FALL 2024

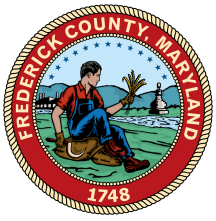
Optimizing Staffing for the Frederick County Division of Emergency Management

COURSE

BMGT490H: QUEST Capstone Professional Practicum

PALS

An initiative of the National Center for Smart Growth
Kathryn Howell, NCSG Executive Director
Kim Fisher, PALS Director



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ACKNOWLEDGMENTS

Thank you to the following contributors for their guidance and resources in completing this report:

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ABOUT PALS

The Partnership for Action Learning in Sustainability (PALS) is administered by the National Center for Smart Growth at the University of Maryland, College Park (UMD). It is a campus-wide initiative that harnesses the expertise of UMD faculty and the energy and ingenuity of UMD students to help Maryland communities become more environmentally, economically, and socially sustainable. PALS is designed to provide innovative, low-cost assistance to local governments while creating real-world problem-solving experiences for University of Maryland graduate and undergraduate students.

QUEST HONORS PROGRAM

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Letter from the Team

Data ConQUEST
QUEST Honors Program
1407 Van Munching Hall
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College Park, MD 20742

December 4, 2024

Amanda Miss, Emergency Communications Specialist IV
Kristie Dutrow, Assistant Director, Department of Emergency Communications
Frederick County Division of Emergency Management

Dear Ms. Miss and Ms. Dutrow,

On behalf of the Data ConQUEST team, we would like to extend our gratitude for the opportunity to work alongside the Frederick County Division of Emergency Management (DEM) on this crucial initiative. Your continued support, accessibility, and thoughtful feedback have been invaluable to the success of our project.

Our team took a comprehensive approach to this project, leveraging a variety of analytical techniques and tools such as Python, Tableau, and Excel.

In this final report, you'll find our detailed analysis, key findings, and actionable recommendations. We hope that our work provides clear, data-driven strategies to support your staffing decisions. Our primary goal has been to present actionable solutions that can be realistically implemented to support DEM's ongoing mission to ensure timely, efficient, and effective emergency response services for Frederick County residents.

If you or any members of your team have questions about the content of our report or would like further clarification on our methodology, we would be happy to provide additional support. Please don't hesitate to reach out to us via email. We would be glad to discuss our findings in detail or address any specific questions you may have.

Thank you again for entrusting us with this important project. We hope our analysis will serve as a valuable resource in your efforts to enhance emergency response capacity.

Sincerely,
The Data ConQUEST Team

Rohan Gudwani, Daniel Samuel, Susie Shollenberger, Marvi Shroff, Wilhelm Smith

Executive Summary

The Frederick County Division of Emergency Management (DEM) is responsible for ensuring the community's safety and security by handling 911 call intake and dispatch services for emergency response teams, including fire, police, and animal control units. With Frederick County experiencing significant population growth, DEM has seen a corresponding increase in 911 call volume, placing new pressures on staffing levels and operational capacity. Historically, the department relied on previous call volume trends to guide staffing decisions, but changes in call behavior—particularly during weekend nighttime hours—have rendered traditional staffing models insufficient.

The Data ConQUEST team partnered with DEM to assess current staffing needs, identify areas of operational inefficiency, and recommend strategies to better align staffing levels with call volume demands. This project utilized existing 911 call data from January to July 2024, focusing on variables such as call frequency by hour, day of the week, and holiday-related spikes. Using statistical analysis, data visualization, and predictive modeling, the team uncovered patterns that can inform optimal staffing decisions.

The analysis revealed two critical call volume trends. First, most 911 calls occur during weekday working hours, from 9 am to 5 pm. However, DEM's existing "power shifts" currently cover 2 pm to 7 pm, leaving a significant portion of peak call hours under-supported. Second, the analysis identified an unexpectedly high call volume during weekend nighttime hours, a trend that had not been observed in previous analyses. These patterns suggest a misalignment between existing staffing schedules and actual call demand.

To address these discrepancies, the Data ConQUEST team recommends the following:

1. **Shift Restructuring**: Adjust current power shifts to align more closely with peak call hours. For weekdays, the 9 am to 5 pm period requires more robust staffing coverage, while on weekends, nighttime coverage should be better distributed. Implementing larger early morning shifts, such as 6 am to 6 pm and 8 am to 8 pm, can better distribute workload during peak call hours and improve emergency response times.
2. **Predictive Modeling**: Use the predictive model developed by the team to forecast future call volumes and proactively schedule staffing. By incorporating call trends from weekdays, weekends, and holiday surges, DEM can create staffing schedules that account for seasonal and event-based call fluctuations.
3. **Data-Driven Staffing Reviews**: Conduct periodic reviews of call volume data and staffing levels to ensure alignment with changing trends. Continuous use of predictive modeling will enable DEM to respond to emerging patterns and adjust staffing schedules accordingly.

By implementing these recommendations, DEM can reduce call wait times, improve emergency response times, and ensure a more efficient allocation of human resources. With stronger staffing alignment, DEM will be better positioned to handle increased call volumes resulting from population growth and other

unpredictable factors. The findings and recommendations in this report are designed to serve as a blueprint for future staffing assessments and operational improvements.

Introduction

The Frederick County Division of Emergency Management (DEM) plays a vital role in ensuring the safety and well-being of Frederick County residents. By managing 911 call intake and dispatch services for emergency responders—including police, fire, and animal control—DEM is a critical hub for emergency response coordination. However, as the county's population continues to grow, the demand for emergency services has increased significantly. This surge in call volume has created new operational challenges, most notably the need for adequate staffing to meet peak call demands.

To address this challenge, the Data ConQUEST team from the University of Maryland's QUEST Honors Program partnered with DEM to assess current staffing needs and recommend a data-driven strategy for staffing optimization. This opportunity was provided by the Partnership for Action Learning in Sustainability (PALS), a University of Maryland organization that provides quality assistance to local governments while providing real-world experience for students.

The project's goal was to align staffing schedules with call demand, ensuring that DEM has sufficient personnel on duty during peak periods. The team relied on detailed call log data from January to July 2024 to analyze call volume patterns and identify areas of staffing misalignment.

By leveraging statistical analysis, predictive modeling, and data visualization, the Data ConQUEST team developed a comprehensive strategy for staffing optimization. This strategy includes recommendations to restructure staffing shifts, implement event-based staffing for holidays and community events, and use predictive modeling to forecast call volumes. These recommendations aim to reduce call wait times, ensure timely emergency responses, and increase the operational efficiency of DEM.

This report presents a full account of the project, from problem identification to actionable recommendations. Each section outlines a critical aspect of the analysis, including the methods used, key findings, and proposed staffing solutions. The conclusion of this report presents DEM with a clear, evidence-based roadmap to better align staffing with call demand, improving both emergency response times and overall operational efficiency.

Problem and Opportunity

Staffing allocation is a critical aspect of emergency management operations because it's vital that all calls are answered in a timely manner. This requires a balance of analytical decision-making and practical implementation. How can staffing schedules be optimized to handle the growing population while maintaining efficiency? Do factors such as hourly call volume, day-of-week trends, or seasonality/holiday surges significantly impact staffing needs? Can predictive modeling ensure proactive resource allocation

rather than reactive adjustments? These are the questions that guided our research as we partnered with the Frederick County Division of Emergency Management to assess their current staffing challenges.

Effective shift scheduling in 911 dispatch centers is crucial for maintaining optimal response times and ensuring dispatcher well-being. According to the Journal of Emergency Dispatch, common schedules include 8-hour, 10-hour, and 12-hour shifts, each with their advantages and challenges. For instance, 12-hour shifts can offer staff more consecutive days off, potentially enhancing work-life balance, but may also lead to increased fatigue due to longer work periods. Additionally, some dispatch centers adopt flexible scheduling practices, including staggered start times and overlapping shifts, to align staffing levels with peak call volumes. This approach allows for dynamic adjustment to fluctuating demand, ensuring that adequate personnel are available during high-demand periods without overstaffing during quieter times.

Using a data-driven approach, we sought to develop solutions that aligned personnel deployment with peak demand periods, ensuring that emergency response capacity remained robust and scalable. By leveraging insights from historical data and predictive analytics, we aimed to create a framework that not only addresses present needs but also anticipates future growth, setting a new standard for effective staffing in emergency services.

Historically, DEM relied on pre-set staffing schedules, which were developed based on previous call volume patterns. They only operate on 12-hour shift schedules. However, as call trends have shifted, these schedules have become misaligned with the actual demand for emergency services.

The problem is particularly acute during certain times of the day and week. The Data ConQUEST team's analysis revealed two critical patterns of staffing misalignment. First, while call volume on weekdays peaks between 9 am and 5 pm, the current "power shifts" at DEM run from 2 pm to 7 pm, resulting in insufficient coverage during critical morning hours. Second, on weekends, the call volume follows a flatter pattern throughout the day, leading to a larger range of peak hours between 9 am and 9 pm. This trend had not been accounted for in DEM's previous staffing models, leading to increased wait times for 911 calls during those hours.

In addition to call volume fluctuations, other operational challenges exacerbate the problem. Employee absences, such as unplanned cancellations, further reduce available staffing, especially during critical periods. With minimal staffing flexibility, even one or two absences can result in significant delays in emergency call response. This issue is amplified during periods of peak demand when staffing shortages are already present.

Addressing these staffing shortfalls is a significant opportunity for DEM to improve its emergency response operations. By realigning staffing schedules with call volume trends, DEM can reduce call wait times, increase response efficiency, and ensure that emergency personnel are available when they are most needed. Additionally, leveraging predictive models allows DEM to take a proactive approach to scheduling, ensuring that staffing needs are met in anticipation of expected spikes in call volume (e.g., on holidays or during large community events).

Data Overview

This project relied on the comprehensive analysis of historical 911 call data provided by the Frederick County Division of Emergency Management (DEM). This dataset served as the foundation for understanding call volume patterns, identifying peak call times, and quantifying staffing shortfalls. It was essential for developing predictive models and formulating actionable staffing recommendations for DEM.

