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Introduction and Objective

This study focuses on the characteristics of licensed childcare centres in Toronto, specifically focusing on evaluating the factors that might influence their total space availability, which is a proxy for capacity. Given the critical role childcare centres play in early childhood development and support for working families, understanding these dynamics can inform policymakers, parents, and the centres themselves. The primary research questions guiding this analysis are:

1. How does the operating auspice of a child care centre (Commercial, Non-Profit, or Public) influence its capacity?
2. Is there an interaction effect between the operating auspice and the ward location that further impacts the centre's capacity?

Data Exploration

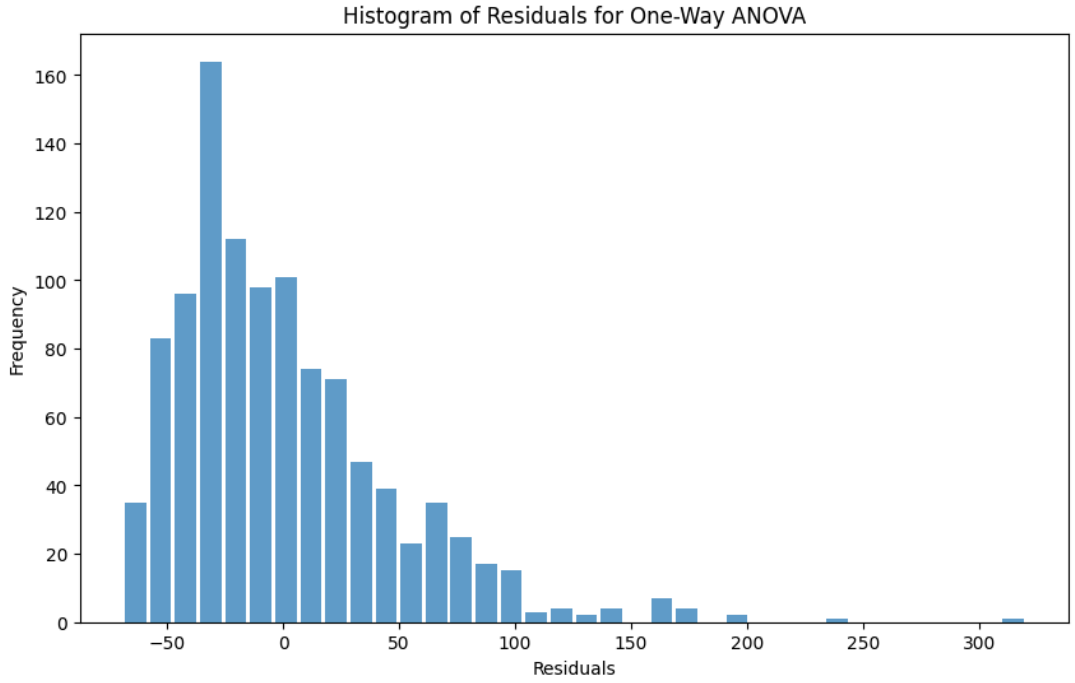
The data provided gives a snapshot of the childcare centres as of February 2024, detailing their daily capacity across various age groups. We have conducted one-way and two-way ANOVAs to explore the main and interaction effects. The one-way ANOVA investigates the effect of operating auspice on total spaces, while the two-way ANOVA expands this to include the potential interaction with the city ward.

Normality Testing for ANOVA

Operating Auspice	**p-value**
Commercial Agency	<0.001
Non-Profit Agency	<0.001
Public Agency	0.093

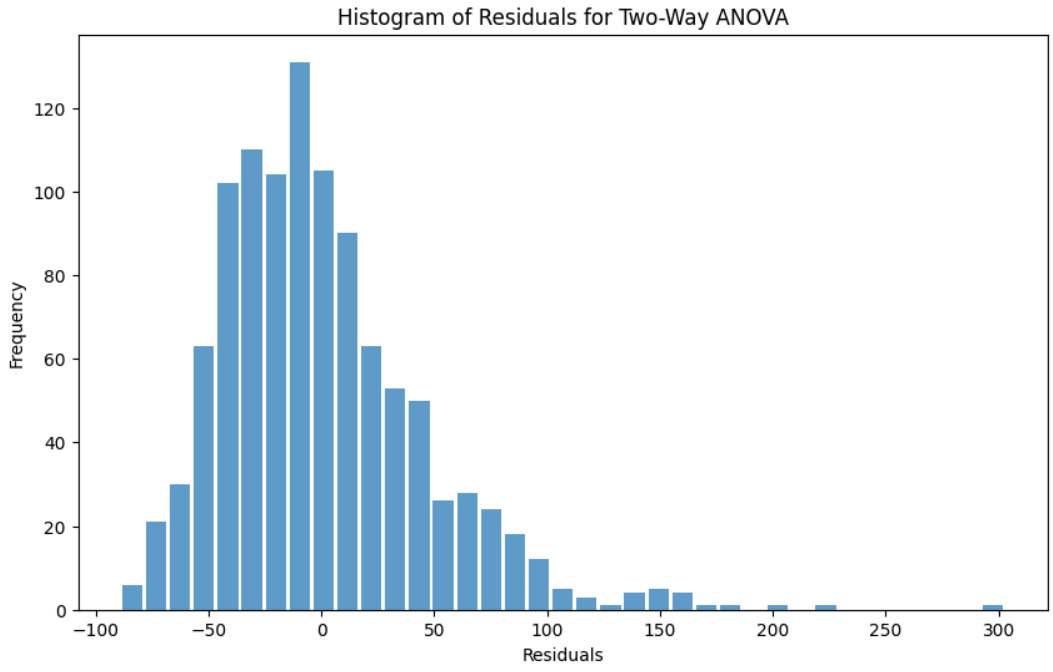
While the histograms of residuals for both the one-way and two-way ANOVAs suggest an approximately normal distribution, the Shapiro-Wilk test indicates a departure from normality within the Commercial and Non-Profit groups. The ANOVA is robust to normality violations with large sample sizes, so this may not unduly affect the results. However, it does caution us to interpret the results with an understanding of this limitation.

