Vastly Challenging Economics
A Deep Dive into the financial health of the city of Engagement Ohio

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1. INTRODUCTION

A city or country's economy plays an integral role in society, as businesses and individuals livelihoods depend on it. In an economic recession, retrenchments are inevitable and businesses see a lost in revenue, which may subsequently see them close down. Conversely, in an economic boom, there's an increase in both income and spending across businesses and individuals. Within an economy, there are patterns we can observe, for example, how are businesses or sectors performing, how much are individuals spending, who are businesses employing. The VAST Challenge 2022 presented an exciting opportunity to understand and analyse the economy of the city of Engagement, Ohio. As a city anticipating rapid growth, it is paramount to first understand the current state of the city and identify opportunities for future growth. This Shiny app allows users to understand the financial health of the city and analyse patterns that exist within businesses, participants and employers.

2. METHODOLOGY

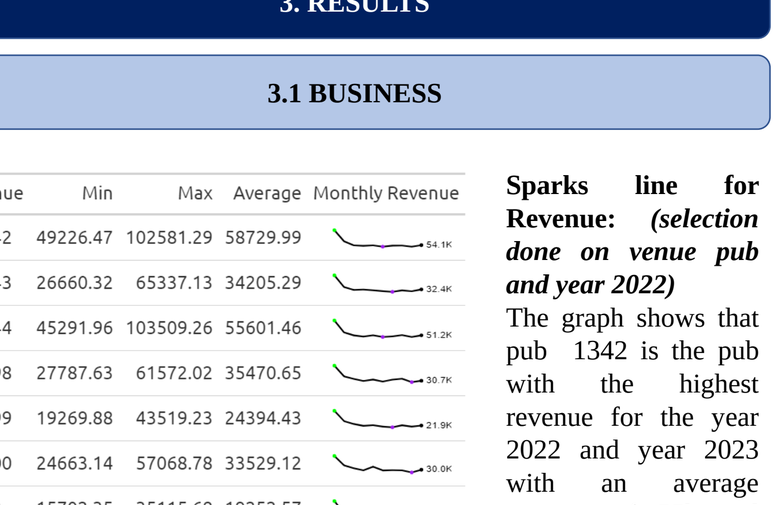
The dataset was acquired from **VAST Challenge 2022**. It contains 3 large sets of data. **Activity logs** tracks the daily activities of the participants in the city. **Attributes** contains the attributes of the city including the jobs that are offered, details of the participants, employers, restaurants and pubs. **Journals** has information on where participants have gone, the spending and wages of participants and who they interacted with. **All 3 data sets were utilized** to understand the financial health of the city.To visualise the financial health of the city effectively, a multi-pronged approach was used, starting with a **descriptive analysis** of the datasets by showing the revenue and foot-traffic of the various businesses (i.e. pubs and restaurants) over time, Income and expenses of participants of different education levels and age groups over time, Jobs offered to various education levels and their respective hourly wage and Jobs with high turnover rates and jobs that employer's are finding difficult to fill. This was done using line charts, histograms and barcharts, boxplots, sparklines and maps. **Correlation analysis** was conducted between average age hired for a job, and the offered hourly rate or the number of jobs they were hired for. This was to glean any insights of any potential correlations between them. Also, a **one-way ANOVA** test was done between hourly wage, and either education level or age groups for average age hired, to see if there was any statistical evidence proving that there is a difference in mean hourly rate within different education levels or age groups. **Predictive analysis** was done on the historical data provided, to forecast future income of participants of different age group and education levels. This was done with models such as **ARIMA, ETS, TSLM.** R programming was used for the data processing, statistical analyses and development of the web applications.

