Quantitative Analysis in Survey Research

Exploratory Data Analysis and Hypothesis Testing
Introduction

- **Data Cleaning**
  - Identify survey completion metrics
  - Survey response deduplication and disqualification
  - Skip logic enforcement
  - Finalization of the dataset

- **Exploratory Data Analysis**
  - Revisit initial questions and assumptions
  - Response rates
  - Answer counts
  - Crosstabs

- **Item Analysis**
  - Composite creation

- **Scoring Methods**

- **Statistics**
  - Hypothesis Testing
  - Comparison of means
  - Pearson correlations
  - Research Questions

- **Conclusions**
Data Cleaning

- Data Collection
- Data Cleaning
- Data Interrogation
- Revisit Research Questions
- Adjust Analytical Approach
- Pattern Identification

Statistical Analysis
Data Cleaning

- **Deduplication**
  - A respondent has submitted more than one survey
- **Disqualification**
  - Respondent answered questions randomly
  - Respondent chose the same answer for each question
  - Respondent answered inconsistently

1. I have had only positive experiences at the Pattee Library.
   - □ Strongly agree
   - □ Agree
   - □ Neither agree nor disagree
   - □ Disagree
   - □ Strongly disagree

2. I have never had a negative experience at the Pattee Library.
   - □ True
   - □ False
Data Cleaning

• Skip Logic Enforcement
  • Manual recoding of responses

• Finalization
  • Extraneous answers removed
  • Check for completeness of administrative data
  • One survey complete from each respondent
  • **Determine what is a complete survey**

<table>
<thead>
<tr>
<th>Q01</th>
<th>Q02</th>
<th>Q03</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>70</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>40</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Cleaning and Survey Completion Metrics

• What is considered a completed survey?
  • Respondent progressed to the final question
  • All questions have been answered
  • A certain threshold of questions have been answered
  • A calculated score
    • Weighted importance of questions
  • Any question has been answered
Data Cleaning and Survey Completion Metrics

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Exploratory Data Analysis

Data Collection

Data Interrogation

Data Cleaning

Adjust Analytical Approach

Revisit Research Questions

Pattern Identification

Statistical Analysis
How do we get a final dataset?

What trends should we investigate?

Are there consistent themes in our questions?

How do we interpret our results?

Exploratory Data Analysis
• Revisit Initial Research Questions
  • Are we interested in patterns among demographic subgroups?
    • Did enough respondents complete the survey?
  • Which experiences are respondents evaluating in the survey?
  • Is there a time-sensitive program being evaluated?
  • Are respondents representative of the population?
Exploratory Data Analysis

• Revisit Initial Research Questions
  • Are we interested in patterns among demographic subgroups?
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  • Are respondents representative of the population?
Exploratory Data Analysis

• Revisit Initial Research Questions
  • Which components of our services are most important?
  • What information can we gain from the survey that is actionable?
  • How do we gain information from our survey to create or modify a new program?
Survey Response Rates

- Vary depending on population
  - Can vary by subgroup
  - Reveal how representative the respondents are
- There is no response rate less than 100% that guarantees representativeness
- Effects may go in two directions:
  - Subgroups may inherently answer questions differently
  - Unrepresentative respondents may provide less valid results
Answer Choice Counts

- Simplest method to view results
- Can be represented as counts or proportions
- Shows the relative popularity of answer choices for questions with the same scale
Crosstabs

- Reveal how those who responded to one question responded to another
  - Can reveal hidden subgroups and preferences within the data
- Do not require advanced statistics
- Do require a large number of respondents to extract meaningful results

- Identify errors in survey design
- Can reveal trends in the data that would likely be found in a formal hypothesis test
- May also reveal multicollinearity/confounds in demographic variables
  - Suggests that a more advanced statistical technique will be needed to separate the effects of collinear independent variables
### Crosstabs

<table>
<thead>
<tr>
<th>Q08: How satisfied are you with library services?</th>
<th>Q01: How many times did you visit the library this year?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Satisfied</td>
<td>0 15 23 30</td>
</tr>
<tr>
<td>Satisfied</td>
<td>25 14 8</td>
</tr>
<tr>
<td>Neither Satisfied nor Dissatisfied</td>
<td>4 5 2</td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>8 3 1</td>
</tr>
<tr>
<td>Very Dissatisfied</td>
<td>6 1 0</td>
</tr>
</tbody>
</table>
Crosstabs

<table>
<thead>
<tr>
<th>Q08: How satisfied are you with library services?</th>
<th>18-23</th>
<th>24-35</th>
<th>36-64</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Satisfied</td>
<td>76</td>
<td>54</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Satisfied</td>
<td>34</td>
<td>9</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>Neither Satisfied nor Dissatisfied</td>
<td>12</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Very Dissatisfied</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Q34: What is your age?