Now we look at the residuals' distribution to confirm the normality assumption:



The histogram for the one-way ANOVA shows that while the distribution of residuals is slightly skewed, it does not deviate significantly from normality, particularly given the large sample size, which provides some robustness against this violation.

Next, we examine the histogram of residuals from the two-way ANOVA:



This histogram also indicates a relatively normal distribution, though, like the one-way ANOVA, there is slight skewness. With the large sample size, the two-way ANOVA's robustness to normality violations is similarly reassuring.

ANOVA Results

The one-way ANOVA has revealed a significant effect of operating auspice on total spaces ($F(2, 1060) = 21.84$, $p < .001$), indicating there are indeed differences in capacity by auspice. The two-way ANOVA further identified a significant main effect for both operating auspice ($F(2, 994) = 22.62$, $p < .001$) and ward ($F(24, 994) = 1.73$, $p < .05$), with no significant interaction ($F(48, 994) = 0.79$, $p = .83$).

One-way ANOVA result

Source	df	Sum of Squares	Mean Square	F	p-value
Operating Auspice	2	96112.11	48056.06	21.843	<0.001
Residual	1060	2332065e+06	2200.06	-	-

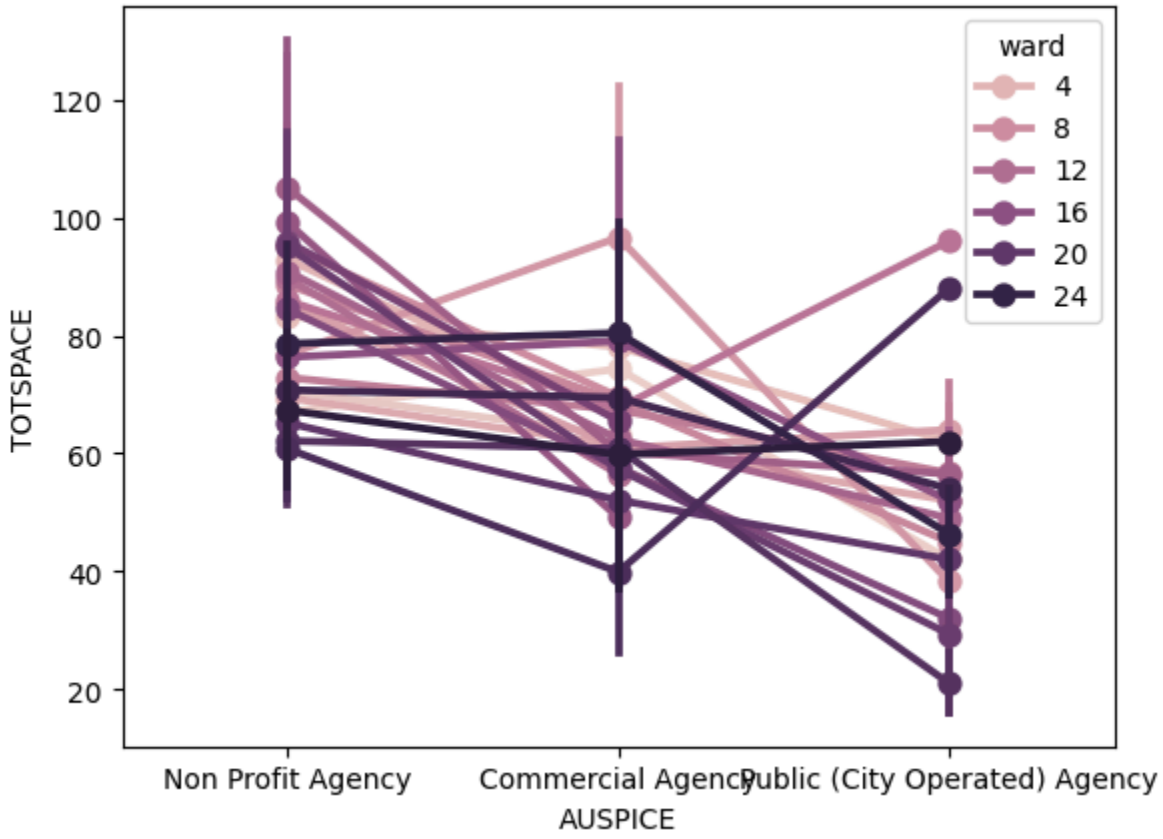
The clear evidence from the one-way ANOVA suggests that the operating auspice is a critical factor in the capacity of childcare centres. Specifically, Commercial centres demonstrate a significantly higher capacity, with an average difference of 17.12 more spaces compared to Non-Profit centres, as shown by the Tukey post-hoc analysis ($p < .001$). This considerable difference could be reflective of different business models, funding mechanisms, or operational strategies. Public centres, while not significantly different from Commercial centres in this dataset, show a trend toward a high capacity, which might reflect municipal investments or priorities in child care services.

