



Chart Design Process

IT 7113 Data Visualization

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<http://idi.Kennesaw.edu/it7113/>

Content Overview



This lecture notes discuss some chart design issues.

- Chart design process and considerations
- Tool selection

Why do we need a design process?



- A design process involves a defined set of design considerations and tasks.
 - A process consists of steps arranged in an order.
 - A repeatable and defined design process embodies maturity in design capability and experience.
- Benefits:
 - serves as a guide and a checklist to plan and manage the whole project
 - reduces the randomness and improves efficiency

Example Processes



- There are various ways to define a design process or a list of consideration.
 - Each process consists of configurable steps and actions.
 - A process can be flexible
- For example:
 - A 3-Step Approach To Data Visualization <https://digitalimpact.io/getting-started-a-3-step-approach-to-data-visualization/>
 - A 5-step guide to data visualization <https://www.elsevier.com/connect/a-5-step-guide-to-data-visualization>
 - The Data Visualization Design Process: A Step-by-Step Guide for Beginners <https://depictdatastudio.com/data-visualization-design-process-step-by-step-guide-for-beginners/>
 - Andy Kirk's 4 stages: <https://www.youtube.com/watch?v=GVkXbQOzKNs&t=754s> or Andy Kirk's book "Data at Work" Chapter 2
 - Design process for information visualization <https://www.interaction-design.org/literature/article/how-to-design-an-information-visualization>

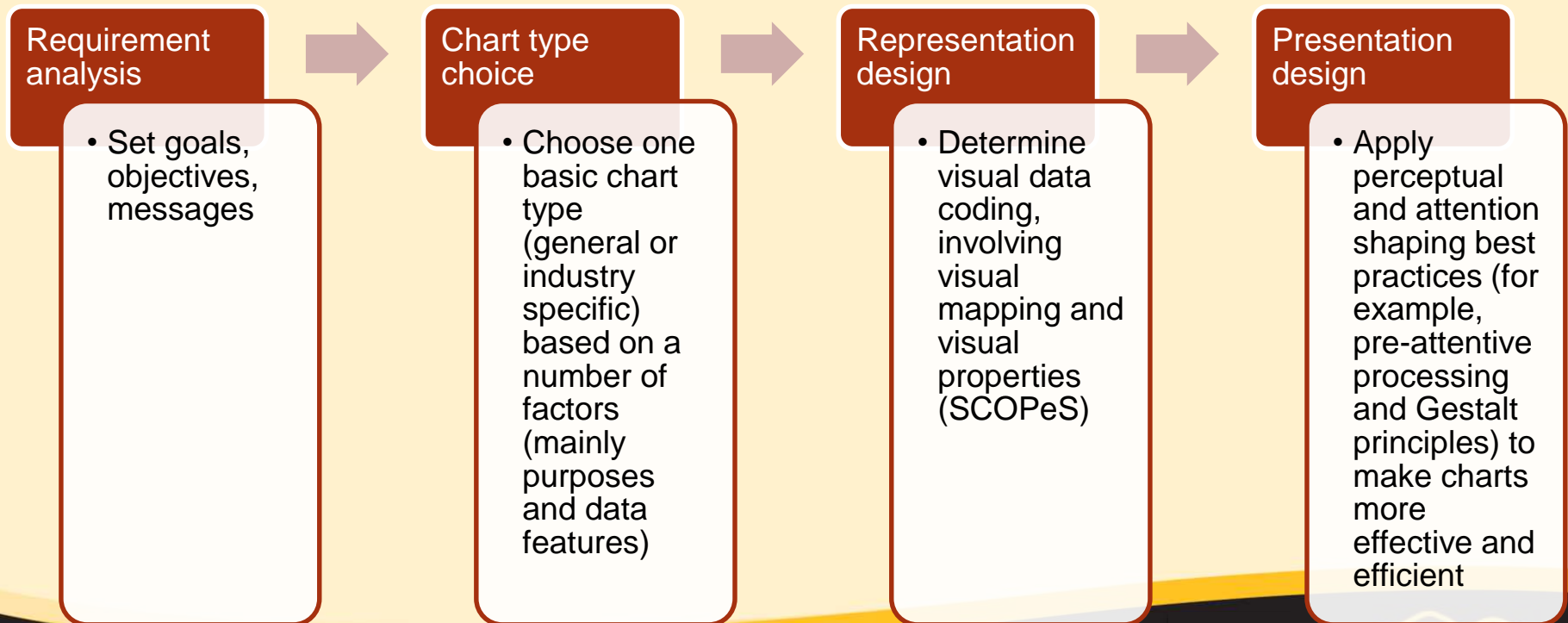
A Basic Chart Design Process



The following is a basic simple process for the most often scenario:

