IDENTIFYING ENTREE-WINE PAIRINGS FOR EATS4LIFE

BLUE FALL 2 TEAM 17

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Overview

Eats4Life would like to update its menu to include wine suggestions for each of their main entrees. The owner has asked our team to perform an apriori association analysis to determine which items are frequently ordered together. The order information is based on over 75,000 individual orders. Every order consisted of a main entree, a wine, and a side dish.

The first portion of our analysis focused on finding a wine pairing for all eight main entrees offered by the restaurant. We found a total of 21 entree-wine associations at the cutoff criteria we selected to give at least one association for every entree. Further, the Filet Mignon and Blackstone Merlot had both the highest confidence and lift of all these associations.

The second portion of our work opened up the analysis to any other trends present in the order data. In doing so, we saw that the top six association rules by confidence and 12 of the top 14 association rules by lift using the same cutoffs implied a two-way relationship: purchasing Blackstone Merlot and a given side indicates the diner is likely to purchase the Filet Mignon. We strongly recommend promoting each of our reported pairings, but especially the most prominent association - the Filet Mignon and Blackstone Merlot.

Methodology

Data Used

The data used in this analysis was collected by the owner over the past several years on the entrees, sides, and wines that were ordered by diners. Each order number is split into the seat that corresponds to a specific diner's order. Then, each seat corresponds to any combination of exactly one entree, one side, and one wine that the diner ordered. Table 1 outlines all of the unique entrees, sides, and wines found in the data, ordered by their frequencies.

Table 1: All Unique Entrees, Wines, and Sides Found in the Data, Ordered by Frequency

	Entree	Side	Wine
1	Filet Mignon	Seasonal Veggies	Duckhorn Chardonnay
2	Sea Bass	Bean Trio	Adelsheim Pinot Noir
3	Pork Tenderloin	Roasted Root Veggies	Blackstone Merlot
4	Pork Chop	Warm Goat Salad	Total Recall Chardonnay
5	Salmon	Roasted Potatoes	Single Vineyard Malbec
6	Duck Breast	Caesar Salad	Innocent Bystander Sauvignon Blanc
7	Swordfish	Mashed Potatoes	Oyster Bay Sauvignon Blanc
8	Roast Chicken		Echeverria Gran Syrah
9			Brancott Pinot Grigio
10			Cantina Pinot Bianco
11			Louis Rouge
12			Helben Blanc
13			Three Rivers Red

As shown in Table 1, above, our dataset has a total of eight entrees, seven sides, and 13 wines available to diners at Eats4Life. The frequencies of each are visualized in the Appendix.

Data Manipulation

In order to have one observation per diner, we created a unique identifier consisting of the order ID and the seat ID for each diner. This made it possible to isolate each diner and identify their specific combination of orders. Once this process was complete, we began conducting the association analysis as documented below.

Association Analysis

In order to identify potential entree and wine pairing options, our team performed an apriori association analysis to identify which entrees were most often paired with which wines. In this part of the analysis, our team decided to ignore side dishes to get one-to-one pairings of entrees to wines. This resulted in 21 unique pairings, which are summarized in Table 4 in the Appendix. After conducting the association analysis on the entrees and wines, confidence and lift were calculated for each pair. Whichever pair resulted in the highest value for each entree was then selected as our recommendation for an entree-wine pairing.

Analysis and Results

Tables 2 and 3, below, summarize the results of the procedure for deriving the best entree-wine pair based on confidence and lift, respectively. The rules were generated via an apriori algorithm based on a support threshold of 0.008 and a confidence threshold of 0.15. These thresholds were selected so that all eight entrees had a combination present in both tables. This ensures that even the least common entree choices, Salmon and Roast Chicken, have two wine suggestions. Rows highlighted blue represent pairings that are consistent between the tables, while orange rows with italicized text indicate two different entree-wine pairing suggestions.

