

## INF2178: A2

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### Introduction

Childcare availability and provision play a crucial role in supporting families and promoting early childhood development. In this project, we aim to analyze a dataset focusing on licensed childcare centres in Toronto, Canada. The dataset, titled "INF2178\_A2\_data.xlsx," provides comprehensive information on the operation, capacity, and characteristics of these centres, including demographic details, auspice (operating type), building types, and daily capacity for various age groups. Through quantitative analysis using one-way and two-way ANOVAs, we seek to gain insights into the factors influencing the total childcare spaces available and their distribution across different agency auspices.

The main research question that this report aims to answer is the following:

- **Research Question 1:** Is there a significant difference in the total childcare spaces based on the auspice of the agency (i.e., whether the agency is a commercial, non-profit, or public city-operated agency)? This question aims to assess whether the operating type of childcare agencies significantly impacts the total childcare spaces available, providing insights into potential disparities in childcare provision across different auspices.

We are using one-way and two-way ANOVAs for quantitative analysis to answer our research question because they are powerful statistical methods for comparing means across multiple groups and assessing the effects of categorical variables on a continuous outcome variable, which in this case is the total childcare spaces available.

By employing both one-way and two-way ANOVAs, we can thoroughly investigate the factors influencing total childcare spaces and their distribution across different agency auspices while leveraging the strengths of each method to obtain comprehensive and meaningful insights.

### Preliminary Exploratory Data Analysis

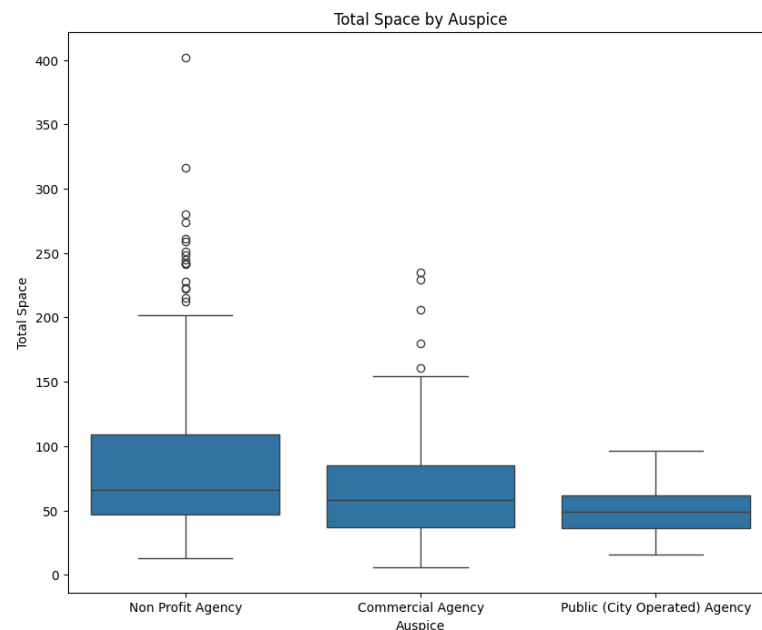
The dataset comprises 1063 rows and 17 columns. Among the columns are identifiers such as '\_id' and 'LOC\_ID', along with descriptive details like 'LOC\_NAME', 'AUSPICE', 'ADDRESS', 'PCODE', 'ward', 'bldg\_type', and 'BLDGNAME'. These descriptors provide information about the childcare centers, including their auspice (whether they are commercial, non-profit, or public), address details, and building type. The dataset also includes information on the capacity of childcare centers, categorized by age groups, ranging from infants to school-aged children. The 'subsidy' column indicates whether the center has a fee subsidy contract, while 'cwelcc\_flag' denotes participation in the CWELCC program.

Examining the numeric variables, we find that on average, childcare centers have around 4 spaces for infants (IGSPACE), 12 spaces for toddlers (TGSPACE), 24 spaces for preschoolers (PGSPACE), 14 spaces for kindergarten children (KGSPACE), and 22 spaces for school-aged children (SGSPACE). The total space available (TOTSPACE) averages around 76 spaces per center. However, there's considerable variability in these figures, with standard deviations

indicating the spread of values from the mean. For instance, while the mean total space is 76, the standard deviation is approximately 48, indicating that the total space varies significantly across childcare centers.

Additionally, looking at the quartile ranges, we can observe the distribution of space availability across centers. For example, the interquartile range for total space (TOTSPACE) indicates that 50% of childcare centers have between approximately 43 and 97 spaces. The minimum and maximum values reveal the range of space availability, with some centers offering as few as 6 spaces and others providing up to 402 spaces.