Data Attributes
The primary data source for this project was the 911 call log dataset provided by DEM, covering the period from January to July 2024. The dataset contained both raw and aggregated data on key call attributes.

- **Calls by Hour**: Hourly call counts to analyze fluctuations in call activity throughout the day.
- **Calls by Day**: Daily call counts to identify differences in weekday vs. weekend call volume.
- **Emergency vs. Non-Emergency Calls**: Classification of calls as emergency (high-priority) or non-emergency (lower-priority).
- **Call Wait Time**: Time (in seconds) between the call initiation and connection to a dispatcher, providing insight into response efficiency.
- **Talk Group Usage**: Allocation of calls to specific service groups, such as police, fire, and animal control, which helped contextualize the demands on each service.

These data attributes were critical for pinpointing the timeframes where staffing adjustments were most needed, as well as for evaluating operational performance metrics like wait times and call prioritization.

Data Limitations
While the dataset was comprehensive for 911 call logs, there were several limitations that affected the scope and depth of the analysis.

- **Limited Call Period**: The analysis period was restricted to seven months (January to July 2024), limiting the ability to identify long-term seasonal trends.
- **Exclusion of Dispatch Data**: The dataset did not include radio dispatch records for fire, police, and animal control, preventing a full analysis of workload across these responding units.
- **Absence of Employee-Specific Data**: The dataset lacked employee-specific information, such as shift schedules and absence rates, which could have provided further insight into staffing constraints.

Despite these limitations, the data was sufficient to conduct a robust analysis of call volume patterns and staffing needs. The results provided strong support for DEM's shift realignment strategy and recommendations for staffing optimization.

Data Preparation

To ensure the accuracy and utility of the 911 call data, a structured data preparation process was implemented. This process included data cleaning, transformation, and validation to make the dataset ready for analysis and predictive modeling. By organizing and standardizing the data, the team was able to extract actionable insights and create a reliable foundation for staffing recommendations.

Data Cleaning
The raw call data contained a few inconsistencies that required correction to ensure the accuracy of timestamps, call counts, and categorical variables. The key cleaning tasks were as follows.

- **Removing Duplicates**: Eliminated repeated entries that could inflate call counts, particularly for calls that were mistakenly logged multiple times.
- **Correcting Timestamp Errors**: Addressed misalignments caused by time zone issues, ensuring that calls were mapped to the correct hour and day of the week.
- **Handling Missing Values**: Addressed missing data in the “Wait Time” and “Call Type” fields. Missing values were either imputed using averages or excluded if deemed non-essential for analysis.
- **Standardizing Data Types**: Ensured consistency in time, date, and categorical variables, making them compatible for use across tools such as Excel, Python, and Tableau.

These cleaning steps ensured that the dataset was error-free and ready for further processing and modeling.

Data Transformation
After cleaning, the raw data was transformed into a structured format that would allow for effective analysis and predictive modeling. The key transformations were as follows.

- **Hourly Aggregation**: Call records were grouped into hourly intervals, allowing the team to identify peak call times and analyze trends by hour of the day.
- **Weekday/Weekend Classification**: Each call was labeled as either a “weekday” or “weekend” call, enabling comparisons of call patterns and the identification of unique weekend call surges.
- **Call Volume Aggregation**: Call volumes were aggregated by day to generate summary statistics (mean, median, variance) and assess variations in daily call activity.
- **Feature Engineering**: New variables were created to enhance modeling capabilities, including a “Holiday Indicator” to flag event-driven call spikes (e.g., July 4th), which significantly affected call volume.

These transformations enabled the identification of peak call times and supported the development of predictive models that could forecast call volume by hour and day.

Data Validation
To ensure the integrity and accuracy of the prepared data, several validation checks were performed to confirm that no key data was lost or altered during cleaning and transformation. The key validation steps were as follows.

- **Accuracy Check**: Cross-checked the cleaned dataset against the original raw data to ensure that no records were inadvertently removed or altered.
- **Completeness Check**: Verified that call counts for the period from January to July 2024 were complete and aligned with the total number of records in the original data.
- **Logic Check**: Confirmed that timestamps and hourly call counts followed logical patterns (e.g., no negative call counts or unrealistic time intervals).

These validation steps confirmed that the data was complete, consistent, and ready for regression modeling, predictive analysis, and the development of staffing recommendations.

Outcomes of Data Preparation
The data preparation process resulted in a clean, structured, and analysis-ready dataset that was essential for all subsequent modeling and recommendations with the following key outcomes.

- **Accurate Peak Call Identification**: Aggregation of calls by hour revealed that call volume peaked between 9 am and 5 pm on weekdays and experienced a longer, flatter peak between 9 am and 9 pm on weekends.
- **Clear Differentiation of Weekday vs. Weekend Trends**: The classification of calls as weekday or weekend calls provided crucial insight into differences in call patterns, supporting the recommendation for shift adjustments depending on the day of the week.
- **Foundation for Predictive Modeling**: By structuring the data according to hourly intervals, weekday/weekend indicators, and holiday flags, the team was able to develop a polynomial regression model that accurately forecasts call volume for different days and times.

The prepared dataset served as the foundation for all analysis, modeling, and staffing recommendations. By following a systematic cleaning, transformation, and validation process, the team ensured that insights from the analysis were accurate, actionable, and aligned with DEM's staffing needs.

Analysis

The analysis of the 911 call data from January to July 2024 provided critical insights into call volume trends, peak demand periods, and staffing shortfalls. The Data ConQUEST team used statistical analysis, predictive modeling, and visualizations to identify patterns in call activity and generate actionable recommendations. This section outlines the key findings and models used to derive them, focusing on hourly call volume trends, weekday vs. weekend comparisons, and the impact of holidays on call surges.

Hourly Call Volume Trends
One of the most significant findings was the clear, recurring pattern of call volume fluctuations throughout the day. The hourly aggregation of call data revealed that weekday call volumes peaked from 9 am to 5 pm, a period corresponding to typical work hours. This finding highlighted a misalignment between DEM's existing "power shifts," which have the most overlap from 2 pm to 7 pm, and the actual peak periods for 911 call activity. As a result, most calls during this high-activity window were being handled by a smaller number of staff, leading to longer wait times for emergency response.

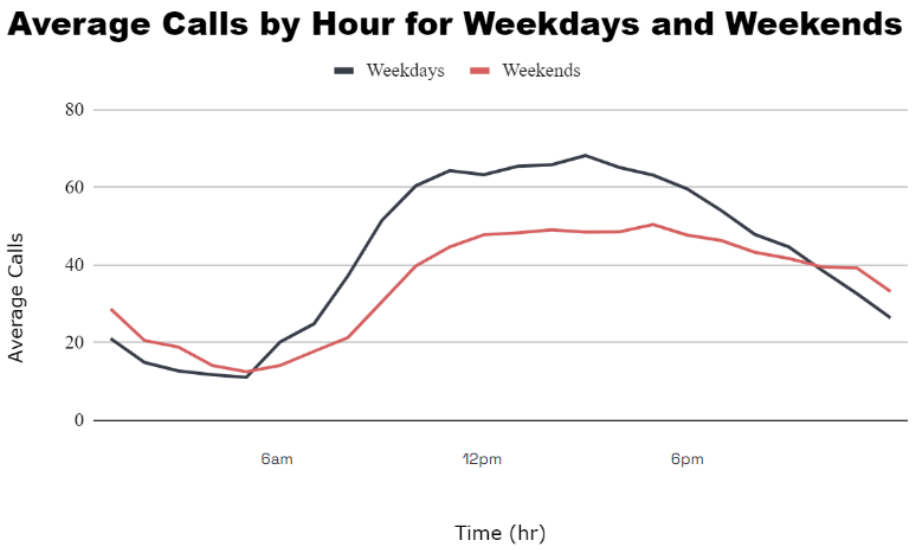
On weekends, call volumes were generally lower than weekdays. The peak hours on weekends comprised a longer range of times, between 9 am and 9 pm. Because of this, staffing may need to be adjusted for both the number of calls and the range of hours those calls occur within. This insight suggested that DEM should consider allocating additional resources during these hours to reduce wait times and improve emergency response capacity.

Weekday vs. Weekend Call Behavior

The analysis showed a clear distinction between weekday and weekend call patterns. Weekdays followed a predictable "workday curve," where call volumes steadily rose from 7 am, peaked from 9 am to 5 pm, and then declined in the evening. This consistent trend made it possible to predict weekday call volume with high accuracy. In contrast, weekend call patterns were more variable and flatter, lacking the pronounced "workday curve" seen on weekdays. Instead, call volume was more evenly distributed throughout daytime waking hours and calls rose starting later in the day, around 9 am.

The comparison between weekday and weekend call behavior revealed the need for different staffing strategies for each. As seen in Figure 1, weekdays required focused staffing during the 9 am to 5 pm window, whereas weekends required increased coverage during a longer range of hours from 9 am to 9 pm. This analysis was instrumental in shaping the Data ConQUEST team's recommendations for shift restructuring.

Figure 1. Average Calls by Hour on Weekdays and Weekends



Holiday Call Spikes

Another key finding was distinct call surges during holidays, particularly on the 4th of July. On July 4th, call volume increased significantly between 9 pm and 11 pm, coinciding with the time of firework displays and related public activities. Compared to a typical day, there was a 50% increase in calls during this window, which was well above the average call volume for that time of night. This insight highlighted the need for DEM to anticipate and plan for staffing increases on certain holidays where call surges are likely.

To address this, the team recommended that DEM include “event-based staffing” as part of its broader staffing strategy. By preparing for call surges on holidays like the 4th of July, DEM can reduce call wait times during these critical periods.

Predictive Models

To better understand and forecast call volumes, the Data ConQUEST team employed a series of predictive models. The primary model used was a polynomial regression model, which aimed to predict hourly call volume based on the time of day and whether it was a weekday or weekend. Polynomial regression was selected due to its ability to capture non-linear patterns in call volume, such as the “workday curve” observed during weekdays.

