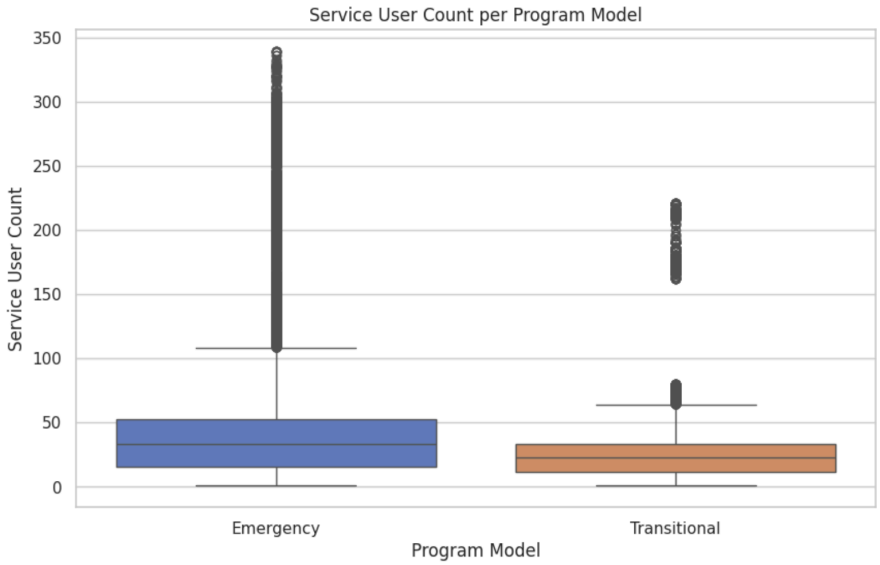
Introduction

The homeless population has seen a discernible rise in the city of Toronto, presenting significant challenges to the city's shelter support system. The provision of adequate overnight and shelter services to the unhoused has become an increasingly pressing issue. To better understand and address these challenges, it is imperative to evaluate shelter usage trends through a detailed analysis of relevant data. By exploring the "INF2178_A1_data.xlsx"dataset, the study seeks to uncover the occupancy patterns within different shelter program models—Emergency and Transitional—and determine the extent of the differences in their utilization. The dataset facilitates a multifaceted examination: from a boxplot analysis that compares the service user count distributions by program model and capacity type to a more dynamic investigation of monthly changes in shelter use.

Method & Analysis

Boxplot analysis on Program Model and Capacity Type per service user count



The above boxplot provides a visual comparison of the distribution of service user count between Emergency and Transitional shelter programs. Here are some critical observations and professional analysis based on the boxplot from three aspects:

Central Tendency: The median service user count for Emergency programs appears to be higher than that for Transitional programs, as indicated by the line within the box. This suggests that, on a typical day, Emergency shelters have relatively more users compared to Transitional shelters.

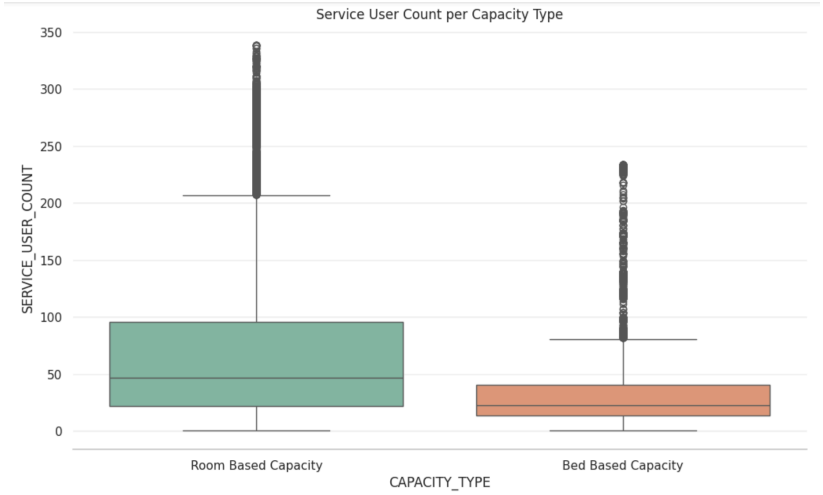
Spread and Variability: The interquartile range (IQR), representing the middle 50% of the data, is wider for Emergency shelters. This indicates a more considerable day-to-day variability in service user counts within Emergency programs. Such variability implies that Emergency shelters experience a less consistent flow of users, which can be attributed to the immediate

and unpredictable nature of emergency assistance. The Transitional shelters exhibit a narrower IQR, which implies a more stable and predictable service user count. This stability could be due to the longer-term housing solutions and the structured entry process often associated with Transitional programs.