Table 2: Main Entree and Wine Pairing Recommendations Based on Confidence

|	Main Entree	Wine	Confidence
1	Filet Mignon	Blackstone Merlot	35.67%
2	Duck Breast	Blackstone Merlot	31.67%
3	Pork Tenderloin	Adelsheim Pinot Noir	29.93%
4	*Sea Bass*	*Duckhorn Chardonnay*	*24.93%*
5	*Pork Chop*	*Duckhorn Chardonnay*	*22.92%*
6	*Roast Chicken*	*Total Recall Chardonnay*	*20.32%*
7	*Swordfish*	*Duckhorn Chardonnay*	*17.97%*
8	Salmon	Total Recall Chardonnay	17.64%

At the top of Table 2, we see diners who order Filet Mignon also order Blackstone Merlot 35.67% of the time. This represents a marked improvement from randomly choosing one of the 13 wine options. This improvement is captured in the lift, as documented in Table 3.

Table 3: Main Entree and Wine Pairing Recommendations Based on Lift

	Main Entree	Wine	Lift
1	Filet Mignon	Blackstone Merlot	3.21
2	*Roast Chicken*	*Oyster Bay Sauvignon Blanc*	*3.07*
3	Duck Breast	Blackstone Merlot	2.85
4	*Sea Bass*	*Innocent Bystander Sauvignon Blanc*	*2.71*
5	*Swordfish*	*Brancott Pinot Grigio*	*2.56*
6	Pork Tenderloin	Adelsheim Pinot Noir	2.21
7	Salmon	Total Recall Chardonnay	1.68
8	*Pork Chop*	*Single Vineyard Malbec*	*1.66*

The same pairing of Filet Mignon and Blackstone Merlot had the highest lift of all entree-wine pairings. This means that a diner is over 3.2 times more likely to order Blackstone Merlot if a Filet Mignon is ordered than buying Blackstone Merlot independently. More broadly, all lift values are above 1.65, indicating that a customer who selects the given entree is at least 1.65 times more likely to purchase the associated wine than a diner ordering that wine randomly.

When expanding the analysis to all rules with the specified support and confidence thresholds, the top 14 rules sorted by descending lift are reported in Table 5 in the Appendix. We notice that the combination of Blackstone Merlot and Filet Mignon is present in 12 of the first 14 instances. A graph representing this phenomenon among these 14 rules is shown in Figure 1.
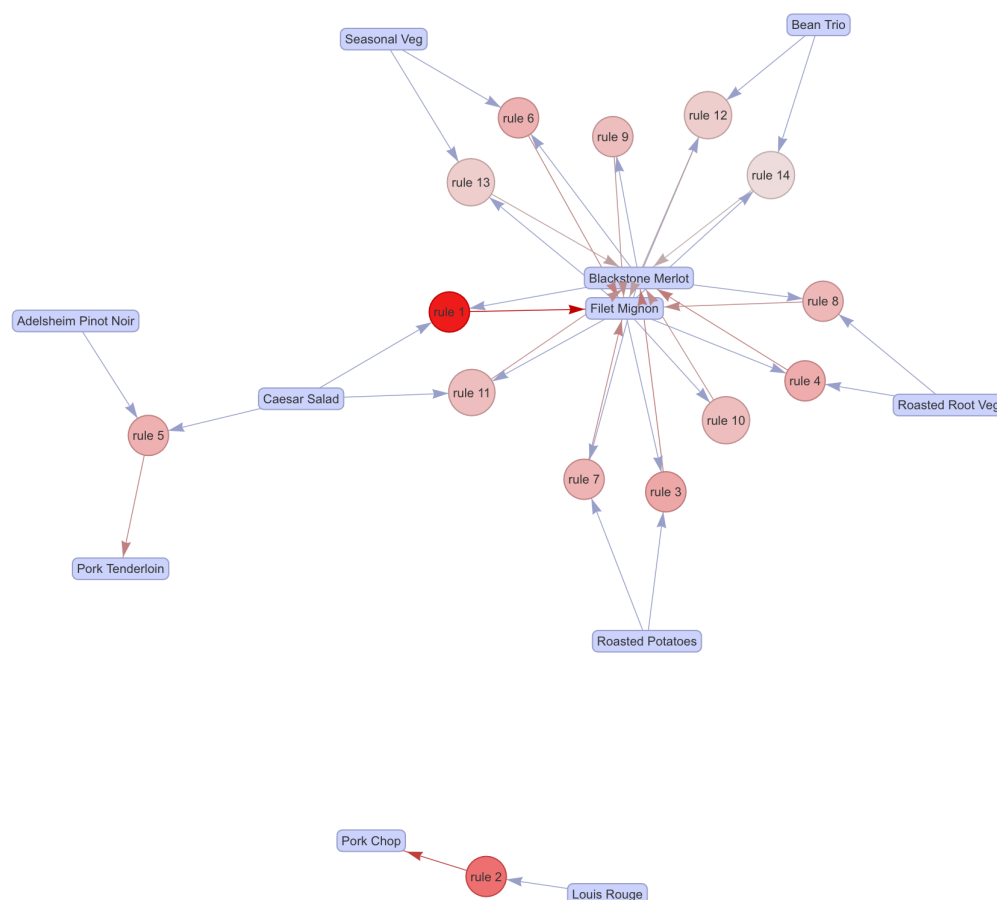
Figure 1: Graph-based Representation of Top 14 Apriori Rules by Lift for All Items