The regression model used the following predictors.

- **Time of Day**: Hour of the day, represented numerically from 0 (midnight) to 23 (11 pm).
- **Day Type**: A binary variable indicating whether the day was a weekday or weekend.
- **Holiday Indicator**: A binary variable indicating whether the day was a holiday (like the 4th of July) or a regular day.

The output of the model predicted the number of calls expected for each hour of the day, allowing for clear identification of peak call times. The model performed well, with a strong fit to the observed call data, especially for weekdays, where the workday curve was predictable. The model was also able to highlight other predictable trends, such as lower overall calls on weekends and holiday spikes.

Summary of Key Takeaways

- **Weekday Trends**: Call volumes peak from 9 am to 5 pm, highlighting a need for increased staffing coverage during these hours. Current “power shifts” from 2 pm to 7 pm do not adequately align with peak call periods.
- **Weekend Trends**: Call volumes are more evenly distributed throughout the day on weekends, and coverage is needed for a larger range of hours.
- **Holiday Surges**: Event-driven spikes, such as those seen on the 4th of July, require dedicated “event-based staffing” strategies to ensure adequate coverage during these unpredictable high-demand periods.
- **Predictive Model Accuracy**: The polynomial regression model proved effective in forecasting call volume trends, allowing DEM to anticipate peak times and better align staffing resources.

By identifying these trends and developing predictive models, the Data ConQUEST team was able to precisely quantify DEM’s staffing needs. These insights formed the foundation for the team’s recommendations to restructure shift schedules, plan for holiday-based call surges, and maintain continuous monitoring of staffing needs as the county’s call patterns evolve.

Recommendations

Based on the analysis of 911 call volume trends and predictive modeling, the Data ConQUEST team has developed a series of actionable recommendations for the Frederick County Division of Emergency Management (DEM). These recommendations are designed to address staffing shortfalls, reduce call wait times, and improve operational efficiency. The focus is on realigning staffing schedules, leveraging predictive models for decision-making, and creating a framework for continuous improvement.

1. Restructure Staffing Shifts

One of the most impactful recommendations is to restructure DEM's staffing shifts to better align with actual call volume patterns. Current power shifts contain the most coverage from 2 pm to 7 pm, but the analysis revealed that peak call volume on weekdays occurs from 9 am to 5 pm. This misalignment leaves critical hours understaffed, leading to increased call wait times during the busiest periods of the day.

Proposed Shift Changes

- **Weekday Shifts**: Introduce new staffing blocks to provide enhanced coverage during peak call periods. Recommended shift times include:
    - **6 am to 6 pm**: This shift ensures coverage through the 9 am to 5 pm peak period while also supporting pre- and post-peak call activity.
    - **8 am to 8 pm**: A shift that fully captures the peak period and provides coverage for late-day call surges.
    - **10 am to 10 pm** and **1 pm to 1 am**: These shifts are smaller but combine to capture evening call volume that is higher than baseline.
- **Weekend Shifts**: Introduce new staffing blocks to provide enhanced coverage during longer peak call periods and a later in the day increase in calls. Recommended shift times include:
    - **8 am to 8 pm**: Covers most of the daytime peak hours and includes some support for the earlier hours and daytime calls when the volume is relatively stable but still higher than early morning periods.
    - **9 am to 9 pm**: Covers the entire peak hour segment on weekends and ensures that enough staff are present to handle peak calls.
    - **10 am to 10 pm** and **2 pm to 2 am**: These shifts are smaller but provide additional support for peak hours and late-night call volume that is higher than baseline.

These revised shift schedules are designed to provide more consistent coverage during peak call periods and ensure that staffing aligns with actual call demand.

2. Leverage Predictive Models for Future Staffing

The predictive model developed by the Data ConQUEST team allows DEM to forecast future call volume based on time of day, day of the week, and holiday status. This model offers an opportunity for DEM to make data-driven staffing decisions.

How to Use the Predictive Model

- **Call Volume Projections**: Use the model to forecast hourly call volumes for specific days of the week. This will allow DEM to identify peak call periods well in advance and schedule shifts accordingly.
- **Holiday-Based Staffing**: The model's ability to capture event-driven call surges, such as those seen on the 4th of July, allows DEM to plan for future high-call events. For example, DEM can anticipate call surges during other holidays and large public events that are likely to increase emergency call activity.
- **Scenario Analysis**: DEM can simulate "what-if" scenarios to see how call volume might shift during holidays, weekends, or special events. This allows leadership to preemptively schedule shifts and avoid emergency staffing shortages.

By incorporating this predictive capability into daily operations, DEM can take a more proactive approach to staffing, reducing reliance on reactive measures and unplanned overtime.

3. Implement Event-Based Staffing Strategies

The analysis identified call surges on holidays and other special events, such as the 4th of July, where calls from **9 pm to 11 pm** surged well above normal levels. To address this, DEM should adopt a strategy of event-based staffing.

Key Elements of Event-Based Staffing

- **Holiday Shift Adjustments**: For known high-call holidays (Independence Day, New Year's Eve, or Halloween), pre-schedule dedicated shifts to handle expected call surges.
- **On-Call Reserves**: Identify employees who can be placed "on call" during specific holidays or community events that are known to generate higher call volumes.
- **Event Forecasting**: Use predictive modeling to identify potential call surges around community festivals, parades, or major sporting events that could drive increased call activity.

These event-based strategies will prevent DEM from being caught off guard during known high-call periods, improving response times and reducing the likelihood of overwhelming the emergency call system.

4. Conduct Continuous Staffing Reviews

While the current analysis covered only seven months (January to July 2024), call volume patterns may evolve over time. As Frederick County's population continues to grow, so will the volume and distribution of 911 calls. To ensure long-term operational efficiency, DEM should conduct periodic staffing reviews.

Steps for Continuous Staffing Reviews

- **Quarterly Call Volume Analysis**: Conduct a quarterly review of call volume patterns using updated call data. This will allow DEM to adjust shift schedules in response to any emerging patterns.
- **Shift Alignment Review**: Regularly review how existing staffing schedules align with actual call volume. If call peaks shift (e.g., due to seasonal trends or large community events), staffing shifts can be adjusted accordingly.
- **Annual Model Recalibration**: Recalibrate the predictive model at least once per year using new call data. This will ensure that the model remains accurate and responsive to changes in call behavior.

By implementing these reviews, DEM will be able to continuously refine its staffing strategy and ensure that emergency response times remain fast and reliable.

Conclusion

The Frederick County Division of Emergency Management (DEM) faces significant operational challenges due to the growing volume and unpredictability of 911 calls. The traditional staffing model, which relies on predetermined power shifts, has proven insufficient to meet the new demands posed by a rapidly growing county.

This project identified several key trends in call behavior, including peaks in call volume from **9 am to 5 pm on weekdays** and lower overall calls on weekends. These findings revealed misalignments between call volume patterns and existing shift schedules, demanding a restructuring of staffing strategies. To address these issues, the Data ConQUEST team developed a series of targeted recommendations:

1. **Restructure Shift Schedules**: Align staffing shifts with peak call periods (9 am to 5 pm on weekdays and 9 am to 9 pm on weekends) to reduce wait times and avoid staffing shortfalls.
2. **Use Predictive Models for Staffing**: Leverage the team's predictive model to forecast call volumes and plan shift schedules in advance.
3. **Adopt Event-Based Staffing**: Implement event-based staffing strategies to handle known call surges during holidays and community events preemptively.
4. **Implement Continuous Staffing Reviews**: Conduct quarterly reviews of staffing needs to adapt to changes in call behavior and ensure ongoing operational efficiency.

By taking these actions, DEM will be better equipped to address current staffing shortfalls and maintain effective emergency response times for Frederick County residents. These changes will reduce wait times, optimize resource allocation, and improve the overall efficiency of emergency call handling.

The Data ConQUEST team is confident that these recommendations provide a clear roadmap for improving staffing efficiency at DEM. By realigning shift schedules, incorporating predictive modeling, and planning for holiday surges, DEM will be better prepared to meet the growing demand for emergency services. This project has laid the groundwork for future staffing reviews, enabling DEM to make continuous improvements and maintain a high standard of emergency response for Frederick County.