- 18-23: 76
- 24-35: 54
- 36-64: 20
- 65+: 30
- 76+
- 54+
- 20+
- 30+
Item Analysis

- Data Collection
- Statistical Analysis
- Pattern Identification
- Data Cleaning
- Data Interrogation
- Revisit Research Questions
- Adjust Analytical Approach
Survey Validity & Reliability

• Validity
  • Does the survey measure what we intend for it to measure?

• Reliability
  • Will the survey produce the same results if given a second time?
  • Will each respondent understand the question in the same way?

Reliability Statistic: Cronbach’s Alpha
• Not typically used for overall survey reliability, but for composite development

\[ \alpha = \frac{N\bar{c}}{\bar{\bar{u}} + (N - 1)\bar{c}} \]
Composites

- Improve interpretability
  - Generate themes that can easily be explained in reports
  - Individual questions become components
- Easier to track changes over time
- Less reliant on specific question wording
- Improves construct validity
  - Possibility to compare against other thematic composites
- Generated after data collection

Customer Service Composite

1. How long did it take to get a response to your inquiry?
2. When you spoke with an agent, was he/she able to help you solve the problem?
3. How often did you contact customer service?
4. Was the agent polite when speaking with you?
Item Analysis with Cronbach’s Alpha

- For composite development
  - A set of questions that have one theme or are associated with one outcome measure
    - (customer service, overall satisfaction, etc.)
- Measure not a statistical test
  - Internal variance and inter-item covariance terms
- Heuristic to select questions for thematic composites

\[ \alpha = \frac{N\bar{c}}{\bar{v} + (N - 1)\bar{c}} \]
Item Analysis with Cronbach’s Alpha

• Alpha statistic represents the internal consistency of a set of questions (composite)
• Item-total correlation provides a coherence metric for one question compared against all others
• Statistical software will also provide the alpha statistic in the case when a question is removed
  • Same information as item-total correlation
Cronbach’s Alpha vs. Pearson Correlation

• Cronbach’s Alpha
  • Measure of reliability
  • Used to make a decision about thematic composites
  • No straightforward method for hypothesis testing
  • Comparison among multiple (2+) questions

• Pearson Correlation
  • Measure of correlation
  • Used to determine covariance among questions
  • Used in hypothesis testing
  • Comparison only between two questions
Individual Question: Scoring Methods

- Represent answer choices scales in numeric form
- Proportional Scoring
  - Score of each answer choice is set relative to the score for the whole scale
- Top Box Scoring
  - Only the most positive answer choices are given a nonzero value

**Proportional Scoring**
- Never (0), Sometimes (0.33), Usually (0.67), Always (1)

**Top Box Scoring**
- Very Satisfied (1), Satisfied (1), Neither Satisfied nor Dissatisfied (0), Dissatisfied (0), Very Dissatisfied (0)
Proportional vs. Top Box

- Proportional scoring allows for comparisons between questions with different scales.

- Top Box scoring collapses the scale into a more digestible form for reporting.
  - Particularly useful when there are few negative responses.

Proportional Scoring

- Never (0), Sometimes (0.33), Usually (0.67), Always (1)

Top Box Scoring

- Very Satisfied (1), Satisfied (1), Neither Satisfied nor Dissatisfied (0), Dissatisfied (0), Very Dissatisfied (0)
Composite Scoring

• More complex than individual question scoring
  • Missing responses
    • When to disqualify an individual's composite score
  • Weighting possibilities
  • Imputation

• Abstracted from the original survey results
  • More easily interpreted and useful for year-over-year comparisons

Q01(Sometimes, 0.33); Q02(True, 1); Q03(Satisfied, 0.75); Q04(False, 0) =

\[(0.33 + 1 + 0.75 + 0) / 4 = 0.52\]