A boxplot was created to examine and compare total space by auspice. The boxplot shows us that all auspices have a mean of around 50-60 for total space. Commercial Agency Auspice and Non-Profit agency have the most outliers with on Non-profit Agency having a total space of 400.



## Testing Assumptions for ANOVA

For a one-way ANOVA, normality was assessed for the total childcare spaces within each type of agency using a Shapiro-Wilk test. The p-values for the Shapiro-Wilk test indicate that the distribution of total spaces is not normally distributed for commercial agencies ( $p = 1.013541e-11$ ) and non-profit agencies ( $p = 8.339871e-22$ ) but is normal for public (city-operated) agencies ( $p = 0.092$ ).

Normality results:

AUSPICE	p-value
Commercial Agency	1.013541e-11

Non-Profit Agency	8.339871e-22
Public Agency	9.225869e-02

### One-Way ANOVA

The one-way ANOVA shows that there are significant differences in the total childcare spaces among different types of agencies ( $F(2, 1060) = 21.843$ ,  $p < .0001$ ).

One-way ANOVA table:

	Sum of Squares	Degrees of Freedom	F	p
C(AUSPICE)	9.611211e+04	2.0	21.843051	5.057716e-10
Residual	2.332065e+06	1060.0		

### Two-Way ANOVA

The two-way ANOVA examined the interaction between 'AUSPICE' (the auspice of the agency) and 'subsidy' (the presence of a subsidy) as independent variables, with 'TOTSPACE' (total childcare spaces) as the dependent variable. The analysis assesses whether the operating type of childcare agencies significantly impacts the total childcare spaces available and whether this effect is influenced by the presence of a subsidy. This approach provides a more comprehensive understanding of the relationship between auspice, subsidy, and total childcare spaces, offering insights into potential disparities in childcare provision across different agency types.

Two-Way ANOVA Table:

	Sum of squares	Degrees of freedom	F	p
AUSPICE	8.567996e+03	2.0	2.057586	1.282730e-01
subsidy	8.352744e+04	1.0	40.117876	3.529094e-10
AUSPICE : subsidy	5.603445e+04	2.0	13.456555	1.694282e-06
Residual	2.202809e+06	1058.0		

The results of the two-way ANOVA table provide insights into the effects of 'AUSPICE' (the auspice of the agency) and 'subsidy' (the presence of a subsidy) on the total childcare spaces ('TOTSPACE'). The sum of squares for 'AUSPICE' is  $8.568e+03$ . The degrees of freedom is 2, indicating there are two levels within the 'AUSPICE' factor (commercial, non-profit, or public city-operated agency). The F-statistic (F) is 2.058 with a corresponding p-value ( $PR(>F)$ ) of 0.128. Since the p-value is greater than the significance level of 0.05, we fail to reject the null hypothesis for the main effect of 'AUSPICE'. This suggests that the type of agency (commercial, non-profit, or public) does not significantly affect the total childcare spaces available.

For the Subsidy variable, the sum of squares for 'subsidy' is  $8.353e+04$ . The degrees of freedom is 1, indicating there are two levels within the 'subsidy' factor (presence or absence of subsidy). The F-statistic is 40.118 with a very low p-value ( $PR(>F)$ ) of  $3.529e-10$ . The low p-value suggests that the presence of a subsidy significantly affects the total childcare spaces available.

For the interaction effect, the sum of squares (sum\_sq) for the interaction between 'AUSPICE' and 'subsidy' is  $5.603e+04$ . The degrees of freedom is 2, indicating the interaction involves multiple levels of both 'AUSPICE' and 'subsidy'. The F-statistic is 13.457 with a very low p-value ( $PR(>F)$ ) of  $1.694e-06$ . The low p-value suggests that there is a significant interaction effect between 'AUSPICE' and 'subsidy' on the total childcare spaces available. This indicates that the impact of subsidy on childcare spaces varies depending on the auspice of the agency, and vice versa.

Overall, the analysis indicates that while the type of agency (AUSPICE) alone does not significantly affect total childcare spaces, both the presence of a subsidy and the interaction between auspice and subsidy have significant effects on the total childcare spaces available.

## **Post-Hoc Test**

The Tukey HSD test results, displayed in tabular form, reveal notable differences in mean values between groups. Specifically, there's a significant disparity between commercial and non-profit agencies, with non-profits boasting an average of 17.1194 more spaces than commercial agencies ( $p < .0001$ ). While the mean difference between commercial agencies and public (city-operated) agencies was -17.2152, it did not reach statistical significance ( $p = .0779$ ). Conversely, non-profit agencies notably trail public agencies, with a mean difference of -34.3346 ( $p < .0001$ ).