The graph above offers a visual representation of the strong relationship between ordering the Filet Mignon and the Blackstone Merlot, as we can see with the large proportion of rules containing edges to both the merlot and the filet. While the main focus of this analysis was to identify wine pairings based on a selected entree, it is interesting to note two additional relationships based on a diner selecting a particular wine. If a diner purchases the Adelsheim Pinot Noir and a Caesar Salad, they are 3.25 times more likely to also purchase the Pork Tenderloin than a diner choosing an entree at random. Additionally, if a diner purchases the Louis Rouge, they are 3.4 times more likely to purchase the Pork Chop than a diner choosing an entree at random. This can be seen numerically in Table 5 in the Appendix.

Recommendations

As a result of our association analysis, we have identified wines that are the most likely to be ordered with a given entree. Based on this result, we recommend promoting these wines to diners who order the paired main entree in the future. Specifically, we recommend:

- Utilizing Table 2 to create a wine pairing suggestion next to each main entree within the menu based on the highest confidence wine pairing. Additionally, utilize Table 3 to create a suggestion list for the wait staff based on the lift from the selected entree.
- Creating a simplified paired tasting menu based on the pairings with the highest confidence. If adopted, consider including the Louis Rouge with the Pork Chop, along with both the Adelsheim Pinot Noir and Caesar Salad with the Pork Tenderloin based on their relatively high lift values.
- Considering promotional discounts that can be offered to the paired wine(s) when a diner orders a main entree.

We believe that adopting the above recommendation pairings will contribute to an increase in sales while offering a more frictionless diner experience. By suggesting wines that were more likely to be ordered together with the main entree, diners are more likely to order that wine compared to choosing it from a wine list themselves. We believe these recommendations will improve the customer experience, in turn generating increased customer loyalty and sales. Given that the Filet Mignon and Blackstone Merlot had the highest confidence and lift, we recommend implementing at least one of the promotional measures stated above for this pairing especially. We also recommend continuing this analysis to explore more dynamic associations that include side dishes.

Conclusion

In our apriori association analysis for Eats4Life, our team found a strong biconditional association between Filet Mignon and Blackstone Merlot. Other entrees such as Duck, Salmon, and Pork Tenderloin had consistent wine suggestions of Blackstone Merlot, Total Recall Chardonnay, and Adelsheim Pinot Noir, respectively. For entrees that had inconsistent wine suggestions, including the Roast Chicken, Sea Bass, Swordfish, and Pork Chop, we suggest utilizing both the highest confidence and lift wine pairings as recommendations to diners. Our team offered a number of recommendations based on our findings for the owner to adopt to encourage diners to order wine with their meal. We suggest showing wine suggestions on the menu next to the main entree, discounts when diners select the wine suggested with the entree, and a tasting menu for diners to try sample entrees with the wine suggestions. We believe that, based on our association analysis, these recommendations will increase sales and customer satisfaction.