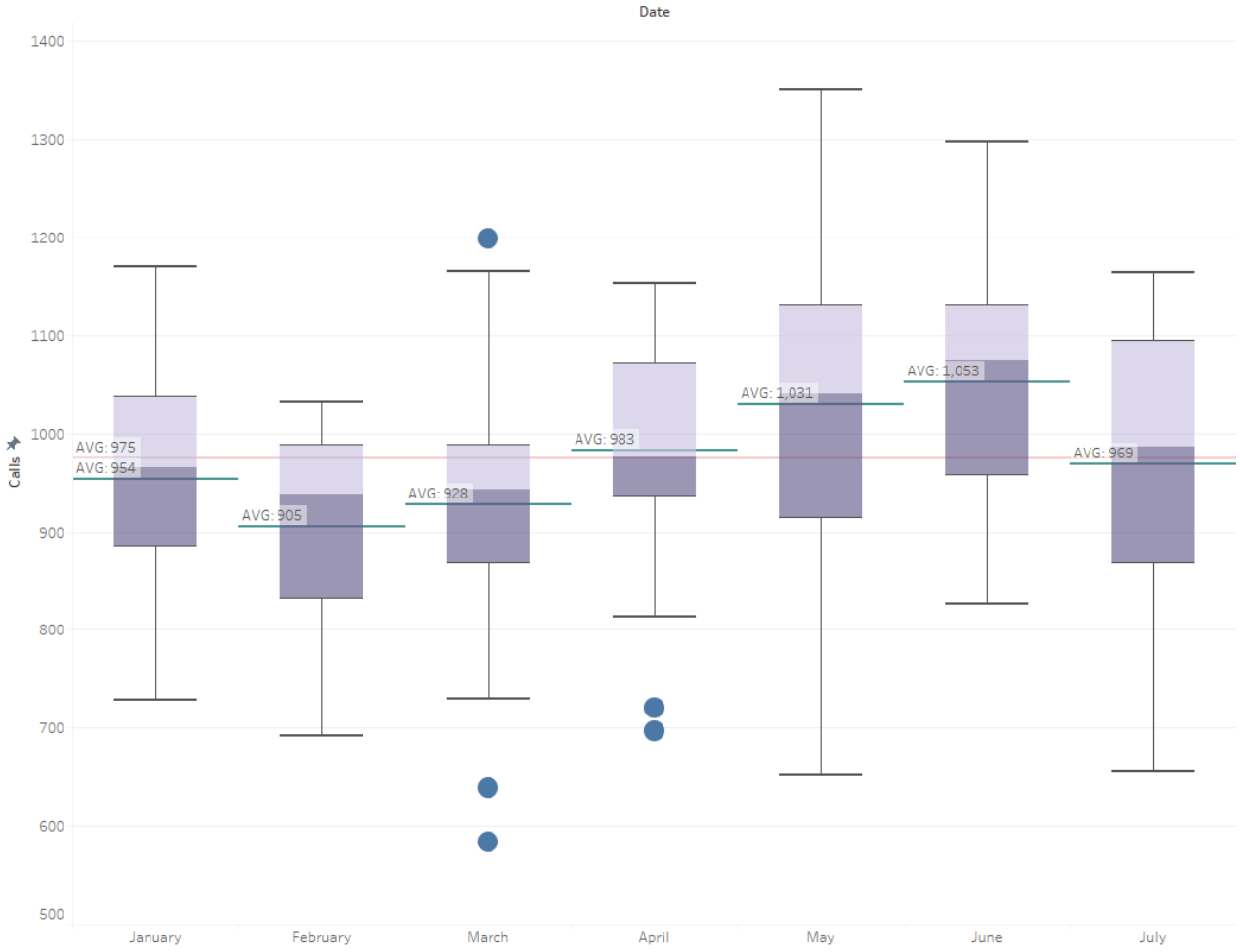
References

The following references were used to support this report's analysis, findings, and recommendations. These references include internal data sources, tools used for data processing, and relevant academic methodologies.

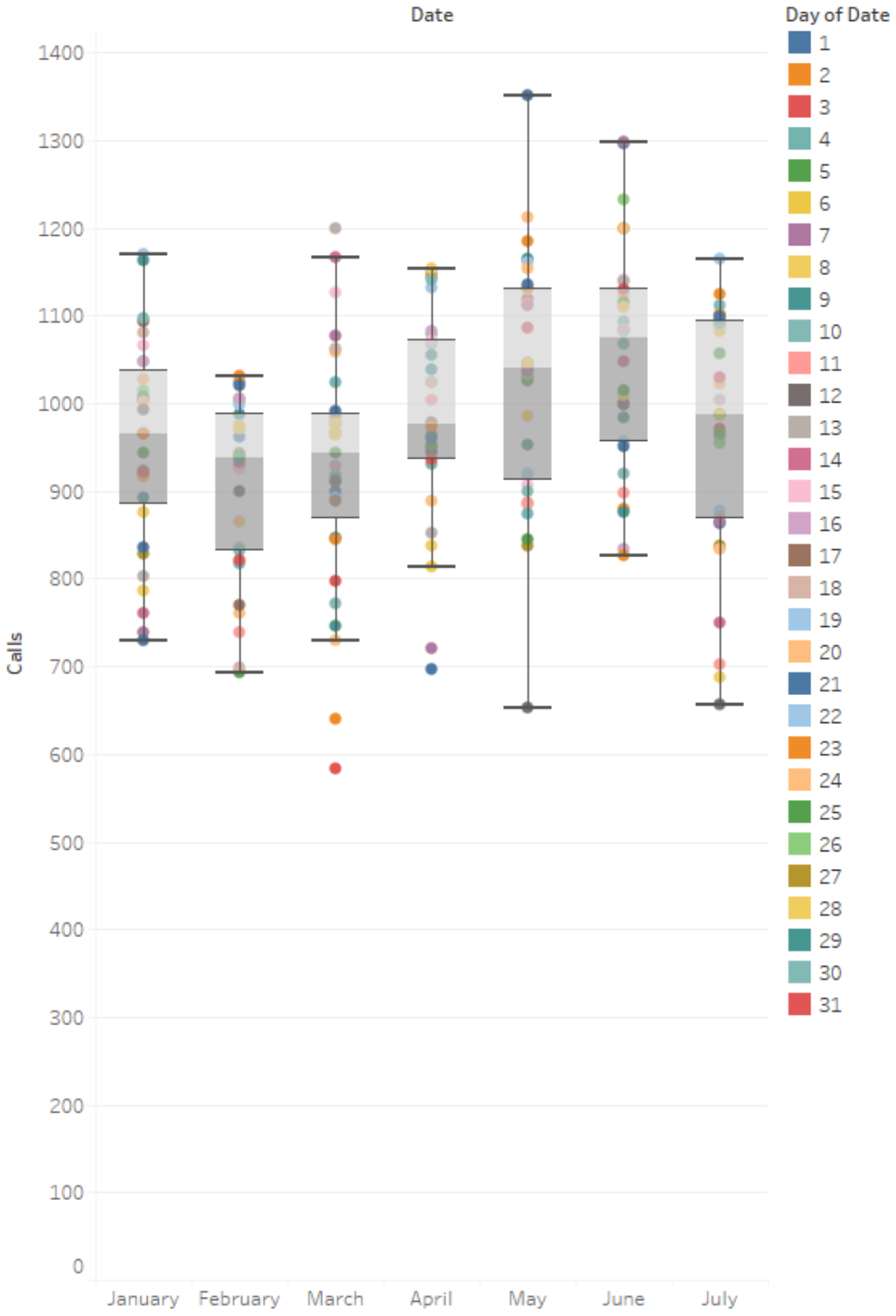
1. **Frederick County Division of Emergency Management (DEM) 911 Call Data** (January 2024 - July 2024): Primary dataset provided by DEM, containing raw and aggregated data on 911 call volumes, wait times, emergency vs. non-emergency classifications, and talk group usage. This dataset served as the foundational source for all analysis, predictive modeling, and recommendations presented in this report.
2. **Internal Reports and Guidance from DEM Staff**: Throughout the project, DEM staff provided feedback on staffing needs, operational challenges, and system constraints. These insights informed the team's understanding of the practical implications of staffing shortfalls and the viability of proposed shift adjustments.
3. **Event-Based Call Surge Data**: Call spikes observed on July 4th, 2024, were used as a case study to support the need for event-based staffing. Analysis of call volume on this date revealed a surge in calls from **9 pm to 11 pm**, underscoring the need for proactive staffing during holidays and large public events.
4. **General Knowledge of Call Center Operations**: Best practices for staffing optimization in emergency call centers were referenced, particularly strategies for shift alignment, event-based staffing, and the use of predictive modeling for proactive scheduling.
5. **Independent Research:** The Journal of Emergency Dispatch – "Let's Talk Schedules"

Appendix

Appendix A: Box Plot, Calls by Day

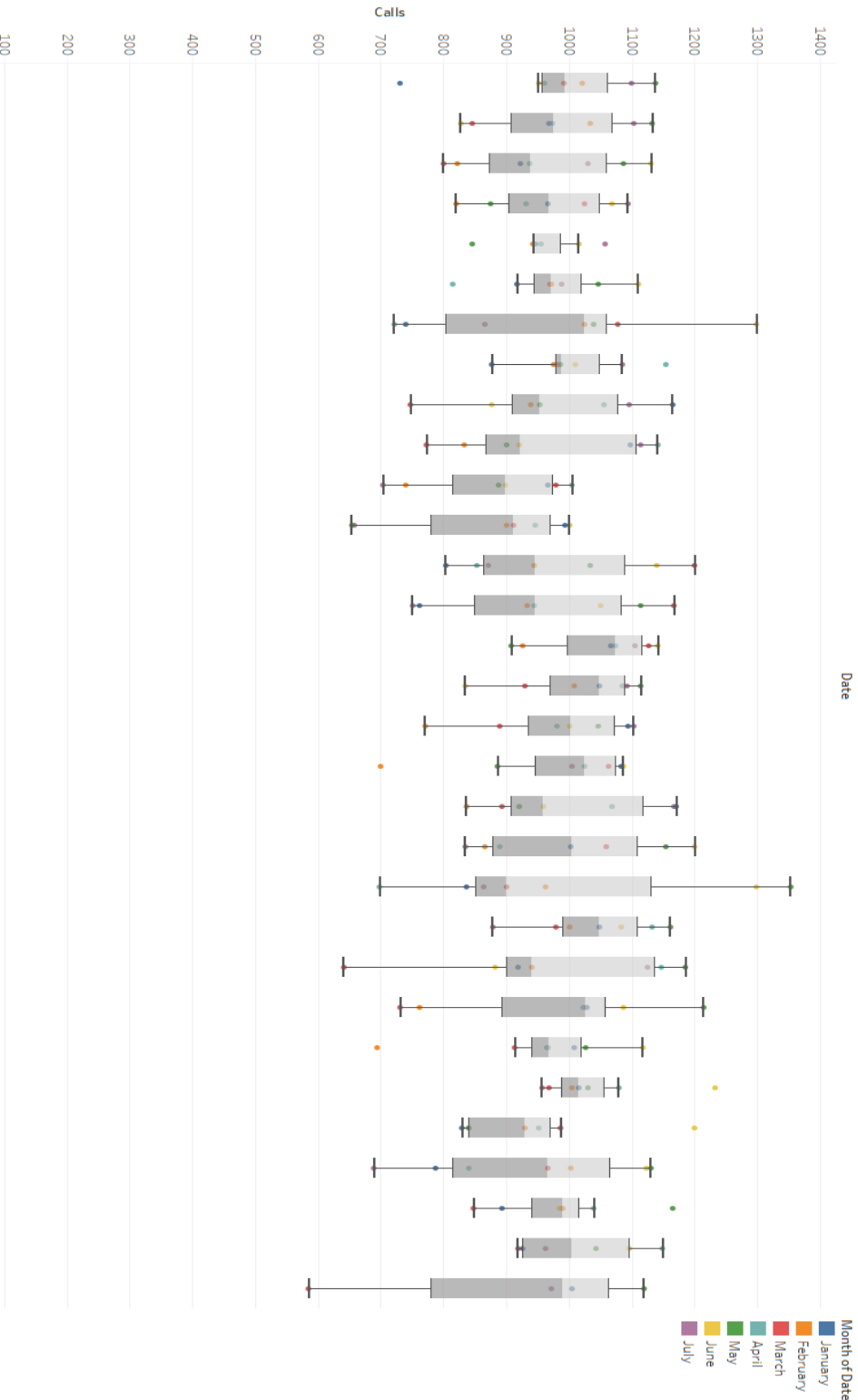


Appendix B: Box Plot, Calls by Day (months)