3. RESULTS

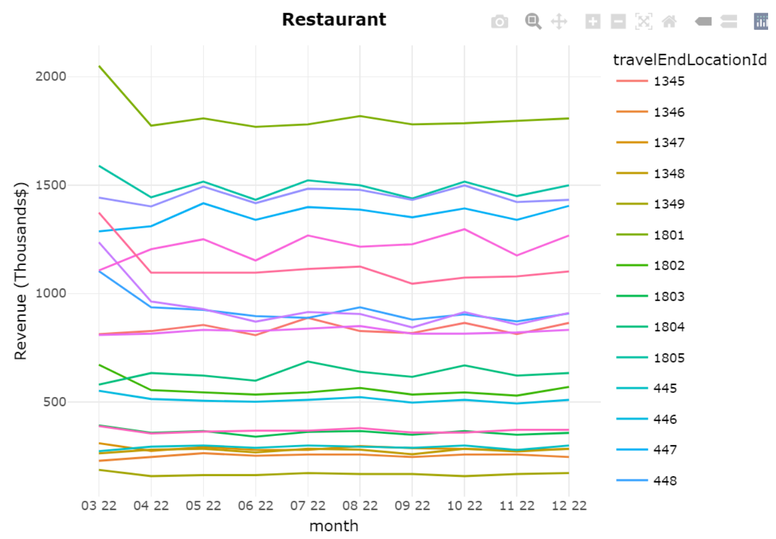
3.1 BUSINESS

Venue	Min	Max	Average	Monthly Revenue
1342	49226.47	102581.29	58729.99	54.1K
1343	26660.32	65337.13	34205.29	32.4K
1344	45291.96	103509.26	55601.46	51.2K
1798	27787.63	61572.02	35470.65	30.7K
1799	19269.88	43519.23	24394.43	21.9K
1800	24663.14	57068.78	33529.12	30.0K
442	15702.35	35115.68	19252.57	18.4K
443	12156.76	30749.12	15475.50	13.0K
444	15747.18	31023.86	19028.69	17.4K
892	21411.65	55681.44	27811.99	24.4K
893	29058.60	65740.53	34876.94	32.7K
894	19046.35	46504.88	23784.18	21.4K

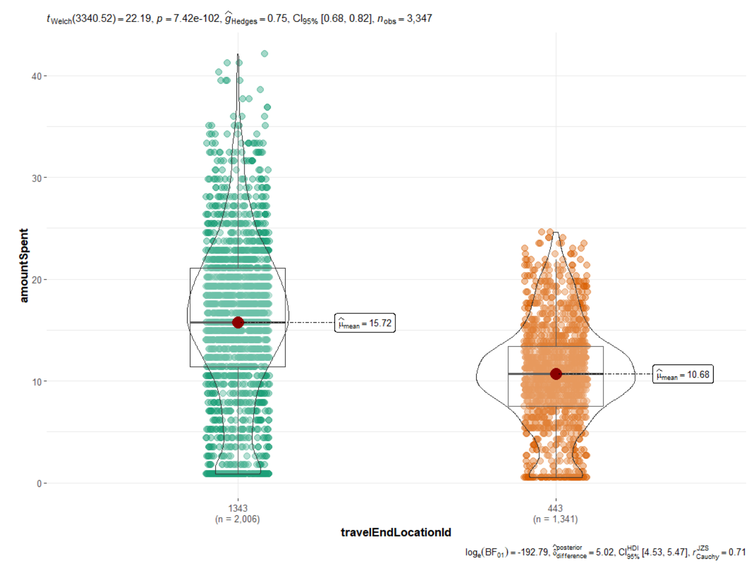
Sparks line for Revenue: ***(selection done on venue pub and year 2022)***
The graph shows that pub 1342 is the pub with the highest revenue for the year 2022 and year 2023 with an average revenue of 55k and 48k respectively.
Similarly, restaurant 1801 is the highest earning restaurant for the both the tears with average revenue of 18k and 16k in 2022 and 2023 respectively.



We can see from the above plot that revenue for all pubs decreases from march to September and then increases and decreases again. Pub 1342 is so far a booming Pub in the city of engagement, Ohio with a constant high revenue. Some of the other pubs doing better are 1343, 1798 and 1800. The pubs which are likely to loose business and need to change their business policy in order to survive the competitive market are 442,443 and 444.



Statistics for restaurants show a flatter trend as compared Pubs. The restaurants with revenue in the mid range and doing average are 1807,445 and 449. Some of the restaurants fetching the lowest revenues in 2022 are 1346,1347,1348,1349, 1803,445 and 898.

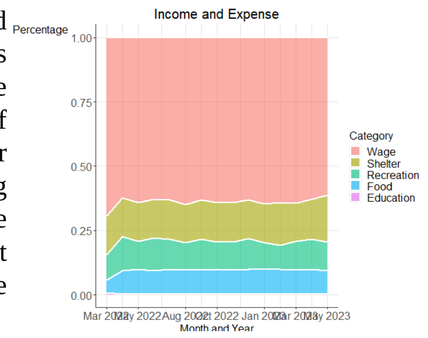


Anova comparison between one of the higher earning Pubs and one of the lower earning pubs shows that the lower bound of spending at both the restaurants is similar but the upper bound is more for the restaurant 1343. Analysis also shows us that participants frequent the pubs more on Saturdays and Sundays as compared to the weekdays. But although this is true for all of the Pubs it does not hold true for all the Restaurants.