Appendix

Descending Order of Entree Frequency
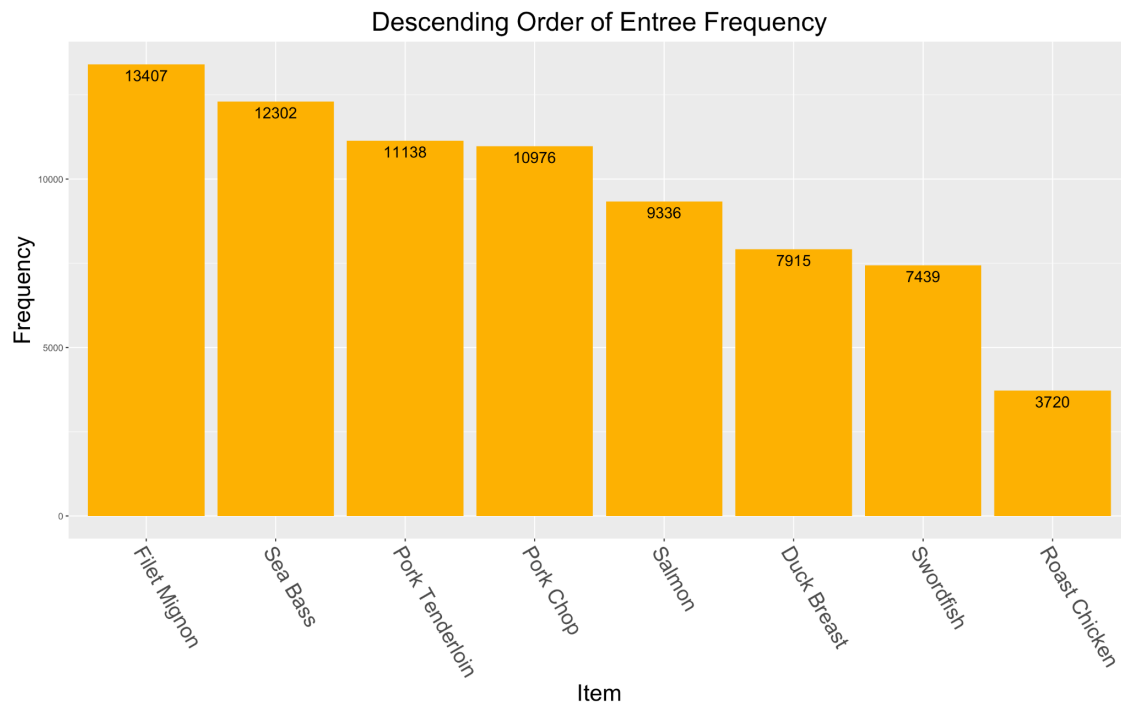
Figure 2: Descending Order of Most Frequently Purchased Entrees