Appendix C: Box Plot, Calls by Day (days)

Appendix D: Calls by Day Regression Results (using date and weekday/weekend)



OLS Regression Results

Dep. Variable:	January	R-squared:	0.461
Model:	OLS	Adj. R-squared:	0.412
Method:	Least Squares	F-statistic:	9.402
Date:	Sun, 03 Nov 2024	Prob (F-statistic):	0.00112
Time:	18:01:11	Log-Likelihood:	-147.68
No. Observations:	25	AIC:	301.4
Df Residuals:	22	BIC:	305.0
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	758.3462	52.551	14.431	0.000	649.363	867.330
date	6.2213	2.632	2.364	0.027	0.762	11.680
weekday	165.5491	44.443	3.725	0.001	73.379	257.719

Omnibus:	0.055	Durbin-Watson:	1.545
Prob(Omnibus):	0.973	Jarque-Bera (JB):	0.062
Skew:	-0.028	Prob(JB):	0.969
Kurtosis:	2.762	Cond. No.	49.6

Appendix E: Calls by Hour Regression Results (using date and weekday/weekend)

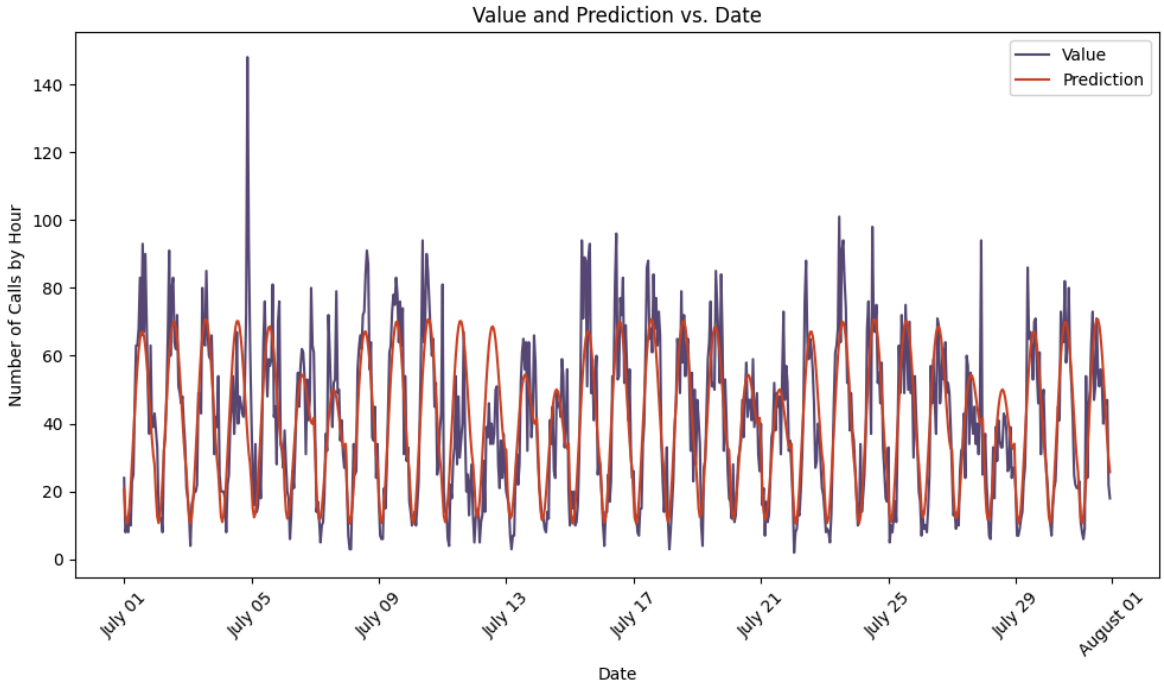
OLS Regression Results

Dep. Variable:	value	R-squared:	0.196
Model:	OLS	Adj. R-squared:	0.195
Method:	Least Squares	F-statistic:	139.9
Date:	Sun, 03 Nov 2024	Prob (F-statistic):	4.82e-29
Time:	18:13:29	Log-Likelihood:	-2574.7
No. Observations:	576	AIC:	5153.
Df Residuals:	574	BIC:	5162.
Df Model:	1		
Covariance Type:	nonrobust		

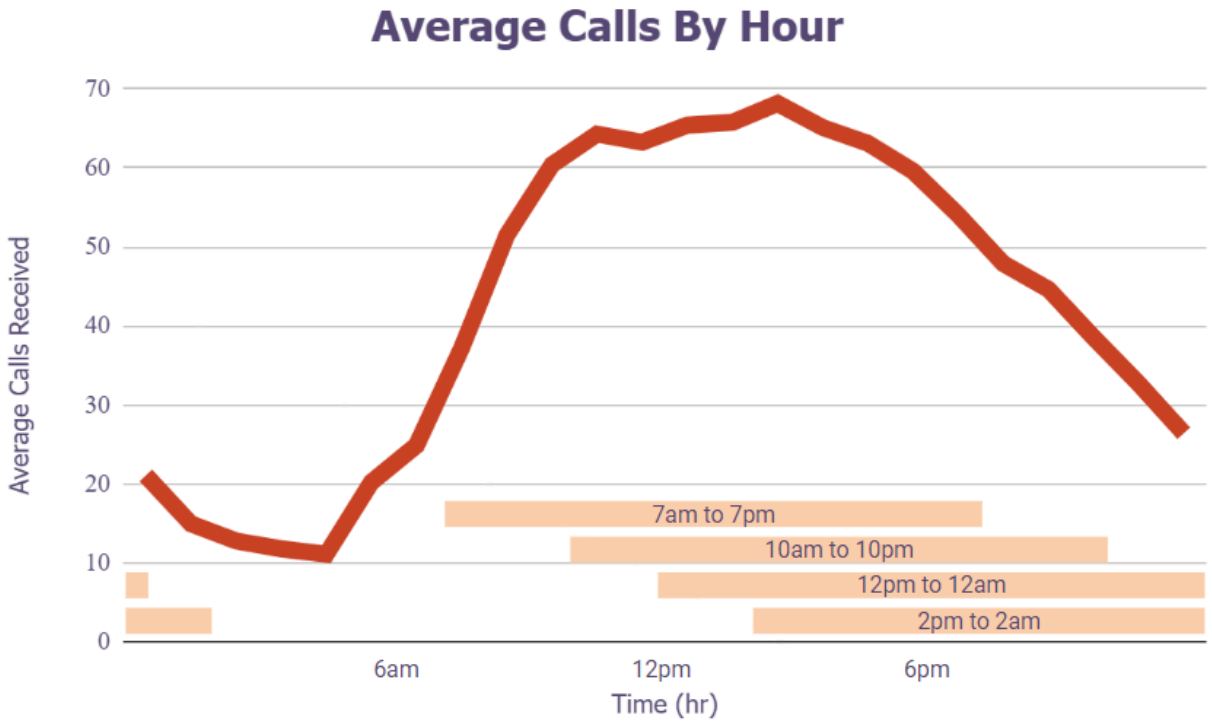
	coef	std err	t	P>|t|	[0.025	0.975]
const	23.7532	1.711	13.885	0.000	20.393	27.113
hour	1.5076	0.127	11.829	0.000	1.257	1.758

Omnibus:	35.156	Durbin-Watson:	0.835
Prob(Omnibus):	0.000	Jarque-Bera (JB):	40.019
Skew:	0.636	Prob(JB):	2.04e-09
Kurtosis:	3.217	Cond. No.	26.1

