

# Case Study

*Grill Testing*



**To:** Lodestone

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## Executive Summary

Through analysis of the grill testing dataset, I have uncovered some insightful findings for the consumer preferences and user experiences towards different kinds of home outdoor grills. Propane grills are more fuel efficient and has more market share. Charcoal grills cost more fuel on a long run.

Considering cost factor, the total cost of both initial investment and fuel cost depends on the user frequency of the household. Regarding ease of use, propane grill is the winner over charcoal grill. For taste aspect, charcoal grills perform better on hotdog, while propane grills perform better on ground beef petty and veggie petty.

I recommend the users to choose from different grill types based on the use frequency and food preferences. I recommend the manufacturers to produce more propane grill 6 and 8, as these two grill devices perform better with beef, which is the top favorite of Americans based on 2020 Survey Data. Besides, I recommend the marketing and sales team to provide food samples to increase sales.

## Brief description of data

SheetA.csv is renamed as Grill\_Feature.csv as it stores the features fact data of the two kinds of grills, such as pre heat time, fuel cost per meal, market share and so on.

SheetB.csv is renamed as Cookoff\_Test\_Result.csv, as it stores the user satisfaction score and fuel cost when using different grill devices to cook different food materials.

SheetC.csv is named as Taste\_Test\_Result.csv, as it stores the volunteers' taste result data.

I went through the third dataset and firstly check the data integrity with exploratory data analysis. The data distribution of the thumbs\_up\_score column falls into 2 scopes, which are from 0 to 1.3 and from 5 to 6.3 respectively. There's a gap between 1.3 and 5, as you could see in **Figure 1**. My assumption for the gap is that the grading system might be different. Also for 91 rows of data, taste volunteers give 0 as thumb-up score, which might skewed the dataset with a lower average. I would like to confirm data aquality with data source provider or the grading scale system with the test designer. But for now I'll conduct the analysis based on the given dataset.

```
import matplotlib.pyplot as plt
fig,ax=plt.subplots(figsize=(6,4))
thumbs_up_score = df3['thumbs_up_score']
thumbs_up_score.plot(kind='hist',density=True,bins=28)
thumbs_up_score.plot(kind='kde')
ax.set_xlim(0,6.3)
ax.set_yticks([])
ax.set_xlabel('Thumbs Up Score')
ax.set_ylabel('Frequency')
ax.set_title('Thumbs Up Score Distribution of Taste Test')
ax.tick_params(left=False, bottom=False)
for ax, spine in ax.spines.items():
    spine.set_visible(False)
plt.show()
```

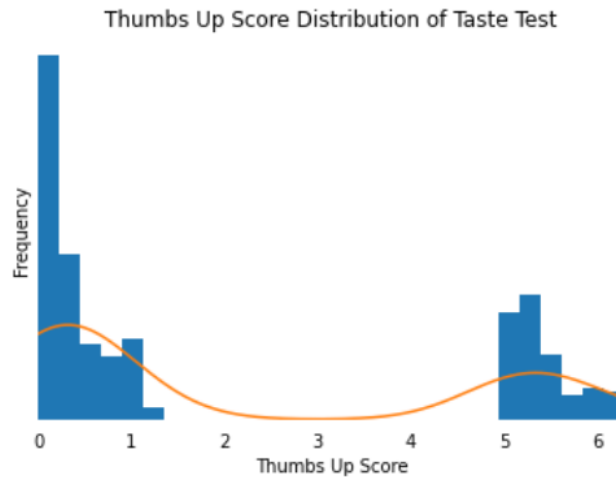


Figure 1: Thumbs Up Score Distribution

### Fact Data Analysis

Propane is more fuel efficient. Regarding the cost of operating the grill over time, charcoal costs \$2 per cookout, while propane costs \$1.55 per cookout. (see **Figure 2**)

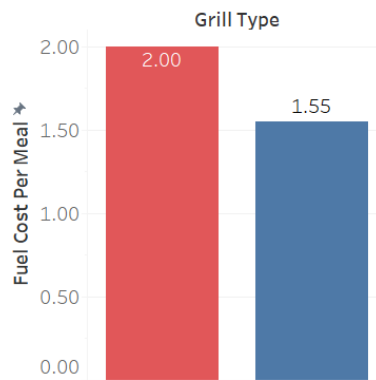


Figure 2: Fuel Efficiency

Propane has more market share. As Propane has 64 percent of market share, while Charcoal has 44 percent (see **Figure 3**).