We need to visualize all data using a commonly used chart type (or with limited alterations).

Details of each step/task are presented in following slides.



1. Goals and Contexts



- Before any design or technical work. Analyze the requirements and be clear about the following factors, which impact all following steps.
- Key questions
 - What is the general goal and purpose of the data visualization?
 - What message am I trying to communicate with the data?
 - Who is the audience?

General Charting Purposes



Review the six general purposes or categories of charts in module 3

- <https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage> (the basic four)
- <http://www.excelcharts.com/blog/classification-chart-types/> (added evolution and profiling)

Purpose/function	Description
Comparison	Comparing and sorting data points; can also compare to benchmarks or norms.
Composition	A hierarchy relationship. Also, it may imply part-to-whole comparisons.
Distribution	Aggregated value (usually count) of data points placed in categories; the category can be value ranges or time (trend).
Relationship	How things (data items) are related or positioned in a bigger context.
Trend/evolution	Variation of comparison involving temporal data.
Profiling	To comprehend things through visual shapes and patterns.

Messages vs. General Purposes



- What message or point I want to make?
 - Messages are more granular details, insights, or stories you want to emphasize.
 - Purposes focuses on big picture for exploration while messages focus on more specific insights for communication.
 - The latest story telling trend in data visualization focuses more on the message.
- Example
 - General purpose: compare student enrollments in different degree programs across three departments
 - One may want to deliver different messages:
 - to emphasize the size of MSIT as the biggest program, or
 - to show in-significance among programs/departments

- Another example:

A general purpose on comparison among areas

A more specific message or point

Investment by area of impact

<https://www.storytellingwithdata.com/blog/2012/10/my-penchant-for-horizontal-bar-graphs>

We invest primarily in four areas

Since we began investing in 2006, **four areas** have received more than \$600K each, accounting for 75% of total grantmaking activity

Audience



- Consider specific user needs and preferences
 - User's familiarity of certain charts or techniques
 - Some chart types may be more complicated for a less-experienced person to understand, but they can communicate information better for more advanced users. For example, radar chart or dual axis chart.
 - Personal preferences: some may prefer more condense visual format while other prefer guided story style with narratives
 - Corporate culture
 - Business sector/industry
- These considerations will influence the choice of more specific chart type and presentation style.
- For example, users (audiences) from a certain industry may have a convention and expectation of using certain color scheme, type of charts, and layout.

2. Chart Choice



- Choosing the specific chart is also depends on the following important considerations.
 1. Start with some general grand purposes; match the intended purpose and the chart's major function.
 - Please review slide #7 and module 3 for more details.
 - Grand purposes and categories still may lead to several choices; so, this is just a starting point.
 2. Examine the data to be presented.
 - What kind of data? Need to know data types, structures, and # of attributes and data items.
- Other considerations (not focused on in this lecture)
 - Shape and size of charting space might be a factor
 - User/audience needs, preferences, conventions, etc.
 - Emotion, affection, culture, etc.
 - Chart customization: is one chart enough?

Initial Selection of Chart Type



- Match the intended purpose and the chart's major function.
 - Many guides and tools are created to guide the selection of chart types based on purposes. Some of them are one-page quick references and others are more interactive and detailed.
 - Please review module 3 for more details.

