Ambient Air Pollution on Home Energy Usage and its Implications

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1 Introduction

This report will focus on analysing data pertaining to changes in home energy usage resulting from the 2015 haze and discuss its implications. The linear probability model and McNemar test were used in the analysis of the survey results.

2 Analysis and Discussion of Survey Data

Results have identified the greatest increase being purifier usage of +302.9% (Fig 1). Ages between 25-44 are 5.26% more likely to use it compared to ages 45-54. Households owning a purifier are +62% more likely to use their purifier during the haze than before. While purifiers consume a meagre 50-200 Watts per hour[1], long duration usage could greatly impact overall home energy consumption.

A negative moderate correlation of -0.34 was spotted between air-conditioner (AC) and fan usage (Fig 2) suggests a switch from fan to the air-conditioner during the haze. This

switch can significantly affect energy usage as an air-conditioner consumes on average 12 times more than a fan[2]. A study by NEA has found that air-conditioners contribute up to 40% of an average household electricity bill[4]. Thus, this switch would further exacerbate this situation. A household is also 72.6% more likely to use the air-conditioner during the haze if they own one. Juxtaposed this fact with almost 87% of total surveyed participants owning an AC (Fig 3), would suggest a noteworthy effect of the haze on AC usage and thus energy consumption. Perhaps including the duration of AC and purifier usage and temperature before and during the haze in the survey would provide a better estimation of the changes in home energy usage.

Ages between 65-85 are 36% less likely to use the AC. There's a direct correlation between dwelling type and AC usage, with the largest proportion of AC users in landed property and smallest in 1 room flats both before and during the haze. The largest increase in AC usage were for 1 room group at 23% and 5 rooms group at 20% (Fig 4). However, the high percentage increase for 1 room group is due to the small sample size and low usage before the haze. Hence, may not be of huge significance. While it seems that the biggest change occurred to people living in the 5 rooms group, where they have the ability and are more willing to use the AC during the haze.

The huge decrease in people dining out (-55.1%) could increase time spent at home and possible increase in home energy usage from cooking, AC and purifier.

Overall, survey results suggest an increase in home energy usage during the haze. To increase the accuracy of survey data, it might be desirable to perform the survey closer to the actual event. Furthermore, it might be interesting to investigate household behaviours throughout the different severity of haze throughout the years.

3 Implications

Singapore derives 95% of its energy from natural gas, through pipelines that connect from Indonesia and Malaysia, and LNG by ships[5]. The increase in energy demand would mean that Singapore would have to increase sources of fuel. However, Singapore has limited abilities to harness renewable energy[6]. The increase in demand for energy could make Singapore more susceptible to disruptions in electricity supply and result in price hikes for electricity. In turn, decreasing consumers' welfare and increasing business' cost of production, negatively affecting Singapore's economy.

Despite natural gas being cleaner than coal, it still produces significant emissions worsening the greenhouse effect[3]. Especially unburned natural gas, when leaked, is a powerful greenhouse gas. Large amounts of negative externalities are produced during the process of generating electricity. Residents living near areas of natural gas development are exposed to more health risks due to concentration of hazardous air pollutants produced. Gas drilling harms the local ecosystem, construction of pipelines can cause erosion of dirt and other pollutants, which contaminates nearby water sources[7]. Thus, posing health risks or reducing water supply for users of these water sources.

4 Conclusion

Survey results obtained suggest a spike in home energy usage during haze periods. However, a report by EMA shows a relatively constant total household electricity consumption before and during haze periods[8]. It seems that even with years of significantly less severe haze (such as 2016)[9] [10], there's an increasing trend on home energy usage. Thus, while the severe haze in 2015 may have worsened energy usage during that period of time, the underlying trend of rapidly increasing energy consumption throughout the years could suggest other significant factors that would require intervention. In 2017 the "Energy-Saving Challenge" campaign started, resulting in the first decrease in total household energy consumption in 6 years[8][11]. This indicates the pressing need for government intervention to limit negative externalities from generating electricity. Which can be achieved through campaigns, encouraging newer households to adopt more efficient systems, developing technologies to improve means of renewable energy. Thereby, substituting existing use of natural gas, and maintaining quality of life for future generations.