Outliers: There are many outliers for Emergency shelters, shown as individual points above the upper whisker. These outliers indicate days where the number of service users is exceptionally high, far above the typical range. This could suggest occasional spikes in demand or special events that lead to increased shelter usage. Transitional shelters also have outliers, but they are less extreme than those in Emergency shelters. This may suggest that while there is variation in usage, it does not reach the extremes seen in Emergency shelters.

In a nutshell, although the median service user count for Emergency programs is slightly higher than for Transitional programs, the wide spread and greater number of outliers for Emergency programs suggest that these numbers are less predictable and can vary widely from day to day.

Boxplot analysis on Capacity Type per service user count



To gain more insights between service user count and capacity type, the above boxplot was made to provide comparison of the distribution of service user count between room based and bed based capacity type. Here are some observations and analysis from four aspects:

Central Tendency: The median service user count is higher for Room Based capacity compared to Bed Based capacity. This suggests that on average, Room Based programs accommodate more users than Bed Based ones. This could reflect larger family units or groups that are housed together in Room Based settings.

Spread and Variability: The IQR for Bed Based capacity is narrower, suggesting that the number of users in Bed Based programs is more consistent day-to-day compared to Room Based programs. This could imply that Bed Based shelters have a more stable demand or a more controlled intake process. On the other hand, Room Based capacity shows a wider IQR, indicating higher variability in the daily number of service users, which might reflect the flexible

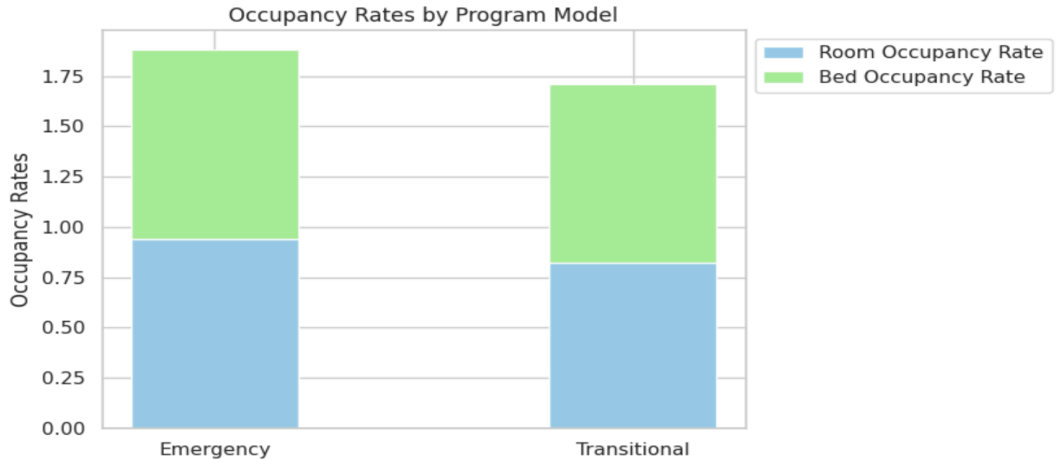
nature of accommodation in these shelters or possibly a variable group size, such as families that can change in number.

Outliers: Both capacity types exhibit a significant number of outliers. The outliers for Room Based capacity, while fewer, reach higher service user counts. These outliers indicate days when the number of users is much higher than typical, which could be due to sudden increases in demand or specific events that drive more individuals to seek shelter.

Skewness: Both Room Based and Bed Based capacities show rightward skewness, with a longer tail of high outliers. However, this skew is more pronounced for Bed Based capacity, suggesting that on some days, these shelters experience exceptionally high usage.