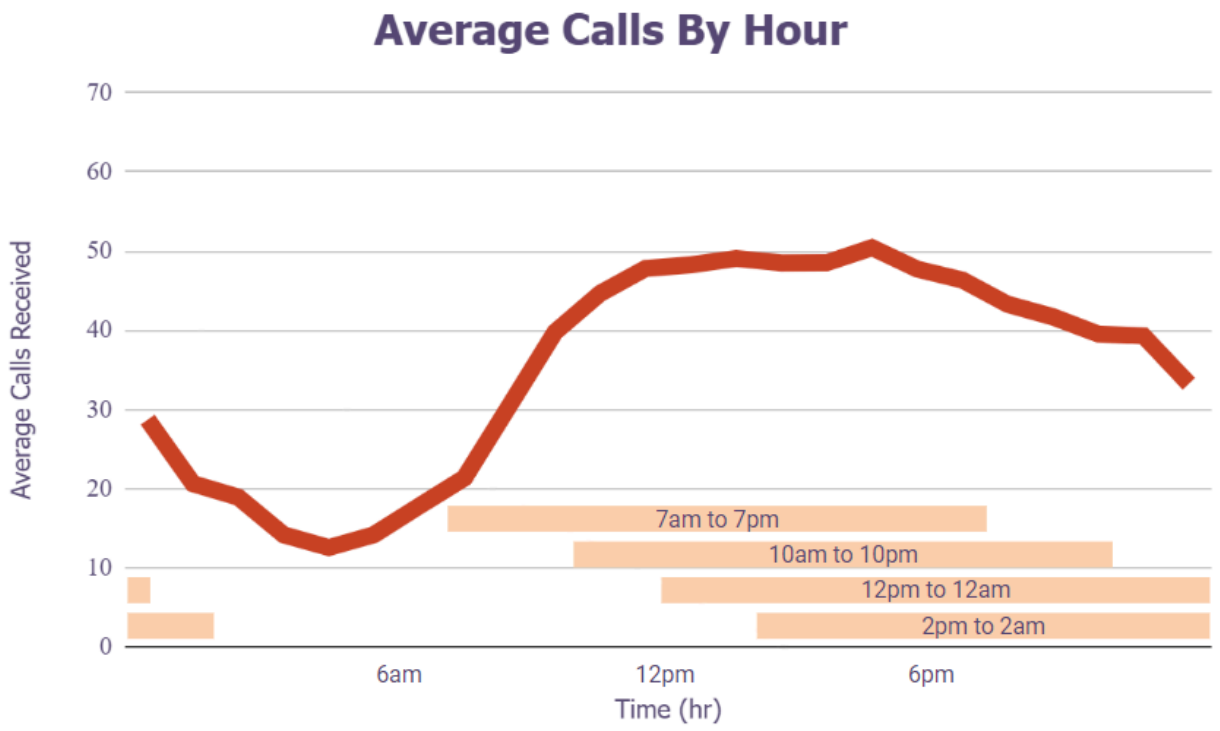
Appendix F: Python Polynomial Predictive Model for July



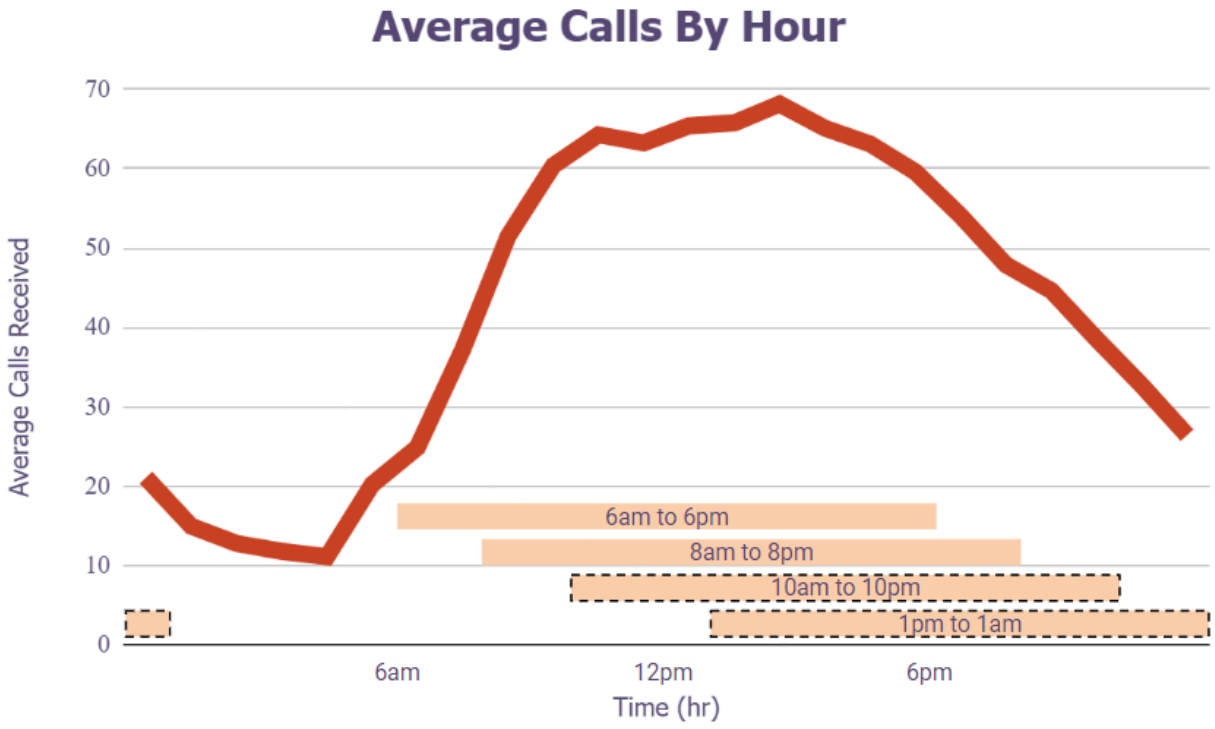
Appendix G: Overall Weekday Calls by Hour (pre-recommendation)



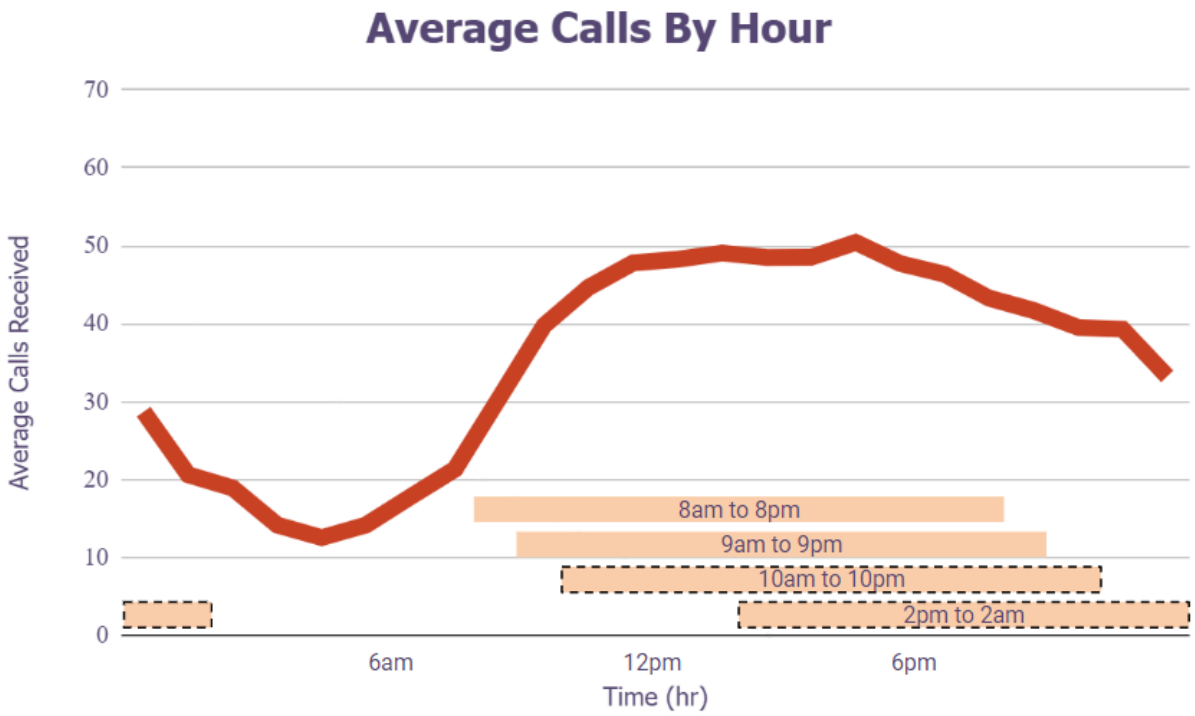
Appendix H: Overall Weekend Calls by Hour (pre-recommendation)



Appendix I: Overall Weekday Calls by Hour (post-recommendation)



Appendix J: Overall Weekend Calls by Hour (post-recommendation)



Appendix K: Traditional and Power Shifters Sample Schedule

EXAMPLE OF THE TRADITIONAL SHIFT SCHEDULE

A / B / C/ D

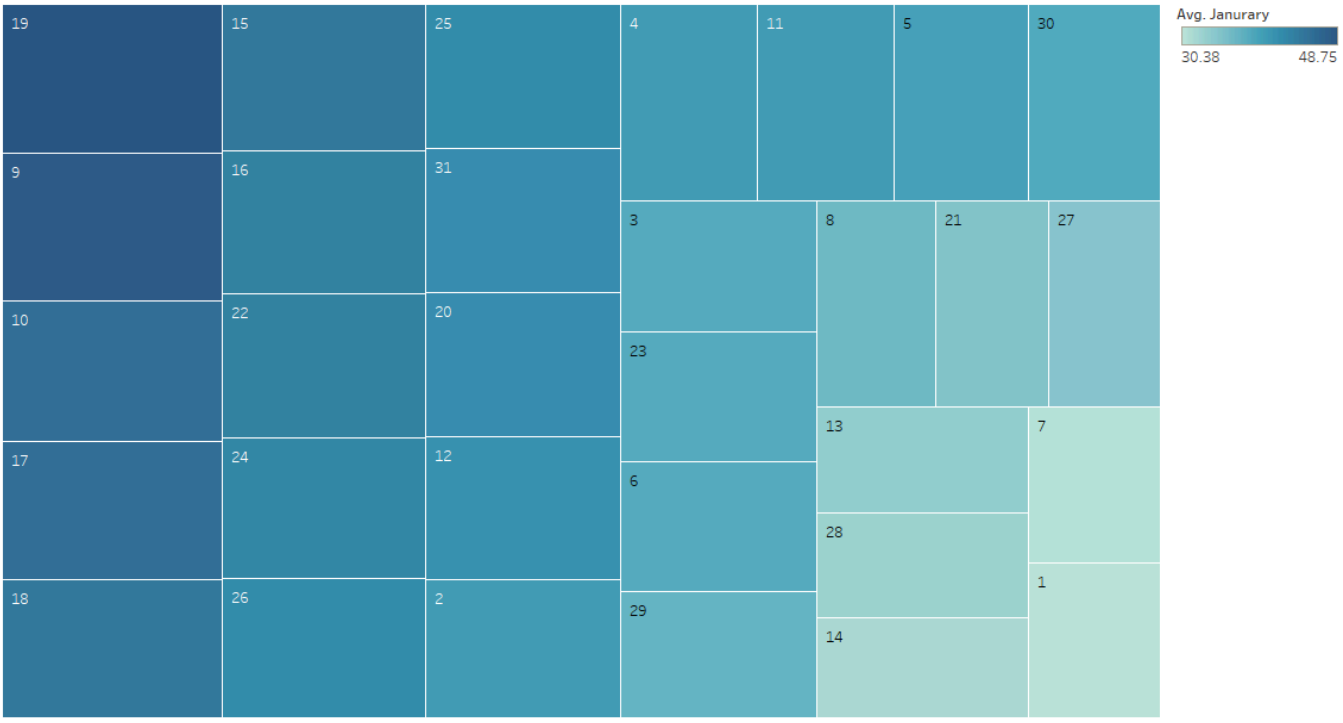
D=6:00AM – 6:00PM; **N**=6:00PM – 6:00AM

