Executive Summary – Kruskal-Wallis analysis of 911 data

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**Problem and Hypothesis:**

Is there a statistically significant difference in the median call processing times in response to the Department of Emergency and Customer Communications (DECC) of the City of Alexandria’s efforts to preserve the continuity of service to their constituents in response to the SARS-COV2 pandemic?

H0: There is no statistically significant difference in population means meaning the department’s actions had no impact on call processing times.

HA: There is a statistically significant difference in the population means meaning the department’s actions did impact call processing times.

**Summary of the Analytical Process:**

The data from 2019 and 2020 for analysis was extracted from Microsoft SQL Server 2016 databases supporting the city’s Computer Assisted Dispatch systems. After the extraction and preliminary cleaning via a SQL query. The exported csv file was imported into RStudio and converted into a data frame. Four variables were constructed for elapsed time points representing the time from phone pickup to time the call is ready for dispatching, the time from ready for dispatching to the assignment of the first unit, the time from phone pickup to the assignment of the first unit, and the time from phone pickup to phone release. After those measurables variables were created and negative interval outliers were removed, medians were calculated for each of the variables in total. Normality of the data was ascertained through density plots, QQ plots, and Anderson-Darling tests. The data was confirmed to be not normally distributed and was skewed to the right. Based on these finding, non-parametric analytical tests were performed for the remainder of the analysis. The medians were then separated by year and density plots were run against each year to ensure they are similar. Upon that proof, Kruskal-Wallis tests were performed against each of the time points against the independent variable Year. All the dependent variables showed significant differences in the medians between the two years. Effect sizes were tested to measure, per Professor Steve Draper of the University of Glasgow, the degree to which the certainty the results are not an accident but as an effect of the difference (Draper, 2020). In all the dependent variables the effect size was small. To discern if there is an independent variable which added to the year would yield a more significant effect. Adding in the independent variable WeekNo, using a Scheirer-Ray-Hare test, which is an extension of the Kruskal-Wallis test. In completing the tests, the p-value for each dependent variable was 0, demonstrating a significant difference between the population means.

**Findings:**

After completing the tests and comparing the medians for the weeks between the years for the data sets, there was a significant rise in three of the four dependent variables around the 12-week mark. The three dependent variables are all based on the time from phone pickup to the time it is available for dispatch to a responding unit. Each of these variables also shows the greatest median and difference between yearly medians at weeks 15 and 16. Per the timeline supplied by DECC Assistant Director for IT and HR, Jeff Wobbleton, the 12-week mark begins the use of remote call takers answering 911 calls and weeks 15 and 16 are when DECC utilized an isolation shift at a local hotel for 8 days (J. Wobbleton, personal communication, May 27, 2021). The final dependent variable, from the time the call is first dispatchable to the time the first unit was assigned to the call, showed more of a marked rise at different points within the year. While the median times were greater in 2020, there was no additional significant independent variable which could otherwise explain the rise in the dispatch times.

Comparing the analysis of the individual weeks with the timeline, the increases in the medians and the distance between medians from year to year coincide with the use of call-takers outside of the city network using software to establish a secure connection to the city network. As the use of the remote call-takers continued through the remainder of the year, the raise in the medians for initial call handling also stayed elevated from the previous year.

**Analytical Limitations:**

The main limitation of this analysis is the use of non-parametric methods, including Wilcoxon and Dunn tests, Kruskal-Wallis tests, and the Scheirer-Ray-Hare test. Per Professor Ron Fricker of the Naval Postgraduate School, non-parametric tests, while appropriate for a dataset such as this, are less powerful and, because they lack assumptions about the distribution of the data, can overlook some sensitivities within the data which can be uncovered through parametric tests. (Fricker, 2013) During the normality tests, the Anderson-Darling tests were used over the Kolmogorox-Smirnow tests due to the presence of ties in the ranking of the data. These ties created warnings in the Kolmogorov-Smirnov tests indicating p values were only approximated. Finally, the Scheirer-Ray-Hare test was used over the aligned rank transformation ANOVA test as all attempts to run the ART ANOVA were met with errors from RStudio indicating that it was not a suitable test for the dataset. The Scheirer-Ray-Hare test is not as supported or documented in the statistics community. Per Professor Salvatore Mangiafico of Rutgers University, the primary concern for this test is it may be less likely to find the interaction effect significant (Mangiafico, 2016).

**Proposed Actions:**

The first action proposed is for DECC to install and configure the NetMotion product currently in use by the APD and DECC administrative staff for use on the Dispatcher in a Box workstations for the remote call-takers. This will enable stronger connections to the city network and will give the call-takers a measurable speed boost. The other action proposed is to open the weekly statistics to a wider audience and share them with the floor supervisors in addition to the executive staff. By opening the statistics to the floor supervisors, DECC can leverage their proximity to operations to react more quickly to changing conditions and find other solutions to ensure faster response times during higher call volumes.

**Expected Benefits:**

Implementing the proposals above will allow DECC to have greater stability in their remote call-taker program and allow the personnel to respond quicker, thus lowering median times and lowering the number of abandoned calls as more constituents will be able to reach DECC in an emergency. DECC will also be able to better access and leverage their institutional knowledge by opening their statistical reports to their floor supervisors who can suggest additional proposals and advise when staffing levels need to change in the face of call volume.

**Bibliography:**

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