In summary, the boxplot provides a visual narrative of how service user counts differ with the type of capacity provided by the shelters. It highlights the need for flexible capacity in Room Based programs to accommodate varying group sizes and the importance of understanding the drivers behind the high usage outliers, especially in Bed Based shelters, to ensure proper resource allocation and planning.

Occupancy Rate analysis by Program Model for Room-based and Bed-based Capacity



	PROGRAM_MODEL	ROOM_OCCUPANCY_RATE	BED_OCCUPANCY_RATE
0	Emergency	0.938630	0.943501
1	Transitional	0.823207	0.885194

In order to understand the intricate relationship between two program models and capacity types, I calculated the room occupancy rate as well as bed occupancy rate, along with the stacked bar plot, visually represents the occupancy rates for Emergency and Transitional program models, segmented into room and bed occupancy rates.

Room and Bed Occupancy Rates: For Emergency programs, the room occupancy rate is approximately 93.86%, and the bed occupancy rate is around 94.35%. This indicates a very high usage of available resources, suggesting that Emergency shelters are operating near full

capacity. Transitional programs have a room occupancy rate of about 82.32% and a bed occupancy rate of 88.51%. While also substantial, these rates are lower than those of Emergency programs, indicating slightly more availability or lower usage rates in Transitional shelters.

Comparison of Program Models: The difference in occupancy rates between the two program models is noteworthy. Emergency shelters have a higher occupancy rate for both rooms and beds compared to Transitional shelters. This could be due to the immediate nature of Emergency shelters, where demand can fluctuate rapidly and often reaches peak capacity.

In summary, the stacked bar plot and the data table together tell a story of high demand for shelter services in Toronto, with Emergency shelters experiencing higher occupancy rates, indicating they are consistently at or near full capacity compared to Transitional shelters, which, underscores the importance of continuous monitoring and flexible resource management to address the needs of the unhoused population effectively.

T-test Analysis Between Service User Count and Program Models

As the goal of this analysis was to explore the patterns of occupancy within different shelter program models and to determine if there exists a significant difference in the habitation rates between them. To this end, an independent samples t-test was performed to compare the mean service user counts between Emergency and Transitional program models.

For the t-test, the hypotheses can be defined as follows:
Null Hypothesis (H0): There is no significant difference in the mean service user count between Emergency and Transitional program models.
Alternative Hypothesis (H1): There is a significant difference in the mean service user count between Emergency and Transitional program models.

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T-statistic: 38.85174699254652, P-value: 0.00000
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Based on the results of the t-test, where we have a very high T-statistic and a P-value of 0.00000, we reject the null hypothesis (H0). This leads us to conclude that there is a statistically significant difference in the mean service user count between Emergency and Transitional program models. The P-value is less than the conventional thresholds for significance (0.05, 0.01), meaning the difference in service user counts between Emergency and Transitional programs is statistically significant. Moreover, the magnitude of the T-statistic indicates not just a statistically significant result, but also a potentially large effect size. This means the difference in means is not only statistically significant but also practically significant.

The rationale behind employing a t-test for this analysis is to evaluate whether two groups have statistically different means, which in this context, helps to ascertain if the observed differences in occupancy patterns are not due to random variation, but are indeed a reflection of the inherent characteristics of each program model.

T-test Analysis Between Room Occupancy Rates and Program Models

The purpose of conducting this t-test is to assess whether the type of shelter program model (Emergency vs. Transitional) influences the rate at which rooms are occupied. This analysis is crucial for understanding the operational dynamics and resource utilization of different shelter models.

Null Hypothesis (H0): There is no significant difference in the mean room occupancy rate between Emergency and Transitional program models.
Alternative Hypothesis (H1): There is a significant difference in the mean room occupancy rate between Emergency and Transitional program models.