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1	D	D	N	N	OFF	OFF	OFF
Week 2	OFF	D	D	N	N	OFF	OFF
Week 3	OFF	OFF	D	D	N	N	OFF
Week 4	OFF	OFF	OFF	D	D	N	N

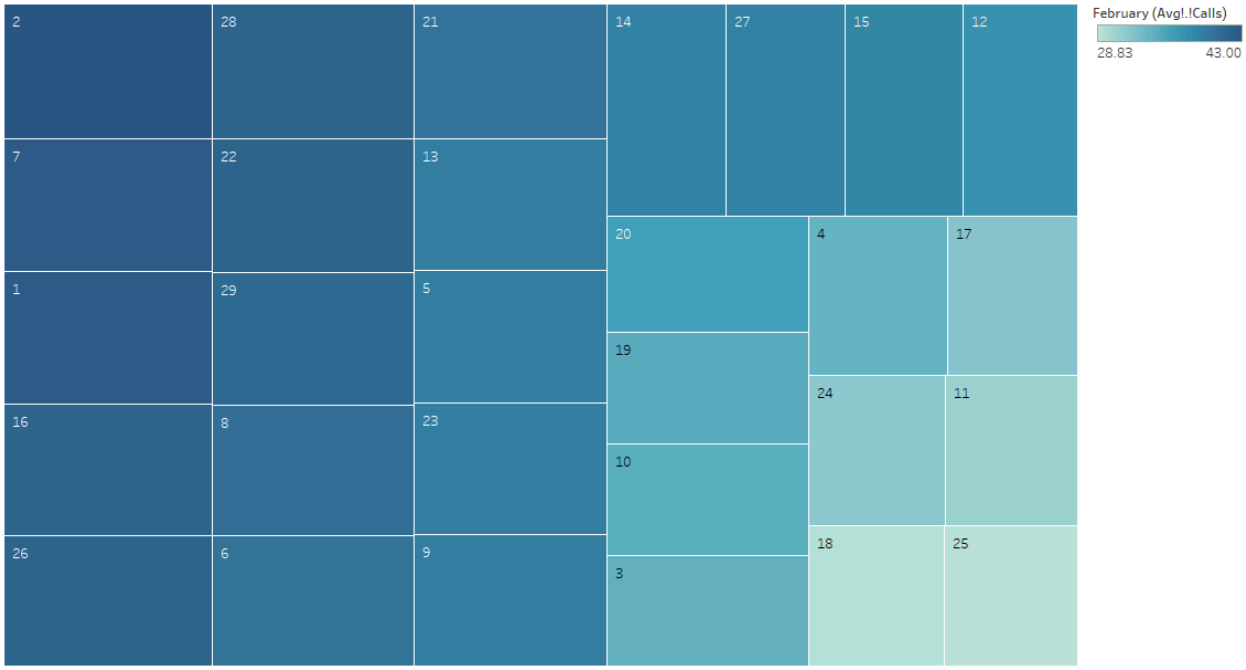
EXAMPLE OF THE POWER SHIFT SCHEDULE
E / F
10:00AM-10:00PM, 2:00PM-2:00AM

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1	OFF	Work	Work	OFF	OFF	Work	Work
Week 2	Work	OFF	OFF	Work	Work	OFF	OFF
Week 3	OFF	Work	Work	OFF	OFF	Work	Work
Week 4	Work	OFF	OFF	Work	Work	OFF	OFF

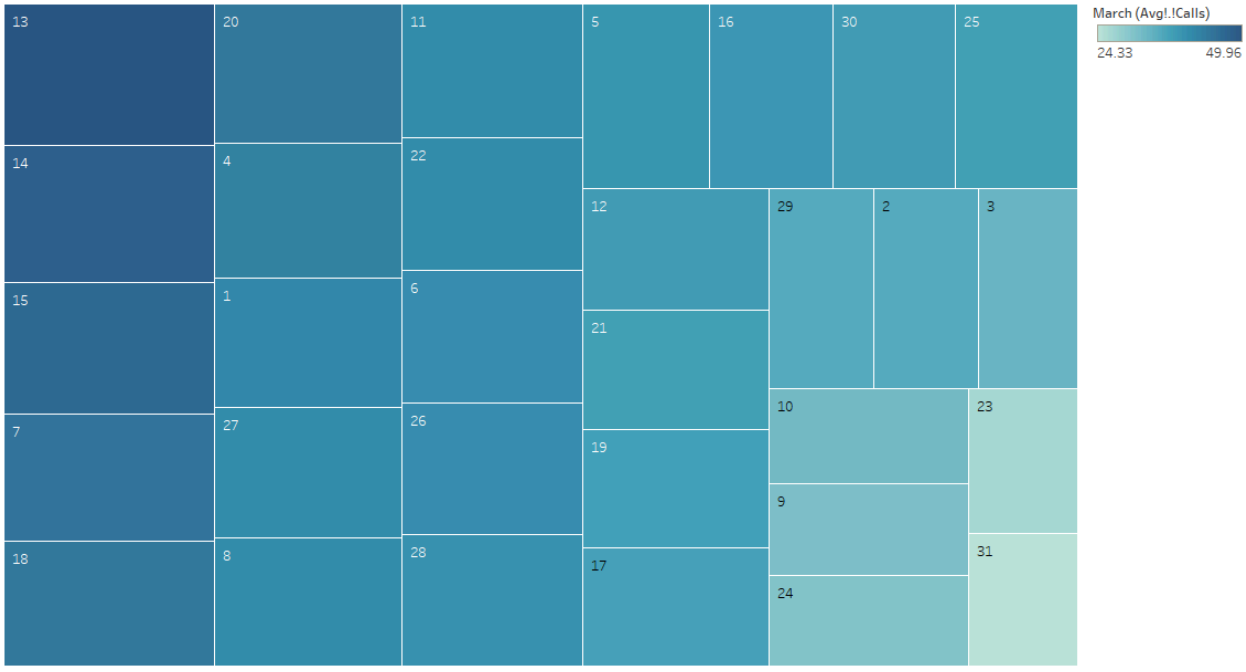
Appendix L: Calls by Day (January)



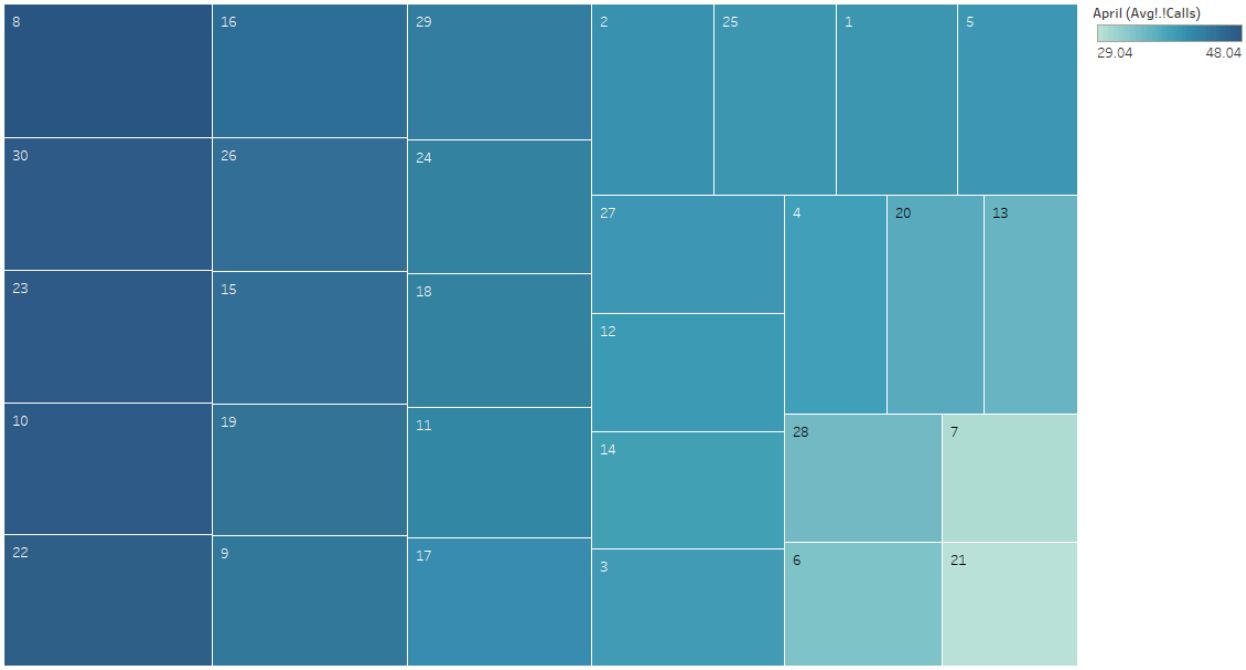
Appendix M: Calls by Day (February)