Ferdio*	http://datavizproject.com
Data catalog*	http://www.datavizcatalogue.com
From Data to Viz	https://www.data-to-viz.com
Chart make directory	http://chartmaker.visualisingdata.com

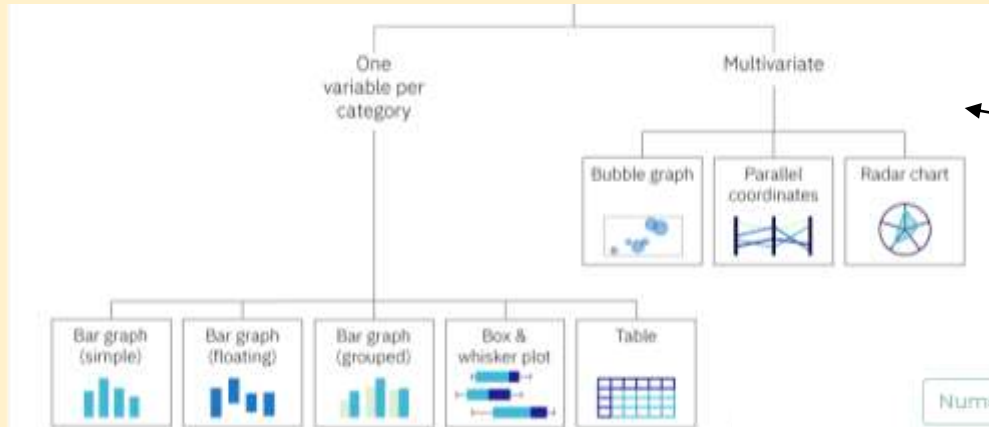
Abela's version	<ul style="list-style-type: none">• https://extremepresentation.com/design/7-charts/• https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage
Camões's version	https://excelcharts.com/classification-chart-types/
Juice Analytics	https://www.juiceanalytics.com/chartchooser
Schwabish's Graphic Continuum	<ul style="list-style-type: none">• https://policyviz.com/2014/09/09/graphic-continuum/• https://www.informationisbeautifulawards.com/showcase/611-the-graphic-continuum
Financial Times Visual Vocabulary	https://www.ft.com/vocabulary
Fraconeri's version	http://experception.net

Examine Data Set Features



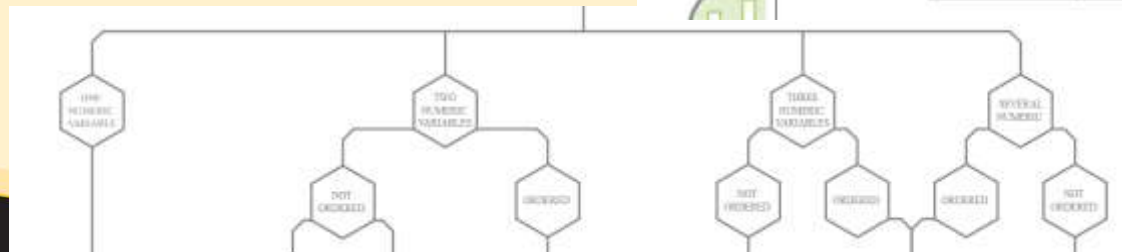
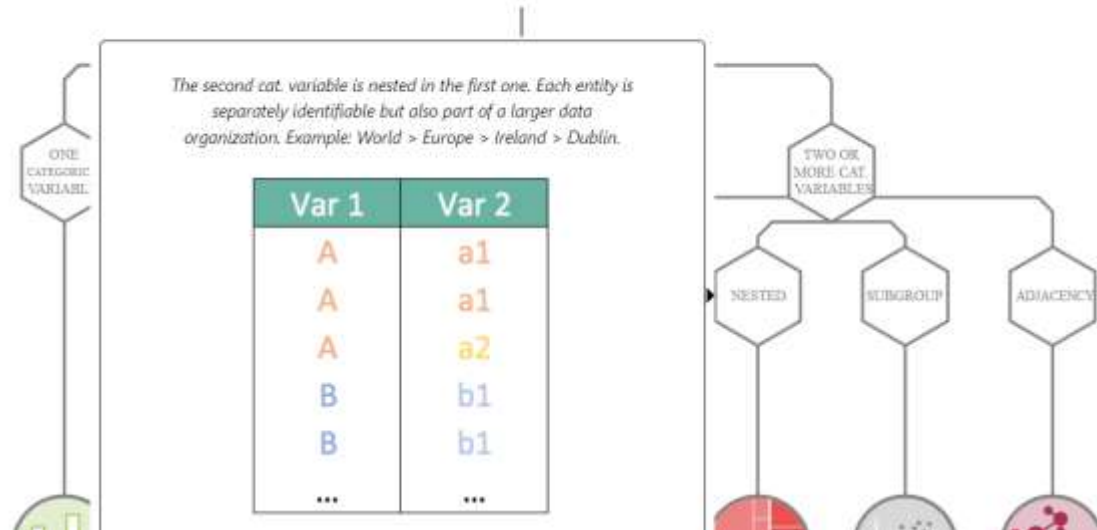
- Important data features to consider
 - Data size: how many data items or data serials will be in the chart?
 - Data type: temporal data, geo data, textual data, performance data, etc.
- Data size: different chart types have different limit for data sizes. Understand each chart type's limit.
 - How many data points or items (rows of data)?
 - How many dimensions or attributes (variables)?
- Variable/measure type – including data value range, measuring unit, business meaning, etc.
 - Measure vs. dimension
 - Numerical, ordinal, and nominal (categorical)
 - Are they same in range and unit?
 - Are data needed to be presented of consistent type or mixed?
- Data structure
 - Is there any specific relationship between data items and between variables, such as hierarchical?
- In addition, data model
 - Is the source data in a format suitable for the intended visual/chart?
 - Do we need to structure/transform data set in a particular form for desired visualization?
 - Depending on the tool, there may be a specific way to structure and transform the data, or special calculations need to be performed. For example, waffle chart in Tableau
<https://www.pluralsight.com/guides/tableau-playbook-waffle-chart>