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T-statistic: 31.71080126309493, P-value: 0.00000
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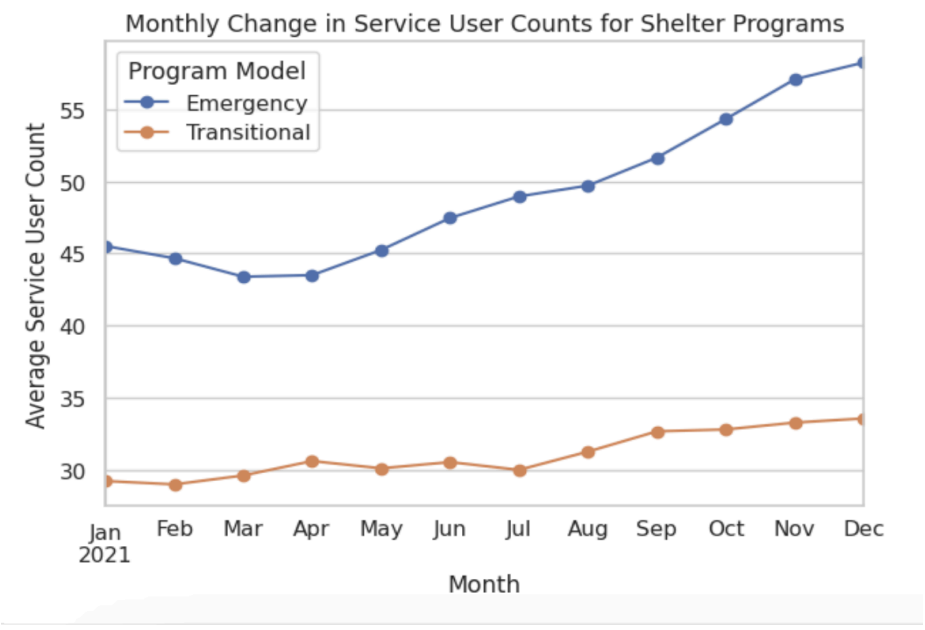
According to the result above, we can reject the null hypotheses since the extremely low P-value indicates that the difference in room occupancy rates between Emergency and Transitional program models is highly statistically significant. The T-statistic's magnitude reflects a large effect size, which means the difference in room occupancy rates between the two program models is not only statistically significant but also of practical significance. In other words, the difference is large enough to be considered important in practical terms.

The significant difference in room occupancy rates implies that Emergency shelters are likely operating with a higher room occupancy rate compared to Transitional shelters. This could be attributed to the immediate nature of the assistance provided by Emergency shelters, which may lead to a higher turnover and usage rate.

Monthly Change Analysis in Service User Counts for Shelter Program Models



The above plot provides a monthly comparison of average service user counts within Emergency and Transitional shelter programs in 2021. The objective of creating this plot is to visually capture and analyze the temporal changes in shelter occupancy, offering insights into how service usage varies across months and to assess the operational dynamics of different shelter types. This visual analysis is particularly pertinent given earlier findings that indicated a greater day-to-day variability in Emergency shelters, as evidenced by a wider interquartile range (IQR) and numerous outliers signifying occasional surges in service user counts.

The plot shows an upward trend in the average service user count for Emergency shelters as the year progresses, with the highest counts towards the end of the year. Surprisingly, this plot indicates not only seasonal pattern where demand for Emergency shelters increases in colder months, it also reflects a growing trend in homelessness or shelter needs (such as Covid Response or Temporary Refugee Response).

Transitional shelters exhibit a relatively stable pattern throughout the year with a slight increase. In contrast, Emergency shelters not only start with higher user counts but also show a steeper increase over time. This suggests that Emergency shelters are subject to more significant changes in demand.

In short, understanding the erratic nature of Emergency shelter usage, with its outliers and wider IQR, is crucial. The monthly trend analysis provides an incentive to delve deeper into what causes these spikes in demand—whether they are due to seasonal factors, economic shifts, policy changes, or other events.

Conclusion

In conclusion, the data analysis of Toronto's shelter system has revealed significant variability in occupancy patterns between Emergency and Transitional shelters. The boxplot and occupancy rate analyses underscored Emergency shelters' higher and more volatile service user counts, with near-full capacity operations, compared to the more stable Transitional shelters. This variability suggests the need for dynamic resource allocation and capacity planning, especially for Emergency shelters that face unpredictable demand spikes.

The t-test outcomes not only statistically confirmed the observed differences in service user counts and room occupancy rates between shelter models but also highlighted the practical significance of these differences. These results advocate for a data-driven approach in policy formulation and strategic planning to ensure that shelter services are responsive to the distinct needs of various user groups, thereby enhancing the city's ability to support its unhoused population effectively.