799 Words

A Additional Data

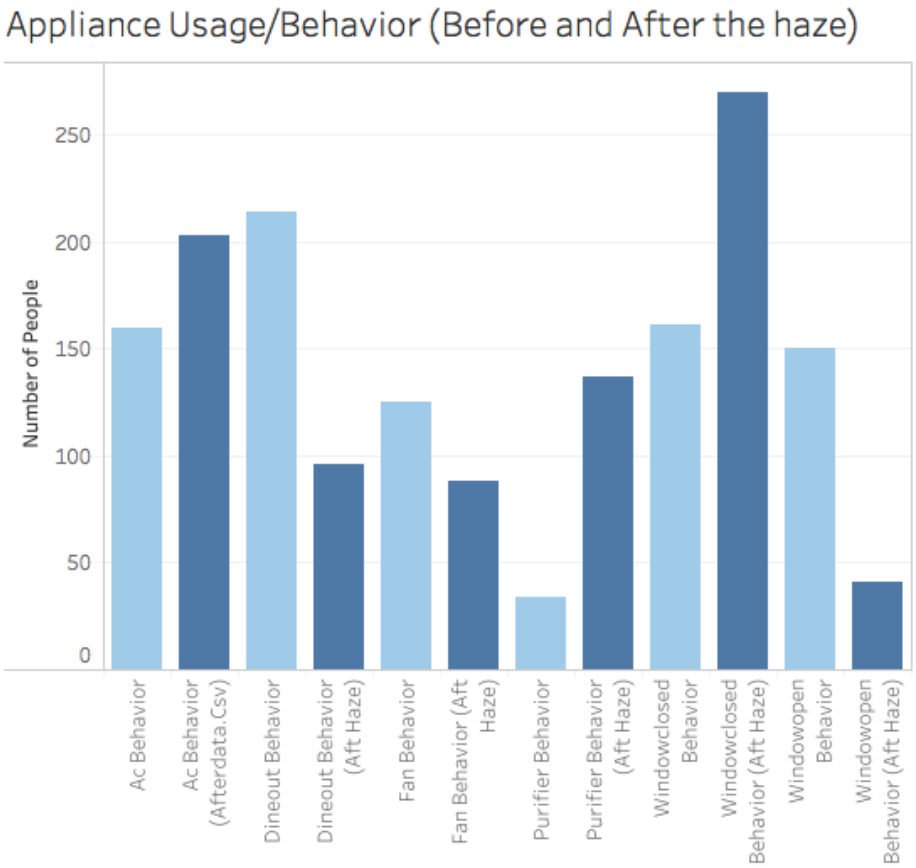

Fig 1: Survey results of human behaviour before and after the haze (Light bar indicates before and Dark bar indicates after the haze)

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        Pearson's product-moment correlation

