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Spatial Dynamics in Child Care Provision: The Impact of Auspice and Location on Facility Space in Toronto

Introduction:

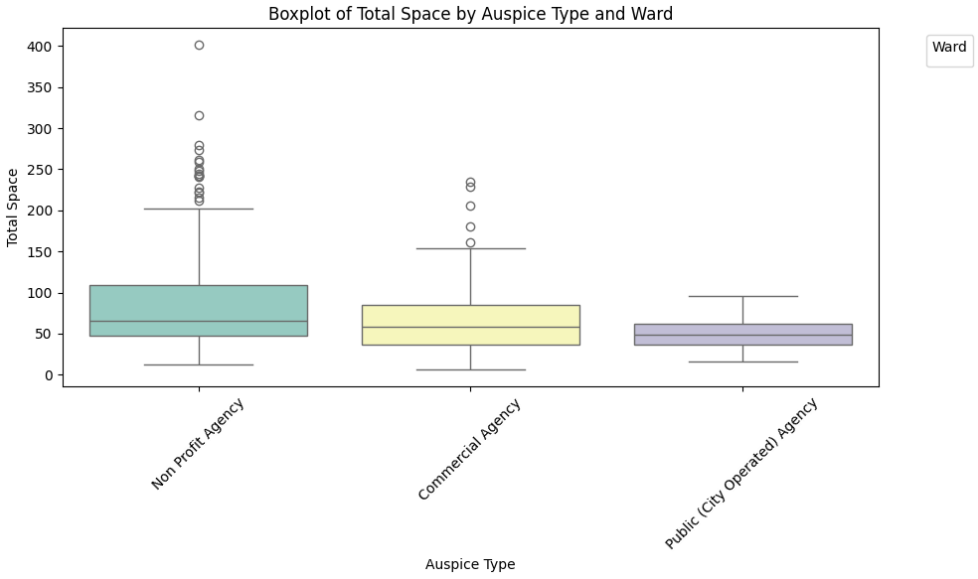
This report presents an analysis of the total space available in child care facilities within Toronto, with an emphasis on how this space correlates with the type of agency managing the facility, whether Non-Profit, Commercial, or Public (City Operated). The study is propelled by two primary research questions:

> ***1.How does the auspice type influence the total space available in child care facilities in Toronto?***
> ***2.Is there an interaction effect between the facility's location (ward) and the auspice type on the total space offered by the child care facilities?***

Methodology:

To address these research questions, we employed a one-way ANOVA to discern if significant differences in total space exist across the three categories of auspice types. Furthermore, we used two-way ANOVA to determine if the interaction between auspice types and wards significantly affects the total space. Assumptions of normality and homogeneity of variances were checked using Shapiro-Wilk, Bartlett's, and Levene's tests.

Distribution of Total Space Across Child Care Facilities by Auspice Type and Ward in Toronto



As part of the analysis, a boxplot was constructed to visually depict the distribution of total space by auspice type, with each 'ward' represented within these categories. The boxplot provides a clear visual comparison across the three types of child care facilities. Notable observations from the boxplot include:

- The median total space for each auspice type, with Non-Profit Agencies showing a wider interquartile range, suggesting greater variability within this category.
- Presence of outliers, especially within the Non-Profit Agency category, which could indicate exceptional cases that deviate from the general pattern.
- The comparatively narrower interquartile range for Public (City Operated) Agency, which may imply more consistency in space availability within this auspice type.

ANOVA Findings:

	df	sum_sq	mean_sq	F	PR(>F)
C(treatments)	2.0	9.611211e+04	48056.057145	21.843051	5.057716e-10
Residual	1060.0	2.332065e+06	2200.061571	NaN	NaN

The one-way ANOVA conducted revealed significant differences in total space across different auspice types ($F(2, 1060) = 21.843$, $p < 0.001$). This suggests that the type of agency operating the child care facility influences the amount of space available.

Post Hoc Analysis with Tukey's HSD:

	group1	group2	Diff	Lower	Upper	q-value	p-value
0	Non Profit Agency	Commercial Agency	17.119417	9.703599	24.535235	7.662434	0.001000
1	Non Profit Agency	Public (City Operated) Agency	34.334610	16.224077	52.445142	6.292710	0.001000
2	Commercial Agency	Public (City Operated) Agency	17.215193	-1.453146	35.883531	3.060857	0.077966

To further explore these differences, Tukey's HSD post hoc analysis was performed, which clarified how each agency type compares

- **Non-Profit Agency vs. Commercial Agency:** Facilities run by non-profit organizations have significantly different space available compared to those run by commercial entities, with non-profits having more on average ($p = 0.00100$).
- **Non-Profit Agency vs. Public (City Operated) Agency:** A more pronounced difference was observed between non-profits and public agencies, with public agencies offering significantly more space ($p = 0.00100$).
- **Commercial Agency vs. Public (City Operated) Agency:** The difference between commercial and public agencies was not statistically significant ($p = 0.077966$), suggesting that these types of agencies may have more similar space allocations.