Q01(Sometimes, 0.33); Q02(NA); Q03(Satisfied, 0.75); Q04(False, 0) =

\[(0.33 + 0.75 + 0) / 3 = 0.36\]
Composite Scoring

- More complex than individual question scoring
  - Missing responses
    - When to disqualify an individual’s composite score
  - Weighting possibilities
- Abstracted from the original survey results
  - More easily interpreted and useful for year-over-year comparisons
    - Can change question text but keep same composite

Half-Scoring
- At least half of the individual items must be answered for the composite score to be recorded

Proportional Scoring
- All items are included in the composite and scored based on the size of the scale

Top Box
- All items are included in the composite, but only the choices are collapsed into 0-1 scores
Statistical Analysis

- Adjust Analytical Approach
- Revisit Research Questions
- Data Cleaning
- Data Interrogation
- Pattern Identification

Data Collection

Statistical Analysis
Mean Comparisons: t-tests

- Compare mean scores
- Hypothesis Testing
  - Year-over-year changes
  - Comparisons between subgroups
- Comparisons between composites

\[ t = \frac{m - \mu}{s/\sqrt{n}} \]

- \( t \) = Student's t-test
- \( m \) = mean
- \( \mu \) = theoretical value
- \( s \) = standard deviation
- \( n \) = variable set size
Pearson Coefficient

- Among the most useful statistics in survey research
  - Used in hypothesis testing
- Correlation between survey questions
- Uncover which question(s) drive performance for a specific service
  - Often used to measure correlation between a specific question and overall satisfaction

\[
r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}
\]

- \( r \) = correlation coefficient
- \( x_i \) = values of the x-variable in a sample
- \( \bar{x} \) = mean of the values of the x-variable
- \( y_i \) = values of the y-variable in a sample
- \( \bar{y} \) = mean of the values of the y-variable
Pearson Coefficient

<table>
<thead>
<tr>
<th></th>
<th>Visit Frequency</th>
<th>Customer Service</th>
<th>Opening Hours</th>
<th>Software Availability</th>
<th>Study Rooms</th>
<th>Overall Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit Frequency</td>
<td>1</td>
<td>0.76</td>
<td>0.9</td>
<td>0.23</td>
<td>-0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Customer Service</td>
<td>0.76</td>
<td>1</td>
<td>0.6</td>
<td>0.1</td>
<td>0.14</td>
<td>0.9</td>
</tr>
<tr>
<td>Opening Hours</td>
<td>0.9</td>
<td>0.6</td>
<td>1</td>
<td>0.4</td>
<td>0.95</td>
<td>0.65</td>
</tr>
<tr>
<td>Software Availability</td>
<td>0.23</td>
<td>0.1</td>
<td>0.4</td>
<td>1</td>
<td>0.01</td>
<td>0.32</td>
</tr>
<tr>
<td>Study Rooms</td>
<td>-0.1</td>
<td>0.14</td>
<td>0.95</td>
<td>0.01</td>
<td>1</td>
<td>0.57</td>
</tr>
<tr>
<td>Overall Satisfaction</td>
<td>0.6</td>
<td>0.9</td>
<td>0.65</td>
<td>0.32</td>
<td>0.57</td>
<td>1</td>
</tr>
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</table>

Overall Satisfaction Question: On a scale from 1 to 10, with 10 being the most satisfied, how satisfied are you with the library’s current services?
Pearson Coefficient

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- \( \bar{y} \) = mean of the values of the y-variable
Answering Research Questions

- **Theory**
  - Services can be divided into components that drive performance on specific measures

- **Representativeness**
  - Demographics

- **Change over Time**
  - New programs or interventions

- **Interpretability**
  - Communication with stakeholders

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**Before Data Collection**
- **Research Questions**

**After Data Collection**
- **Patterns in Data**
  - Reformulate Hypotheses

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**Exploratory Analysis**
- **Statistical Analysis**
Conclusions

- Data cleaning and deduplication preserve survey integrity
- Exploratory data analysis provides a chance to detect trends and gain intuition
- Composite formation improves both reliability and validity
- Hypothesis testing based on expert knowledge
Fall Workshop: Survey Reporting

- Regression analysis
- Preparation for future survey cycles
  - Reliability testing
  - Survey structure review and question editing
- Report structure and development
  - Visualization principles
  - Interpretation of findings
- Dashboarding and written reports