * Data table: Serves as a precise numerical reference for each plotted data point |
| **Strengths** | * ***Effective Use of Line Chart:*** The chart type is well-suited to depict longitudinal trends and facilitates comparison across countries. * ***Dual Modal Presentation:*** The inclusion of a numerical table enhances precision and supports users who prefer raw data. * ***Temporal Consistency:*** Regular annual intervals support cognitive tracking of changes over time. * ***Clear Distinction Through Color:*** Country trends are differentiated through a consistent color legend. |
| **Weaknesses** | * ***Limited Accessibility:*** Some color combinations (e.g., orange/yellow, blue/green) may pose difficulties for viewers with color vision deficiencies. * ***Visual Clutter from Line Intersections:*** During periods of close convergence (notably between 2008 and 2012), intersecting lines can obscure individual trends. * ***Lack of Contextual Explanation:*** Significant shifts—such as the sharp decline in several countries after 2012—are presented without annotation or contextual interpretation. * ***Suboptimal Legend Placement:*** Positioning the legend at the top of the chart disrupts the natural left-to-right reading flow; a side alignment would support smoother interpretation. |
| **Application of Perceptual and Ethical Principles** | * ***Gestalt Principles – Continuity and Similarity:*** Uniform line formatting reinforces a sense of continuity and comparability between countries. * ***Ethical Representation:*** The chart maintains an honest scale and displays the full data range, avoiding any manipulation of trends. * ***Cognitive Load:*** Generally manageable, though overlapping lines may slightly increase the effort required for interpretation during dense periods. |

* **Overall Evaluation**

This visualisation provides a robust and transparent depiction of temporal trends in environmental innovation. Its combination of graphical and tabular elements caters to different user preferences, from exploratory to precise analysis. However, its accessibility and interpretability could be significantly improved through better color differentiation, strategic legend placement, and the inclusion of contextual annotations that explain key changes or anomalies in the data.

## **Conclusion and Comparative Analysis**

The three visualisations examined each strive to communicate insights into environmental innovation using OECD patent data, and while they adopt suitable chart formats, their effectiveness varies depending on audience needs and visual design choices.

Each visualisation employs a chart type that aligns with its analytical purpose: a choropleth map for spatial comparison, a scatter plot for examining growth relationships, and a line chart for tracking changes over time. These structural choices demonstrate an understanding of how best to match data form with interpretative goals. Color is used consistently to emphasise categories and highlight key trends; however, none of the visuals address accessibility concerns, particularly for viewers with color vision deficiencies.

A common limitation across all three charts is the management of visual complexity. The first visualisation delivers extensive multidimensional information but may overwhelm general audiences due to cognitive overload. The second visualisation is visually compact yet suffers from label congestion, impairing clarity. The third provides a straightforward temporal view but lacks contextual annotations to explain major shifts and is hindered by color similarity and line crossings.

Another shared shortcoming is the absence of interactive functionality. Features such as zoom, tooltips, or filters would significantly enhance user engagement and allow for deeper data exploration. Likewise, annotations to explain anomalies—such as the sharp declines seen after 2012—would improve interpretability.

Overall, these visualisations underscore that effective data communication requires more than just accurate representation; it demands careful encoding, user-centred accessibility, and contextual depth. Future enhancements should prioritize interactive design and inclusive visual strategies to better support diverse audiences and decision-making contexts.