Data Size (Variables) Impact on Chart Choice



Number of variables leads to different chart types

See how data set features are described at <https://www.data-to-viz.com> and <https://datavizproject.com> (under the “Input” menu item)



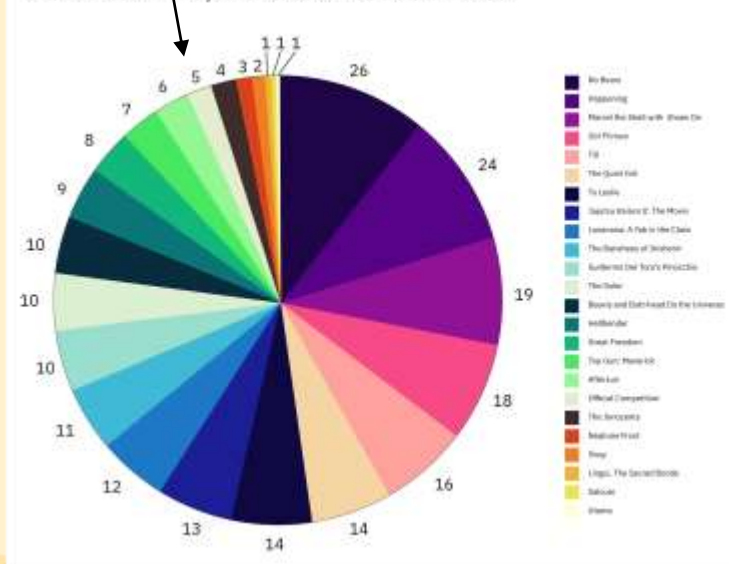
Data Size (Items) Impact on Chart Choice



- A few data items <5
 - Pie chart, column/bar chart
- Quite some items <10 or 20
 - Bar chart, line, bubble chart
- Many many data items (rows) >20
 - Profile charts, tree map, bubble chart, scatterplot, line charts (many time periods), parallel coordinates, etc.

Pie charts cannot handle too many data points; and can only display one variable.

Pseudo-random survey of favorite movies released in 2022



Bubble charts can handle up to 4 variables, and many data items.

Competitive landscape



3. Representation (Visual Features) Design



- A chart type only provides a foundation or framework to the final chart design. The next step is to apply various visual features.
- Note a chart type already sets a framework for most of the visual mapping on measures – column chart maps values to size of the columns, etc.

This usually involves two major tasks.