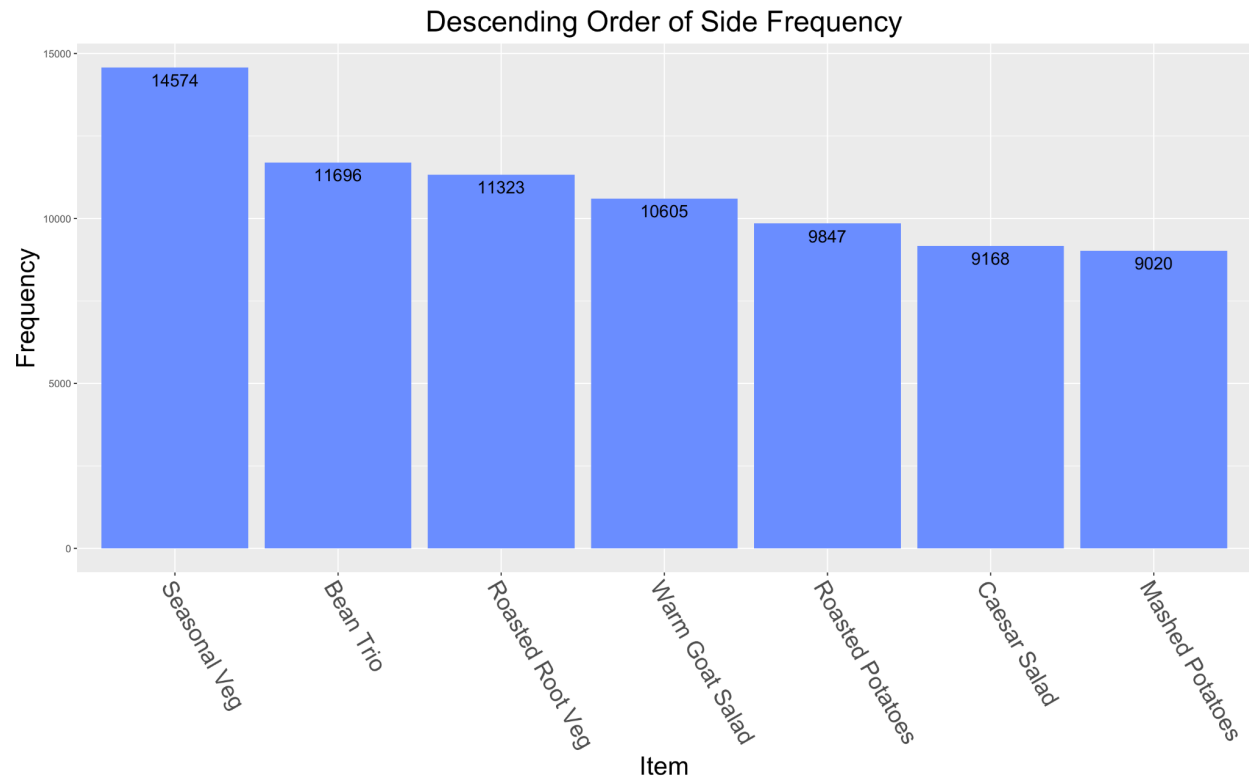
Descending Order of Wine Frequency
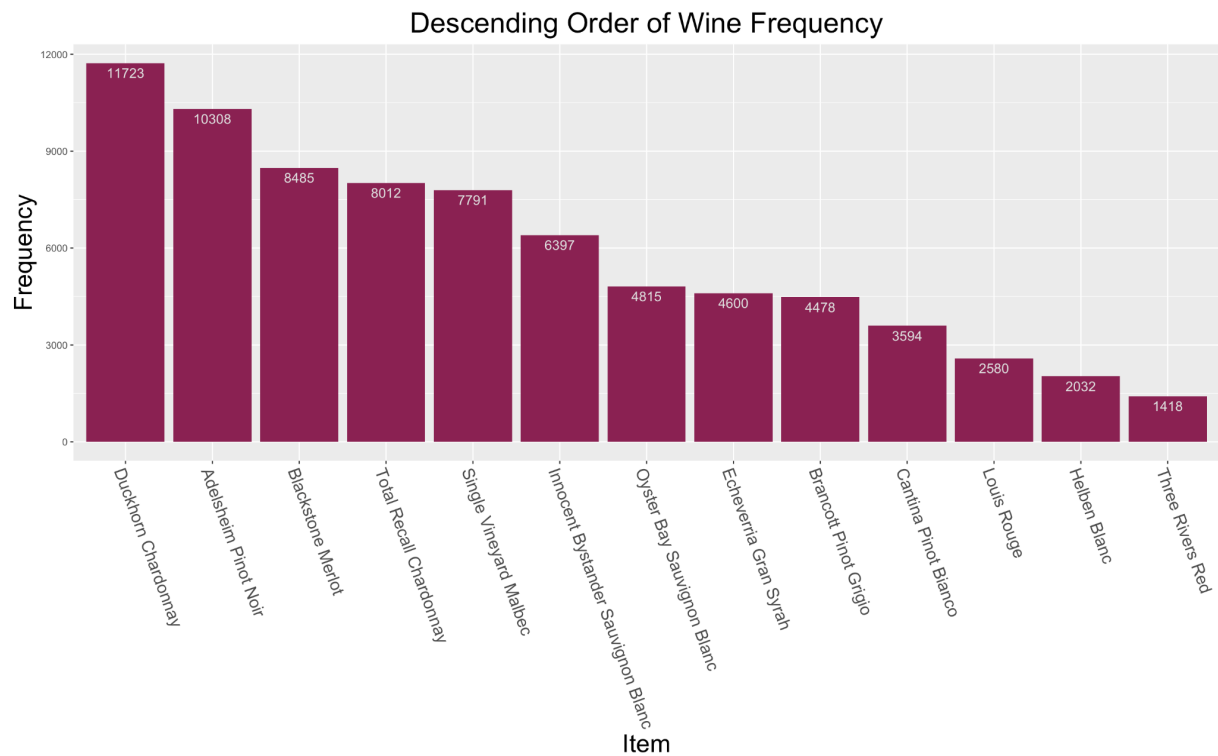
Figure 3: Descending Order of Most Frequently Purchased Wines