data:  aftQn$ac_behavior and aftQn$fan_behavior
t = -6.2807, df = 309, p-value = 1.142e-09
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.4315337 -0.2340040
sample estimates:
       cor
-0.3364647
```

Fig 2: Correlation coefficient between AC Usage and Fan Usage

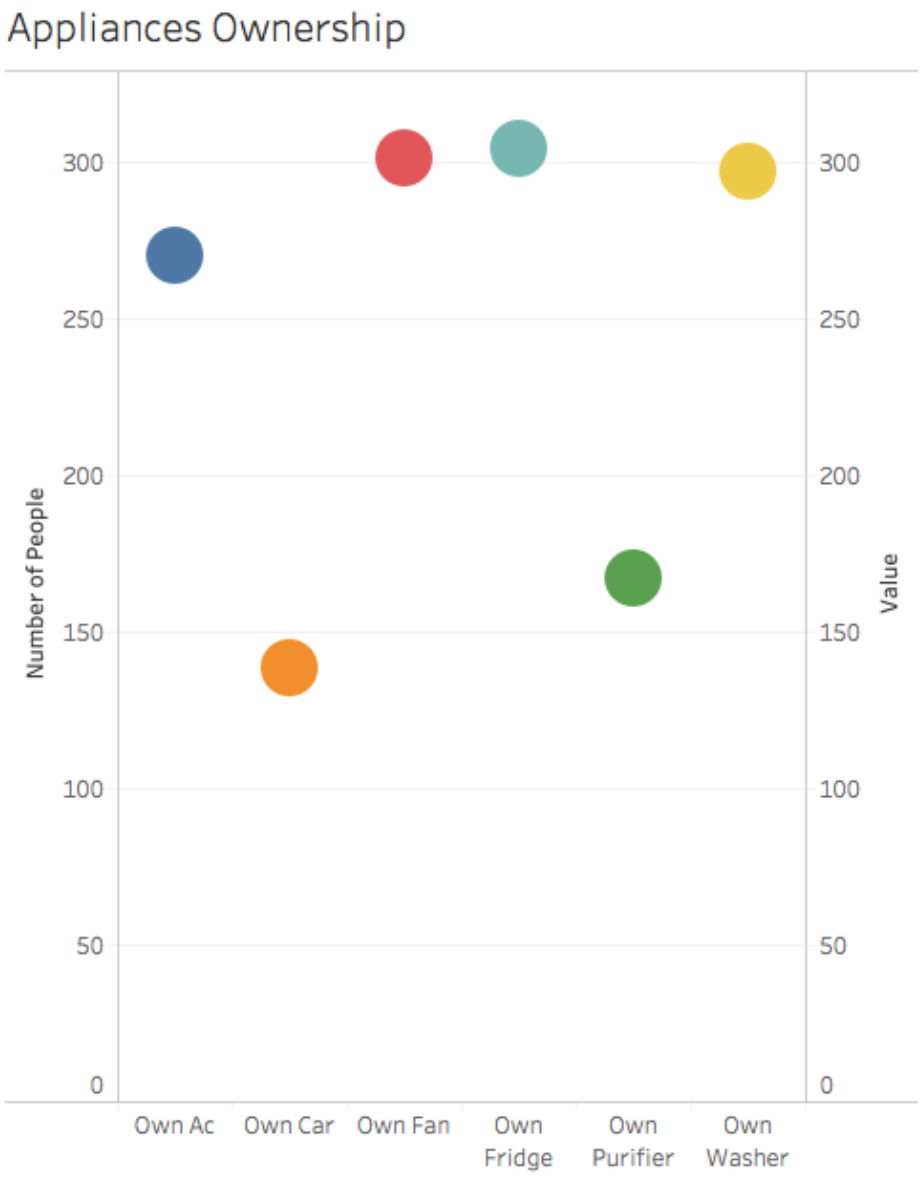

Fig 3: Number of people who own respective appliances

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> (prop.table(table(befQn$dwellingtype, befQn$ac_behavior, useNA = "always"), 1))*100

                                                                          0        1     <NA>
Condo (Condominium apartment)                                      38.09524 61.90476  0.00000
HDB Flat 1 Room or 2 Rooms (1 bedroom)                             72.22222 27.77778  0.00000
HDB Flat 3 Rooms (2 bedrooms + Living/ dining area)                52.08333 47.91667  0.00000
HDB Flat 4 Rooms (3 bedrooms + Living/ dining area)                53.68421 46.31579  0.00000
HDB Flat 5 or 6 Rooms, Executive Flat or Multi-generation flat     46.59091 53.40909  0.00000
Landed property (Townhouse, terrace or semi-detached house, bungalow) 25.00000 75.00000  0.00000
<NA>
> (prop.table(table(aftQn$dwellingtype, aftQn$ac_behavior, useNA = "always"), 1))*100

                                                                          0        1     <NA>
Condo (Condominium apartment)                                      23.80952 76.19048  0.00000
HDB Flat 1 Room or 2 Rooms (1 bedroom)                             50.00000 50.00000  0.00000
HDB Flat 3 Rooms (2 bedrooms + Living/ dining area)                43.75000 56.25000  0.00000
HDB Flat 4 Rooms (3 bedrooms + Living/ dining area)                44.21053 55.78947  0.00000
HDB Flat 5 or 6 Rooms, Executive Flat or Multi-generation flat     26.13636 73.86364  0.00000
Landed property (Townhouse, terrace or semi-detached house, bungalow) 15.00000 85.00000  0.00000
<NA>
```

Fig 4: Proportion of people who uses the AC with respect to dwelling type

B Statistically Significant Data Consolidation

Ac usage:

+26.875% increase in AC usage, statistically significant

-0.36174 aft age 65-85

+0.253 aft Head of household

+0.264 aft Spouse of head of household

+0.591 $-->$ + 0.726 if you own an AC

Purifier usage:

+302.94% increase in Purifier usage, statistically significant

-0.132 aft age group 25-34

-0.135 aft age group 35-44

-0.1876 aft age group 45 – 54

+0.199 $-->$ +0.815 if you own a purifier

Fan usage:

-29.6% decrease in fan usage, statically significant

Dine out behaviour:

-55.14% decrease in dine out behaviour, statically significant

+0.189 bef male dine out –¿ -0.0711 (Aft Not significant)

+0.182 bef 4 room

+0.1686 bef 5 room

+0.418 −− > -0.0410 (Aft Not significant)

Windows Open:

-72.67% decrease in opening windows, statistically significant

Windows Closed:

+67.7% increase in closing windows, statistically significant

References

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[4] Hill, T. (2018, February 23). High time Singapore does something about its inefficient reliance on air-conditioning. Retrieved February 3, 2019, from https://www.todayonline.com/commentary/high-time-singapore-does-something-about-its-inefficient-reliance-air-conditioning

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