1. Visual mapping – mapping of data to visual elements of the chosen chart; this is usually *chart specific*
 - For example, in a dual axis combo chart, which data series should be mapped to x axis or y axis, etc.; which data should be represented by bars, etc.
 - Or in a cluster column chart, determining clustering order.
 - Or in a bubble chart, choose which dimension to be coded (as the bubble chart support limited number of dimensions)
2. Choice of visual property and visual encoding for data
 - SCOPeS (refer to module 2 <https://www.edocr.com/v/631d1wpb/jgzheng/scopes-visual-properties>). For example, choosing colors or sizing options.
 - Proper use of visual variables; apply the right visual decoration/properties.
 - Color choices

4. Presentational Design



- The main focuses of presentational design is the usability and perceptual enhancement features, which involves preattentive features and Gestalt laws

For details, refer to learning module 2

<https://www.edocr.com/v/e6ql9njin/jgzheng/data-visual-foundation>

- Apply pre-attentive attributes to distinguish the major data points or serials, or ones closely related to you message.
 - Pre-attentive processing can help to rapidly draw the focus of attention to a target with a unique visual feature
 - For example, using contrast to differentiate the part that needs to draw attention
 - <http://kenhirakawa.com/significance-of-contrast/>
 - <https://www.coursera.org/lecture/dataviz-design/strategic-use-of-contrast-sDV6C>
- Apply Gestalt principles to group and sort data points and chart objects
 - <https://www.webfx.com/blog/web-design/data-visualization-gestalt-laws/>

Other Presentational Issues



- Contextual data
 - Benchmark, trend line, total, average, difference, quartile, estimate, confidence range, etc.
 - How to add them?
 - added directly in the chart, as a data serial
 - using annotations
- Other UI and decorative features
 - font, grid line, shading, etc.
- Descriptive and explanatory features
 - including title, legend, annotation, label, etc.

Note: these issues are not focused on in this class. We will briefly mention general UI design principles and guidelines in module 5. Please apply them based on your own study and experience.

Need Customization?



- Most of the time, we start with a conventional and standard chart, and that may be enough.
- Sometimes, we have some need to go beyond conventional chart types.
- Customization examples
 - Add more objects and properties
 - Incorporate features from other chart types
 - Using additional charts
 - Need to stack or overlay additional chart to make desired effect
 - These additional charts can be hierarchical, supplementary, or just change of view/perspective.
 - Arrangement of multiple charts: need to consider position, layout, sequence, transition.
 - Multiple charts can be placed side by side, stacked, overlapped, and sequenced.
- If, none of the standard chart and customization is satisfying – rare situation but it happens
 - Design some unique and innovative visualizations beyond common well-known chart types – a good research topic.

Other Design Issues



- Charting principles and best practices (see module 5)
- Design with geo data and map (see module 7)
- Dashboard design (see module 9)
- Interactivity features (see module 10)

Choosing and Using a Visualization Tool



- Modern visualizations are largely dependent or enabled by visualization software tools
- The design of the visualization should also consider tool features and capabilities
- Know tool (software application) features
 - Data handling features: complexity, volume, structure, source import, calculation, data modeling/structuring and transformation capability, etc.
 - The possibility or complexity of certain types of charts
 - Customization and hacks: overlapping, static add, scripting, annotation
 - Data update: how, frequency
 - Delivery medium: screen type, web, etc.
 - Skills sets and needs of users and developers
- Refer to this web app for a summary of tools and features match
 - <http://chartmaker.visualisingdata.com>