Figure 4: Descending Order of Most Frequently Purchased Side Items

Table 4: Entree-Wine Association Rules, Ranked by Confidence and Lift

Main Entree	Wine	Lift Rank	Lift	Conf Rank	Confidence
Filet Mignon	Blackstone Merlot	1	3.21	1	35.67%
Roast Chicken	*Oyster Bay Sauvignon Blanc*	*2*	*3.07*	*11*	*19.41%*
Roast Chicken	Brancott Pinot Grigio	3	2.95	17	17.31%
Duck Breast	Blackstone Merlot	4	2.85	2	31.67%
Sea Bass	*Innocent Bystander Sauvignon Blanc*	*5*	*2.71*	*8*	*22.71%*
Swordfish	*Brancott Pinot Grigio*	*6*	*2.56*	*21*	*15.07%*
Pork Tenderloin	Adelsheim Pinot Noir	7	2.21	3	29.93%
Filet Mignon	Adelsheim Pinot Noir	8	2.09	4	28.23%
Filet Mignon	Single Vineyard Malbec	9	2.07	9	21.17%
Roast Chicken	Innocent Bystander Sauvignon Blanc	10	1.98	19	16.59%
Roast Chicken	**Total Recall Chardonnay**	**11**	**1.93**	**10**	**20.32%**
Pork Tenderloin	Single Vineyard Malbec	12	1.75	14	17.88%
Swordfish	Total Recall Chardonnay	13	1.70	13	17.88%
Pork Tenderloin	Total Recall Chardonnay	14	1.70	15	17.83%
Salmon	Total Recall Chardonnay	15	1.68	16	17.64%
Pork Chop	*Single Vineyard Malbec*	*16*	*1.66*	*18*	*16.95%*
Sea Bass	**Duckhorn Chardonnay**	**17**	**1.62**	**5**	**24.93%**
Pork Tenderloin	Duckhorn Chardonnay	18	1.58	6	24.30%
Pork Chop	**Duckhorn Chardonnay**	**19**	**1.49**	**7**	**22.92%**
Duck Breast	Adelsheim Pinot Noir	20	1.17	20	15.87%
Swordfish	**Duckhorn Chardonnay**	**21**	**1.16**	**12**	**17.97%**

Blue rows represent pairings that had both the highest confidence and lift for a given entree, green rows with bold text represent pairings that had only the highest confidence, and orange rows with italicized text represent pairings that had only the highest lift.

Table 5: Top 14 Overall Apriori Rules by Lift

	Antecedent	Consequent	Lift
1	{Blackstone Merlot, Caesar Salad}	Filet Mignon	3.54
2	Louis Rouge	Pork Chop	3.40
3	{Filet Mignon, Roasted Potatoes}	Blackstone Merlot	3.27
4	{Filet Mignon, Roasted Root Veg}	Blackstone Merlot	3.26
5	*{Adelsheim Pinot Noir, Caesar Salad}*	*Pork Tenderloin*	*3.25*
6	{Blackstone Merlot, Seasonal Veg}	Filet Mignon	3.24
7	{Blackstone Merlot, Roasted Potatoes}	Filet Mignon	3.24
8	{Blackstone Merlot, Roasted Root Veg}	Filet Mignon	3.22
9	Blackstone Merlot	Filet Mignon	3.20
10	Filet Mignon	Blackstone Merlot	3.20
11	{Caesar Salad, Filet Mignon}	Blackstone Merlot	3.20
12	{Bean Trio, Blackstone Merlot}	Filet Mignon	3.16
13	{Filet Mignon, Seasonal Veg}	Blackstone Merlot	3.16
14	{Bean Trio, Filet Mignon}	Filet Mignon	3.11

Blue rows involve Blackstone Merlot and Filet Mignon. Orange rows with italicized text involve Pork Tenderloin and Adelsheim Pinot Noir.