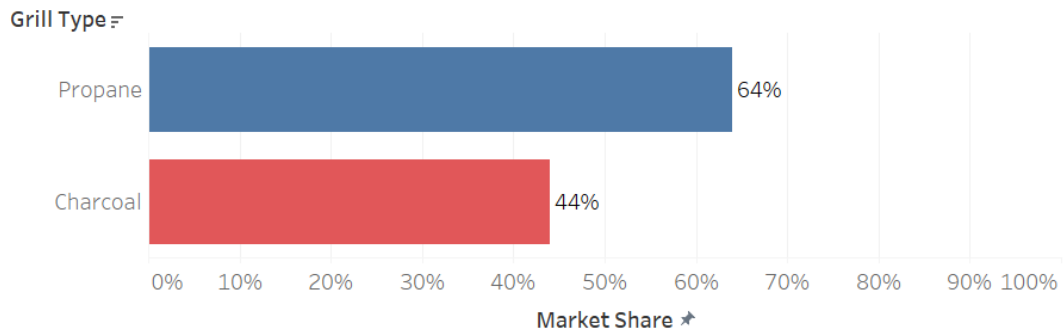


Figure 3: Market Share

## Cost Analysis

Based on the cookoff dataset, charcoal grill cost more fuel on a long run. As you could see in the **Table 1**, average fuel cost for charcoal grill is \$381, while average fuel cost for propane is \$158. Charcoal grills cost more fuel no matter cooking ground beef patty, hotdog, or veggie patty (see **Figure 4**).

Table 1: Fuel Cost Pivot Table

fuel_cost	
grill_type	
Charcoal	380.890083
Propane	158.108333

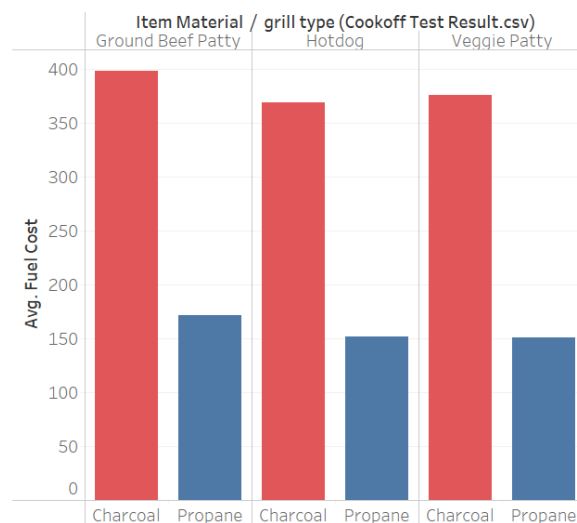


Figure 4: Cookoff Fuel Cost Breakdown by Grill Type and Food Type

## Break-even Analysis

With the initial investment and fuel cost per meal data, I conducted a break-even analysis as you could see in **Figure 5**. The x-axis is number of meals, and the y-axis is the cost. The break-even point is 107 meals.

If we assume that the life span for a new grill is 3 years, the cost for both initial investment and fuels used in the 3 years depend on the grill use frequency of the household. I considered 4 scenarios, which are households that grill only once a month, households that grill twice a month, households that grill three times a month, and households that grill once a week. For example, households that grill only once a month grill 36 meals in total for 3 years, which are smaller than the break-even point, suggesting charcoal grill total cost is smaller than propane grill total cost. For households that grill three times a month, the cost using either propane or charcoal grill is almost the same. (see **Figure 6**)

So we suggest users to purchase propane grill if they use the grill more than three times a month and purchase charcoal grill if they use the grill fewer than three times a month.