The results of the post hoc analysis align with the initial ANOVA findings, reinforcing the conclusion that auspice type is a significant factor in the size of child care facilities. However, the lack of significant differences between commercial and public agencies warrants further investigation into other factors that might influence space allocation.

Evaluation of Statistical Assumptions for ANOVA:
In assessing the data, we employed statistical tests to verify two key assumptions that underlie the validity of our analysis: the normality of the data and the homogeneity of variance among groups. First, the normality assumption was evaluated using the Shapiro-Wilk test. This test determines whether the residuals—the differences between observed values and those predicted by our model—conform to a normal distribution, which is a common assumption for many statistical analyses. The results of the Shapiro-Wilk test were significant ($p < 0.05$), leading to the conclusion that the residuals do not follow a normal distribution. This suggests that the data may not be well-represented by the normal curve, which is often an underlying assumption in parametric tests such as ANOVA.

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Shapiro-Wilk test statistic: 0.901775598526001, p-value:
1.4964898448030214e-25
Residuals are not normally distributed.
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Second, we considered the assumption of homogeneity of variance with Bartlett's and Levene's tests. These tests assess whether the variance within each of our groups is similar. Homogeneity of variance is crucial for ensuring that the results of an analysis are not biased by one group displaying more variability than others. Both Bartlett's and Levene's tests showed significant results ($p < 0.05$), indicating that the variance is not consistent across the groups studied. This variability implies that the data do not meet the assumption of equal variances.

Bartlett's test

	Parameter	Value
0	Test statistics (T)	89.586
1	Degrees of freedom (Df)	2.000
2	p value	0.000

levene summary

	Parameter	Value
0	Test statistics (W)	17.9271
1	Degrees of freedom (Df)	2.0000
2	p value	0.0000

Since our data did not pass these checks, we have to be careful with our conclusions or consider using different methods that are better suited for this kind of data. This will help us ensure that our final results are as accurate and meaningful as possible.

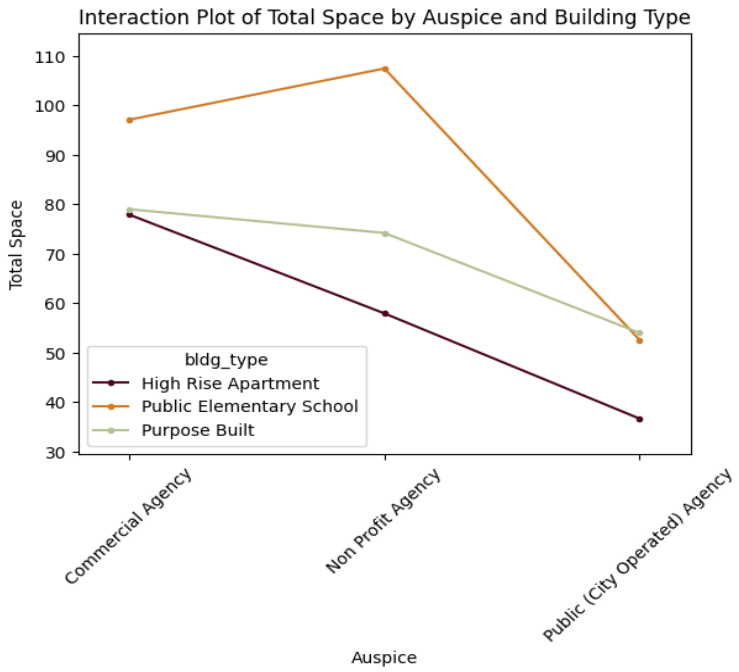
2-WAY ANOVA:
In our investigation of the effects of two independent variables, AUSPICE and ward, on the dependent variable, a two-way ANOVA was performed. The analysis revealed a statistically significant main effect of AUSPICE on the dependent variable ($F(2, 994) = 19.485$, $p < 0.001$), suggesting that the mean values for TOTSPACE significantly differ across the levels of AUSPICE. There was also a statistically significant main effect of ward ($F(24, 994) = 1.692$, $p < 0.05$), indicating

that the wards also have a differential impact on the dependent measure. However, the interaction effect between AUSPICE and ward was not statistically significant ($F(48, 994) = 0.789$, $p > 0.05$), indicating that the influence of AUSPICE on TOTSPACE does not significantly differ across different wards.