In summary, the data highlights substantial variation in childcare space provision across different agency types, notably favoring Non-Profit Agencies with higher capacity. Furthermore, there appears to be a significant interaction between agency type and participation in the CWELCC program, suggesting an influence on childcare space capacity. These insights offer valuable understanding of the childcare landscape in Toronto, informing future investigations and policy decisions.

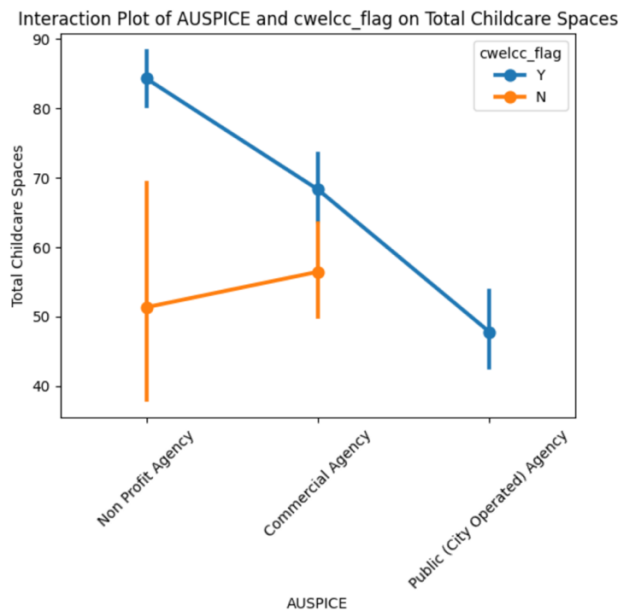
tukey summary:

Multiple Comparison of Means - Tukey HSD, FWER=0.05

group1	group2	meandiff	p-adj	lower	upper	reject
Commercial Agency	Non Profit Agency	17.1194	0.0	9.7037	24.5351	True
Commercial Agency Public (City Operated) Agency	Non Profit Agency Public (City Operated) Agency	-17.2152	0.0779	-35.8832	1.4528	False
Non Profit Agency Public (City Operated) Agency	Commercial Agency Public (City Operated) Agency	-34.3346	0.0	-52.4448	-16.2244	True

## Interaction Plot

The interaction plot illustrates how total childcare spaces vary with agency auspice and participation in the CWELCC program ('Y' for yes, 'N' for no). Non-Profit Agencies participating in CWELCC have the highest number of total childcare spaces, while Commercial Agencies not participating have the lowest. The slopes of the lines suggest an interaction effect between auspice type and CWELCC participation on childcare spaces. Specifically, the plot demonstrates the interaction between 'AUSPICE' (Operating auspice - Commercial, Non-Profit, or Public) and 'CWELCC\_FLAG' (participation in CWELCC) variables on total childcare spaces ('TOTSPACE'). It indicates that non-profit agencies tend to have more childcare spaces than commercial and public agencies, regardless of CWELCC participation. However, an interaction effect exists between agency type and CWELCC participation, with the largest discrepancy observed in commercial agencies, where the presence of a CWELCC flag corresponds to fewer childcare spaces.



## Conclusion

In this study, we set out to explore the factors influencing childcare provision, focusing on agency auspice and the presence of subsidies. Through quantitative analysis using one-way

and two-way ANOVAs, we sought to address the research question: whether the auspice of the agency significantly impacts total childcare spaces.

Our findings reveal several significant insights into the dynamics of childcare provision in Toronto. First, while agency auspice alone does not significantly affect total childcare spaces, the presence of subsidies has a notable impact. Non-profit agencies generally offer more childcare spaces compared to commercial agencies, with public (city-operated) agencies also showing higher capacity, particularly when subsidies are present.

Furthermore, our analysis highlights a significant interaction effect between agency auspice and subsidy presence on childcare space provision. This suggests that the influence of subsidies on childcare capacity varies depending on the auspice of the agency, indicating potential nuances in how different types of agencies utilize subsidy programs to expand their childcare services.

Our post-hoc analysis further supports these findings, revealing significant differences in mean values between agency types, particularly favoring non-profit agencies in terms of childcare space provision. The interaction plot further illustrates the complex interplay between agency auspice, subsidy participation, and childcare spaces, offering valuable insights into the childcare landscape in Toronto.

Overall, our study contributes to a better understanding of the factors shaping childcare provision, informing policymakers, childcare providers, and stakeholders about strategies to improve childcare accessibility, affordability, and quality. By considering the interactions between agency auspice, subsidy programs, and other factors, policymakers can develop targeted interventions to address disparities and enhance childcare services for families in Toronto and beyond.