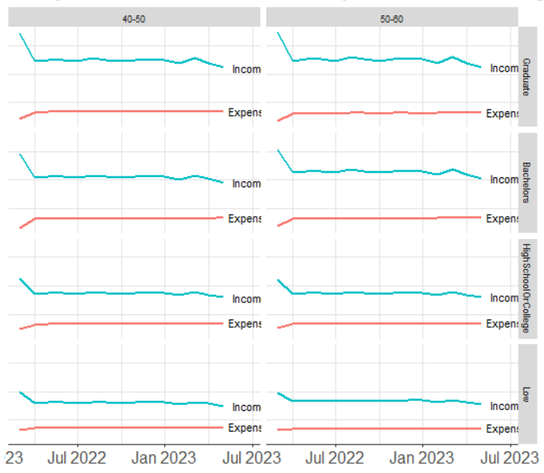
The plot of the participants on map tell us that Participants frequent restaurants which are either Near to their place of stay or workplaces. Hence Those located in centralized areas fare well as Compared to those located in less popular suburbs.

3.2 FINANCE

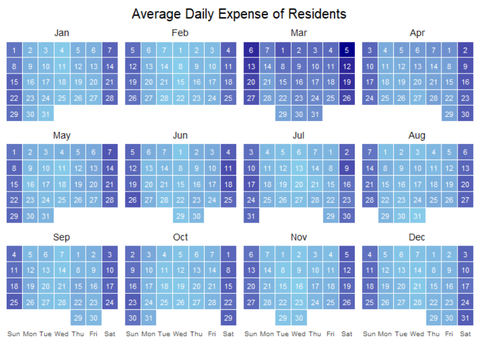
Our analysis of Income and Expense of the participants revealed interesting facts. We found that the largest portion of the income was spent on Shelter and least on Education. Spending on Food and Recreation were comparable. We also saw that though the income of Graduate and Bachelor educated participants were higher but the expenses were similar to the participants with lower education indicating higher savings for higher educated participants.



Comparison of Income and Expense of various groups:

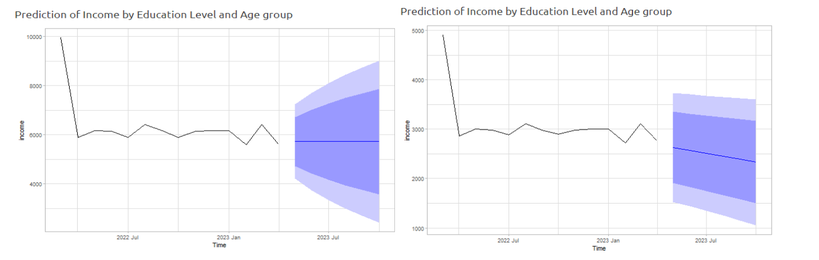


We compared the income and expenses of various groups over time and found there was an increase around March of every year and a dip thereafter. We also observed that bachelor educated residents in the age range 50-60 had slightly higher income than others with same education.



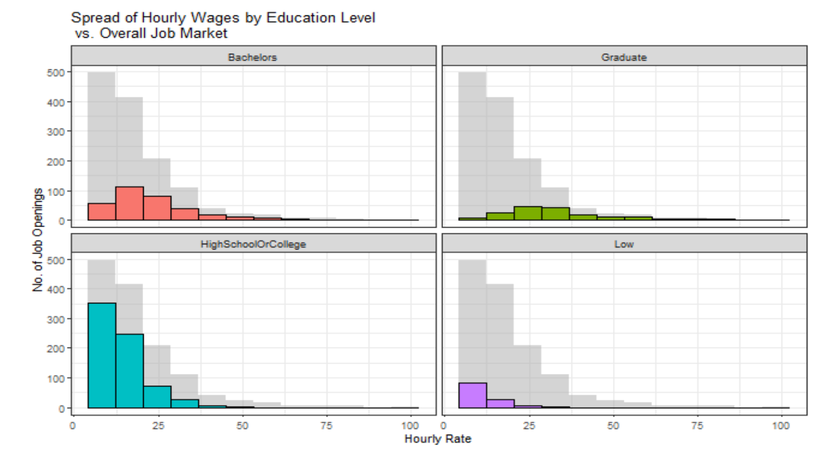
From the calendar heatmap of expenses, it can be seen that the residents of Engagement spend more on weekends. This is valuable insight for City Planning Committee so that they can plan development of recreational and getaway facilities

Predictive Analysis: 2 out of 3 models predicted the income of residents to be stable where as the third model predicted it to go down. This is also an important indicator for the authorities to act upon.