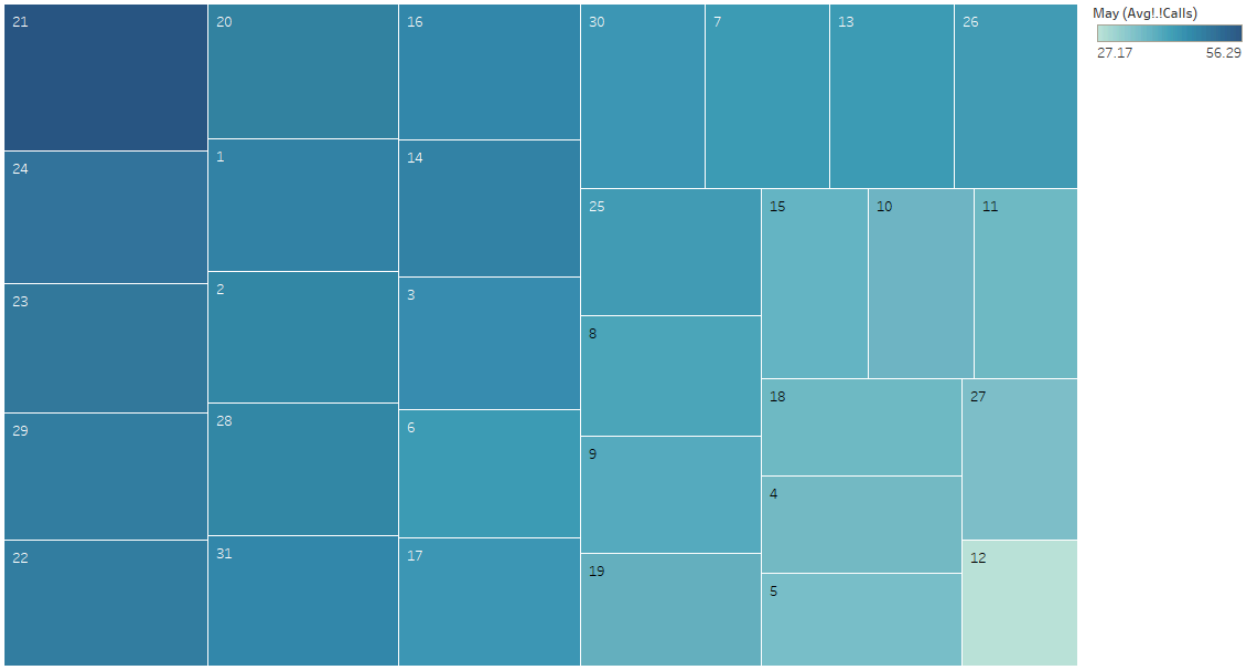
Appendix N: Calls by Day (March)



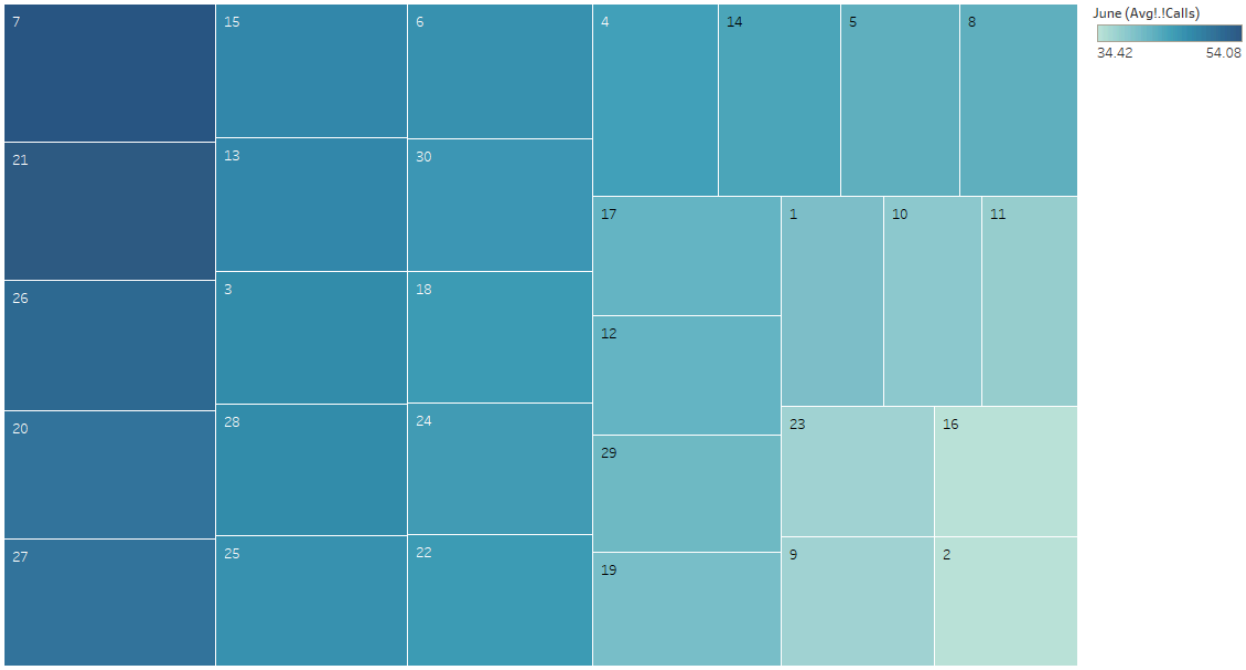
Appendix O: Calls by Day (April)



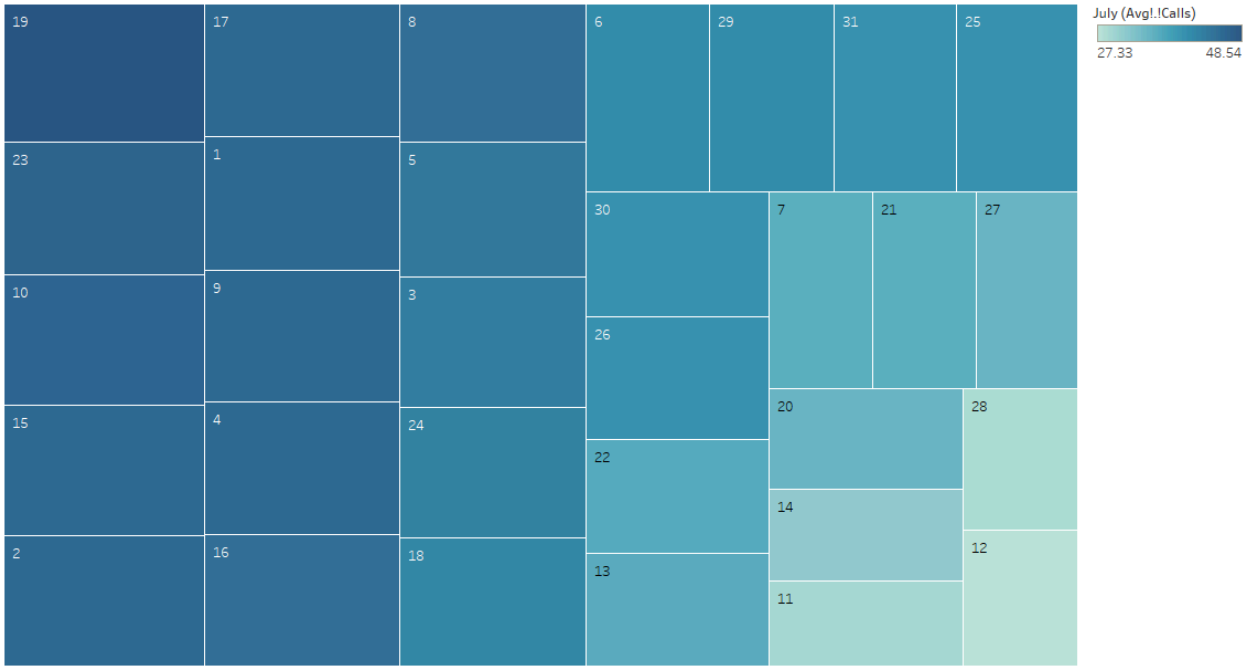
Appendix P: Calls by Day (May)



Appendix Q: Calls by Day (June)



Appendix R: Calls by Day (July)



Appendix S: Polynomial Regression Coefficients and Errors

```
Intercept: 20.6605
Coefficients:
  1: 0.0000
  Hour: -10.1176
  Day of Week: -1.4675
  Weekend: 0.0562
  Hour^2: 2.9040
  Hour Day of Week: 1.2270
  Hour Weekend: -0.4192
  Day of Week^2: -0.3679
  Day of Week Weekend: 0.2018
  Weekend^2: 0.0562
  Hour^3: -0.1891
  Hour^2 Day of Week: -0.0644
  Hour^2 Weekend: 0.3218
  Hour Day of Week^2: -0.2805
  Hour Day of Week Weekend: -1.1093
  Hour Weekend^2: -0.4192
  Day of Week^3: 0.3024
  Day of Week^2 Weekend: 0.5325
  Day of Week Weekend^2: 0.2018
  Weekend^3: 0.0562
  Hour^4: 0.0036
  Hour^3 Day of Week: 0.0004
  Hour^3 Weekend: -0.0007
  Hour^2 Day of Week^2: 0.0135
  Hour^2 Day of Week Weekend: -0.1001
  Hour^2 Weekend^2: 0.3218
  Hour Day of Week^3: -0.0021
  Hour Day of Week^2 Weekend: 0.3725
  Hour Day of Week Weekend^2: -1.1093
  Hour Weekend^3: -0.4192
  Day of Week^4: -0.0242
  Day of Week^3 Weekend: -0.1963
  Day of Week^2 Weekend^2: 0.5325
  Day of Week Weekend^3: 0.2018
  Weekend^4: 0.0562
Results for the Polynomial Model (Predict July)
Mean Absolute Error (MAE): 10.08
Mean Squared Error (MSE): 190.18
Root Mean Squared Error (RMSE): 13.79
R-squared (R²): 0.6385
```