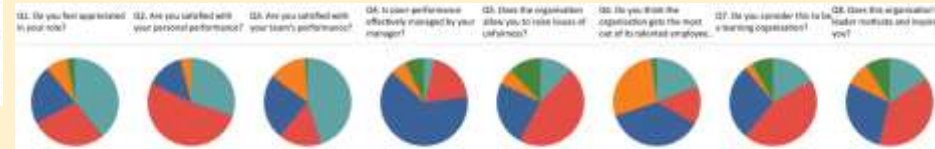
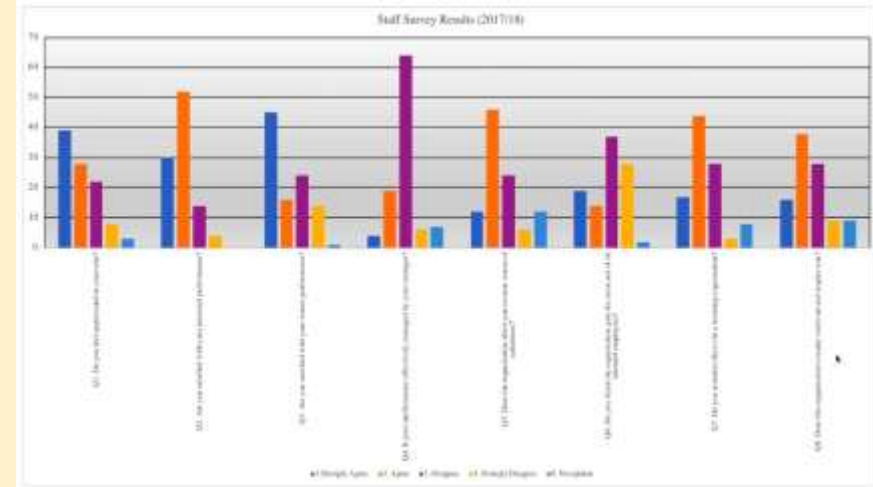
A Design Case

<https://youtu.be/GVkXbQOzKNs?t=2152> The discussion of the case started at 35:52



Based on 258 responses conducted during March 2018

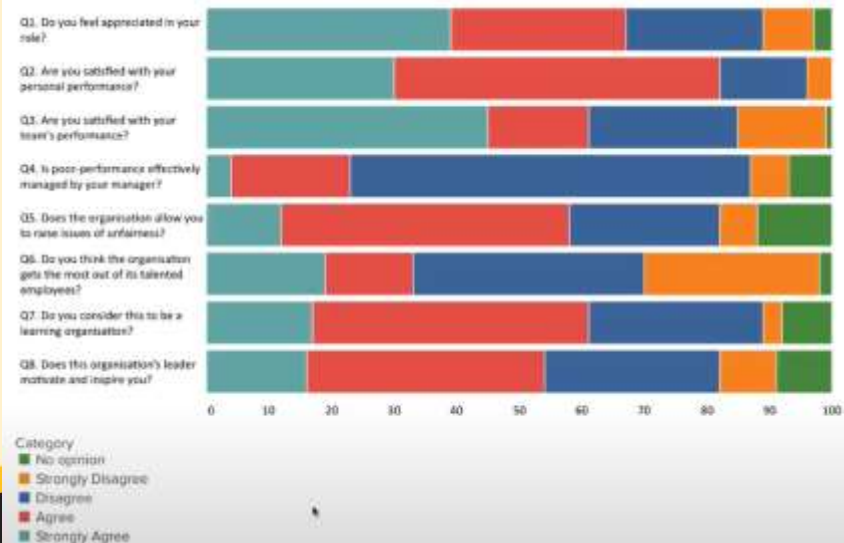
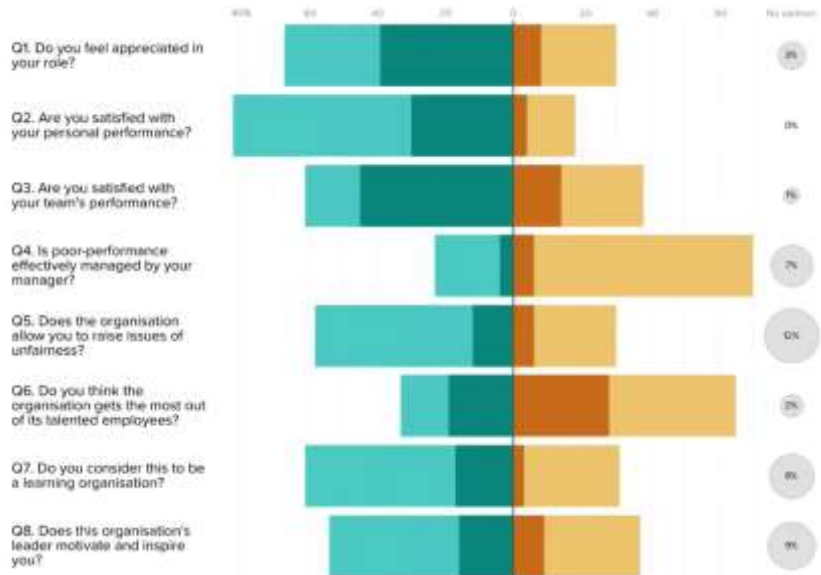
Qu. Fall 2017/18	1. Strongly Agree	2. Agree	3. Disagree	4. Strongly Disagree	5. No opinion
Q1. Do you feel appreciated in your role?	39	28	22	8	3
Q2. Are you satisfied with your personal performance?	30	52	14	4	0
Q3. Are you satisfied with your team's performance?	45	16	24	14	1
Q4. Is poor-performance effectively managed by your manager?	4	19	64	6	7
Q5. Does the organisation allow you to raise issues of unfairness?	12	46	24	6	12
Q6. Do you think the organisation gets the most out of its talented employees?	19	14	37	28	2
Q7. Do you consider this to be a learning organisation?	17	44	28	3	8
Q8. Does this organisation's leader motivate and inspire you?	16	38	28	9	9