Homework Report Checklist

The team member(s) responsible for checking each item should enter their initials in the field next to each question. All items should be addressed before submitting the assignment with the initialed checklist attached.

Sections & Structure

Overview

JL	Is the overview concise?
FM	Does it provide context about the business problem? <Content>
FM	Does it briefly address your team's work, quantifiable results, and recommendations? <Action>
FM	Does it offer audience-centered reasons for recommendations? <Context>

Body Sections

FM	Does the report body include information on methods, analysis, quantifiable results, and recommendations?
FM	Is content grouped into appropriate sections (*methodology*, *analysis*, *results*, *recommendations*)?

Conclusion

FM	Does the report have a conclusion?
FM	Does the conclusion sum up the report and emphasize relevant takeaways?

Structure

FM	Does each major section have a heading?
FM	Are sections, subsections, and paragraphs organized logically for easy navigation?

Visuals

Introduction, Discussion, and Captions

JL	Is each visual introduced in the text before it appears?
FM	Is each visual close to where it is introduced?
NJ	Does each visual include a title with the following information: type (*table* or *figure*), number, and a descriptive caption?
NJ	Is each visual discussed and interpreted in the text?
FM	Are figures and tables numbered separately?
NJ	Are table captions above the table? Are figure captions below the figure?

Visual Design

FM	Do figures/tables use audience-friendly labels rather than variable names?
FM	Are the visuals easy to interpret?
FM	Are the visuals appropriately sized?
NJ	Do tables appear on one page (*not split between 2 pages*)?
NJ	Are legends and axis labels included for figures?
FM	Are numbers in tables right aligned?
FM	Are the visuals designed well (*ex*: *re-created in Word or Excel, not blurry or stretched,…*)?

Document Design

Title Page Design

FM	Does it include a descriptive title?
FM	Does it state the team name, team members' names, and the submission date?

Table of Contents Design

FM	Does it list all the major sections of the report with corresponding page numbers?
FM	Do the page numbers and sections in the Table of Contents match the report?

Document Design for Entire Report

FM	Is a standard typeface (*Calibri*, *Arial*, *etc.*) used?
FM	Is the size of the body text between 10-12 pt.?
FM	Are headings and subheadings used to organize information?
FM	Are distinctive text styles (*bold*, *italic*, *etc.*) used to distinguish between heading levels?
FM	Are text styles for headings used consistently (*ex: all level-one headings are bold*)?
FM	Are all paragraphs an appropriate length (*fewer than 12 lines*)?
FM	Is white space used to indicate paragraph breaks?
FM	Are bullet lists used for a series of items and numbered lists to show a hierarchy?

Writing Style and Mechanics

Spelling and Capitalization

PO	Are spelling errors located and corrected?
PO	Is spelling consistent throughout (*no switching between acceptable spellings*)?
PO	Is capitalization used appropriately (*proper nouns*, *etc*.)?
PO	Is capitalization of words consistent throughout the report?

Grammar and Punctuation

PO	Are verb tenses used appropriately?
PO	Are marks of punctuation used appropriately?
PO	Is subject-verb agreement used in every sentence?
PO	Is the grammar checker updated and are underlined grammar issues addressed?

Writing Style

JH	Are all sentences in the report easy for your audience to understand quickly?
JH	Are most sentences written in active voice?
JH	Are idioms and vague words eliminated from the report?
JH	Are acronyms introduced before being used?
JH	Are well-written topic sentences included at the beginning of each paragraph?
JH	Are lists parallel?
JH	Is the appropriate point of view used when addressing your audience or describing team actions?