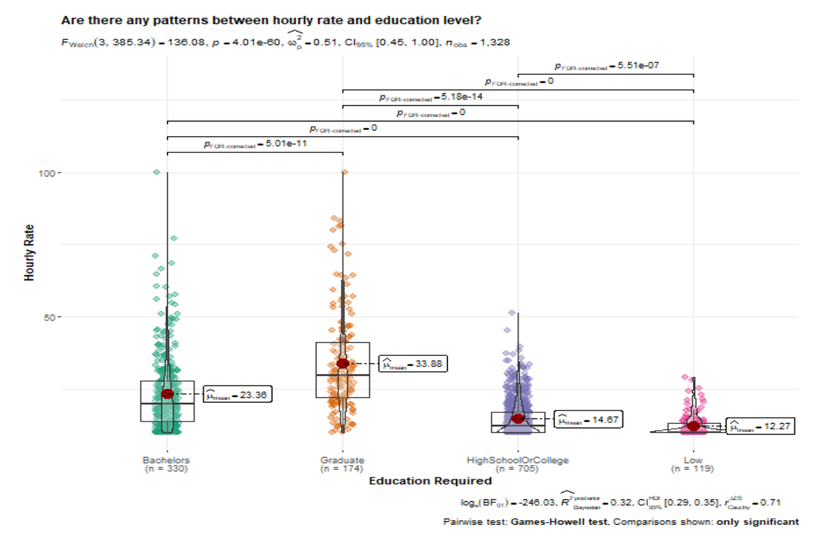


3.3 EMPLOYERS

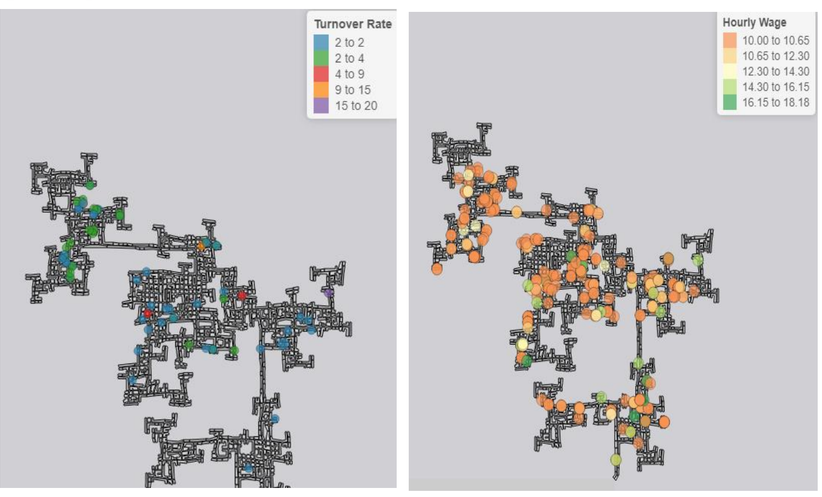
Looking at the spread of hourly wages and number of job openings by education level, we can see that employers' have a strong preference for hiring high school or college participants, followed by participants with a bachelor's degree. However, it is also important to note that there's a huge skew for hourly wages when it comes to participants with a high school or college education or those with low education, whilst hourly wages for those with a bachelor's and graduate degree are relatively more even spread and are rewarded more handsomely.



This was further backed by statistical evidence. We ran a one-way parametric ANOVA test, at 95% CI, which found that there was significant evidence to suggest that there was a difference in mean hourly wages between different education levels.



We've also found areas of high turnovers to be in the northwest, and central region of the city, with jobs mainly requiring high school or college participants or participants with low education. Further, we've found that the jobs that were difficult to fill were on the lower end of the hourly wage spectrum (i.e. 10-19), and required mainly high school or college, or bachelor degree participants.



4. FUTURE WORK AND CONCLUSION

Given the fact that we're seeing a flat or downward trend in business (i.e. Pubs and Restaurants) revenues, Incomes across different age groups and education levels dropping over time, coupled with the fact that employer's are looking to hire more high school or college participants with a hourly wage on the lower end of the spectrum, the anticipated rapid growth of the city of Engagement, Ohio could have been over-estimated and may need to be re-calibrated. One area for future work for the app could be to allow users to upload updated datasets to continue monitoring the financial health of the city.