Category

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- No opinion

% breakdown of 258 responses that AGREE, STRONGLY AGREE, STRONGLY DISAGREE, or DISAGREE with each statement



More Cases



- What's your point? Communicate the most important insight, from a story telling perspective
 - <https://www.storytellingwithdata.com/blog/2021/1/10/lets-improve-this-graph-yt9xj>

BEFORE: SHOWING DATA

July Results



ANALYSIS FINDINGS: Total unit decline in 12-month (-26%) and 48-month (-36%) from August to July, while cash grew (10%).

AFTER: STORYTELLING WITH DATA

Consumer behavior has shifted

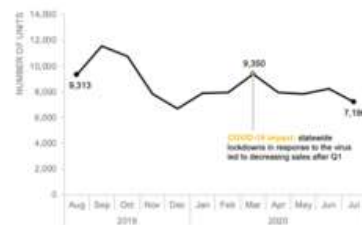
Total units sold is **down 22.7% YoY** and down 23% since **the impact of COVID lockdowns** in the US.

The COVID impact caused a sharp decrease in the number of units sold as of July. We expect this decline to level out by each year-end due to discussions with key customers about resuming their purchasing cycles.

Purchase type composition has evolved over time. **How might this impact our go-forward strategy?**

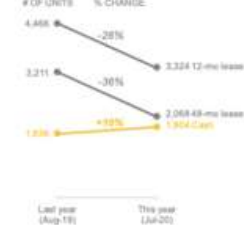
As a result of the market and access to financing, the 12 and 48 month leases are decreasing in utilization. **Cash purchases have increased 10% in the last 12 months.** We expect this to continue.

Total sales over time



Footnote here with data source, relevant metrics definitions, assumptions, methodology, etc.

Sales by purchase type



- An alternative to tree maps
 - <https://www.storytellingwithdata.com/blog/2018/6/5/an-alternative-to-treemaps>

Key Resources



- A 3-Step Approach To Data Visualization
<https://digitalimpact.io/getting-started-a-3-step-approach-to-data-visualization/>
- A 5-step guide to data visualization
<https://www.elsevier.com/connect/a-5-step-guide-to-data-visualization>
- The Data Visualization Design Process: A Step-by-Step Guide for Beginners
<https://depictdatastudio.com/data-visualization-design-process-step-by-step-guide-for-beginners/>

Additional Good Resources



- Andy Kirk's 4 stages:
<https://www.youtube.com/watch?v=GVkXbQOzKNs&t=754s> or Andy Kirk's book "Data at Work" Chapter 2
- Design process for information visualization
<https://www.interaction-design.org/literature/article/how-to-design-an-information-visualization>
- Accurate vs. Emotional Comparisons
<https://www.datarevelations.com/accurate-vs-emotional-comparisons-sometimes-pies-bubbles-and-waffles-are-the-better-choice/>