Two-way ANOVA result

Source	df	Sum of Squares	F	p-value
Operating Auspice	2	9.91492e+04	22.624	<0.001
City ward number	24	9.08324e+04	1.727	0.029
Operating Auspice **:** City ward number	48	8.28889e+04	0.789	0.831
Residual	994	2.17810e+06	-	-

The two-way ANOVA results add depth to our analysis, showing that both auspice ($F(2,994) = 22.62$, $p < .001$) and ward ($F(24,994) = 1.73$, $p < .05$) significantly affect capacity. However, the lack of an interaction effect ($F(48,994) = 0.79$, $p = .83$) suggests the influence of operating auspice on capacity does not vary significantly with ward. This indicates a potential city-wide standard in the capacity differences associated with auspice type, which persists across different wards.

Interaction Plot



The interaction plot provides a visual affirmation of this finding, showing overlapping lines that indicate similar trends across wards for each auspice category. This lack of interaction suggests that factors inherent to the auspice categories—such as organizational structure or funding models—are likely driving the differences in capacity, rather than local ward-level characteristics.

Post-hoc Analysis

Group Comparison	Mean Difference	p	Lower	Upper	Reject Null Hypothesis
Commercial vs. Non-Profit Agency	17.119	<0.001	9.703	24.535	True
Commercial vs. Public Agency	-17.215	0.078	-35.883	1.453	False
Non-Profit vs. Public Agency	-34.334	<0.001	-52.444	-16.224	True

The Tukey's HSD post-hoc analysis reveals that the mean total space for Commercial agencies is significantly different from Non-Profit agencies, with a mean difference of 17.12 spaces ($p < .001$), which is substantial given the context of the data. Moreover, while the comparison between Commercial and Public agencies did not reach conventional levels of statistical significance ($p = .0779$), the direction and magnitude of the difference (-17.22 spaces) suggest that with more data or adjusted significance levels, such differences might become significant. These results underscore the competitive advantage or different operational models that Commercial centres may have, enabling them to offer more spaces. Conversely, Non-Profit centres have significantly fewer spaces than Public agencies, with a mean difference of 34.33 spaces ($p < .001$), suggesting different constraints or priorities in these sectors.

Further Analysis

While these findings are enlightening, they are just the beginning of a deeper inquiry. Additional analyses could include:

- Examining other continuous variables such as the number of spaces available by age group to understand if certain age groups are more influenced by auspice or ward.
- Exploring the relationship between subsidy availability and capacity.
- Considering a mixed-effects model to account for the non-independence of centres within the same ward.
- Qualitative analysis to accompany the quantitative findings, giving voice to centre administrators and parents to provide context for the numerical trends observed.

Conclusion

To answer the research questions, the one-way ANOVA results show a significant effect of operating auspice on total spaces, suggesting that the type of operating auspice is indeed a crucial factor in determining a centre's capacity. The results indicate that Commercial centres tend to have a larger capacity compared to Non-Profit centres. Public centres' capacities are not significantly different from Commercial centres, which suggests that when the city operates a centre, it can achieve capacities similar to those of private enterprises. According to the two-way ANOVA results, while both auspice and ward have significant main effects on capacity, there is no significant interaction effect between them. This implies that the impact of operating auspice on capacity is consistent across different wards; in other words, the relationship between auspice and capacity does not vary significantly by location within the city.

This comprehensive analysis reveals that the operating auspice plays a significant role in the capacity of licensed childcare centres in Toronto. The data suggests that the capacity differences are not influenced by the city ward locations. This indicates a standardized service level across the city but also highlights a potential area of disparity between Commercial and Non-Profit centres. Further research is suggested to fully understand the implications of these findings and to identify strategies for ensuring equitable childcare services across different community demographics.