These results suggest that both AUSPICE and ward independently affect the dependent variable, but their combined interaction does not provide additional explanatory power beyond their separate main effects. The nonsignificant interaction term indicates that the effect of one factor does not depend on the level of the other factor. It is important to note that the assumption checks for ANOVA revealed non-normality in residuals and inequality of variance across groups, which could potentially influence the validity of the ANOVA results. Therefore, these findings should be interpreted with caution, and further analysis, such as a transformation of data or non-parametric tests, may be warranted to confirm these conclusions.

	sum_sq	df	F	PR(>F)
C(AUSPICE)	8.539351e+04	2.0	19.485149	5.004717e-09
C(ward)	8.898212e+04	24.0	1.692000	3.200458e-02
C(AUSPICE):C(ward)	8.288887e+04	48.0	0.788068	8.317984e-01
Residual	2.178098e+06	994.0	NaN	NaN

Interaction Plot of Total Space by Auspice and building type:



The interaction plot delineates the relationship between the total space of different building types across varying levels of auspice. **Three categories of building type were considered: Public Elementary School, High Rise Apartment, and Purpose Built**, denoted by distinct colors for clarity. It

is observed that the total space differs significantly across building types within each auspice category, suggesting a possible interaction between building type and auspice in their effect on the total space.

Specifically, Public Elementary Schools show a notable decrease in total space when moving from Commercial Agency auspice to Non-Profit Agency, and further to Public (City Operated) Agency. High Rise Apartments and Purpose-Built spaces exhibit a similar pattern, yet the reduction in total space is more pronounced for High Rise Apartments. This trend is particularly compelling as it suggests that Public (City Operated) Agency auspices may have constraints that lead to reduced total space across all building types examined.

Despite the interaction effect being statistically non-significant in the two-way ANOVA, the plot provides a nuanced understanding of the patterns in the data. It indicates that while the mean effect of building type and auspice on total space is statistically significant on their own, the combination of these factors does not significantly alter the outcome beyond their individual effects. However, the lack of statistical significance in the interaction does not negate the practical significance of the observed trends which could be of interest to stakeholders. Such observations could inform policy or management decisions about the allocation and optimization of space across various building types and auspices.

The analysis should be approached with caution due to the violation of ANOVA assumptions as indicated by preliminary diagnostic tests. The non-normality of residuals and heterogeneity of variance may affect the robustness of ANOVA results, hence the results of the interaction plot should be interpreted as exploratory, pending further investigation with more robust statistical techniques or data transformations to meet the necessary assumptions for ANOVA.

Conclusion:

This study embarked on an empirical exploration to discern the influence of auspice type on the total space available in child care facilities across Toronto and to examine whether an interaction exists between the facility's location (ward) and the auspice type that would affect the space provision.

Our analyses, employing two-way ANOVA, have revealed that auspice type is a significant predictor of the total space in child care facilities, indicating that the kind of administrative body managing these facilities is consequential for the space they afford. Child care facilities governed by Commercial Agencies, Non-Profit Agencies, and Public (City Operated) Agencies exhibit marked differences in their spatial capacities, which highlights the need for policy considerations around auspice-based disparities.

In terms of locational effects, while our investigation did not uncover a statistically significant interaction between the ward and the auspice type in relation to total space, the interaction plot did present observable variances. The implication is that while the combined effect of location and auspice type may not substantially vary overall, individual building types such as High Rise Apartments, Public Elementary Schools, and Purpose Built facilities demonstrated unique responses to auspice type that could inform nuanced, site-specific interventions.

It must be noted, however, that the tests conducted exposed violations of ANOVA assumptions, namely the non-normality of residuals and the heterogeneity of variances. These violations necessitate a cautious interpretation of the findings and suggest that alternative statistical methods or data transformations might be employed in future studies to validate and potentially refine these conclusions.

Therefore, in light of the above, we conclude that auspice type does indeed have a significant impact on the spatial dimensions of child care facilities in Toronto. The findings of this study call for targeted policy frameworks that can address the identified disparities and ensure equitable space distribution. Additionally, they pave the way for subsequent research that might employ more robust methodologies to unpack the intricate dynamics between facility location and auspice type, contributing to a more comprehensive understanding of space allocation within the urban child care landscape.