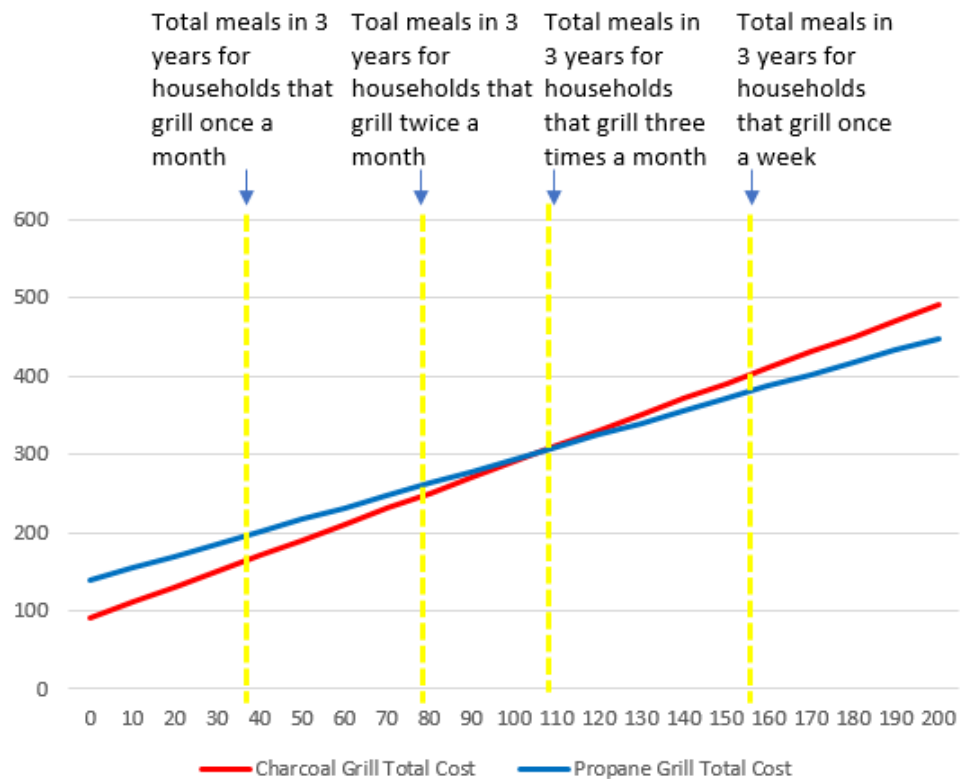


Figure 5: Break-even Analysis for Grill Total Cost

grill_type	fuel_cost_per_meal	initial_investment				
Charcoal	2	91				
Propane	1.55	139				
			Charcoal		Propane	
Meals	Fuel Cost	Charcoal Grill Total Cost	Fuel Cost	Propane Grill Total Cost		
0	0	91	0	139		
10	20	111	15.5	154.5		
20	40	131	31	170		
30	60	151	46.5	185.5		
40	80	171	62	201		
50	100	191	77.5	216.5		
60	120	211	93	232		
70	140	231	108.5	247.5		
80	160	251	124	263		
90	180	271	139.5	278.5		
100	200	291	155	294		
110	220	311	170.5	309.5		
120	240	331	186	325		
130	260	351	201.5	340.5		
140	280	371	217	356		
150	300	391	232.5	371.5		
160	320	411	248	387		
170	340	431	263.5	402.5		
180	360	451	279	418		
190	380	471	294.5	433.5		
200	400	491	310	449		

User Frequency	#Meals in 1 year	#Meals in 3 years
Once a week	52	156
Three times a month	36	108
Twices a month	24	72
Once a month	12	36

Figure 6: Break-even Analysis Process (see in Excelsheet)

## User Experience Analysis

Propane is easier to use based on the user satisfaction score. Users' satisfaction scores for charcoal grill are all negative as you could see in **Table 2**.

Table 2: User Satisfaction Pivot Table by Grill Type, Device ID, User Satisfaction

		user_satisfaction			
		item_material	Ground Beef Patty	Hotdog	Veggie Patty
grill_type	device_id				
Charcoal	1		-0.9	-1.3	-1.2
	3		-1.3	-1.9	-1.3
	5		-2.5	-0.5	-2.5
	7		-1.7	-2.4	-0.3
Propane	2		1.6	1.8	2.0
	4		2.4	1.2	1.2
	6		2.6	2.0	0.2
	8		2.0	1.2	2.8

Based on the data, users show different satisfaction level when cooking different food as you can. In **Figure 7**, the user satisfaction score is visualized on a red-to-blue scale, which represents low-to-high user satisfaction score. Users prefer to use propane grill 4 and 6 to cook ground Beef Patty. Users are satisfied with propane grill 2 and 6 to cook hotdog. Users are strongly satisfied with propane grill 8 to cook veggie Patty.

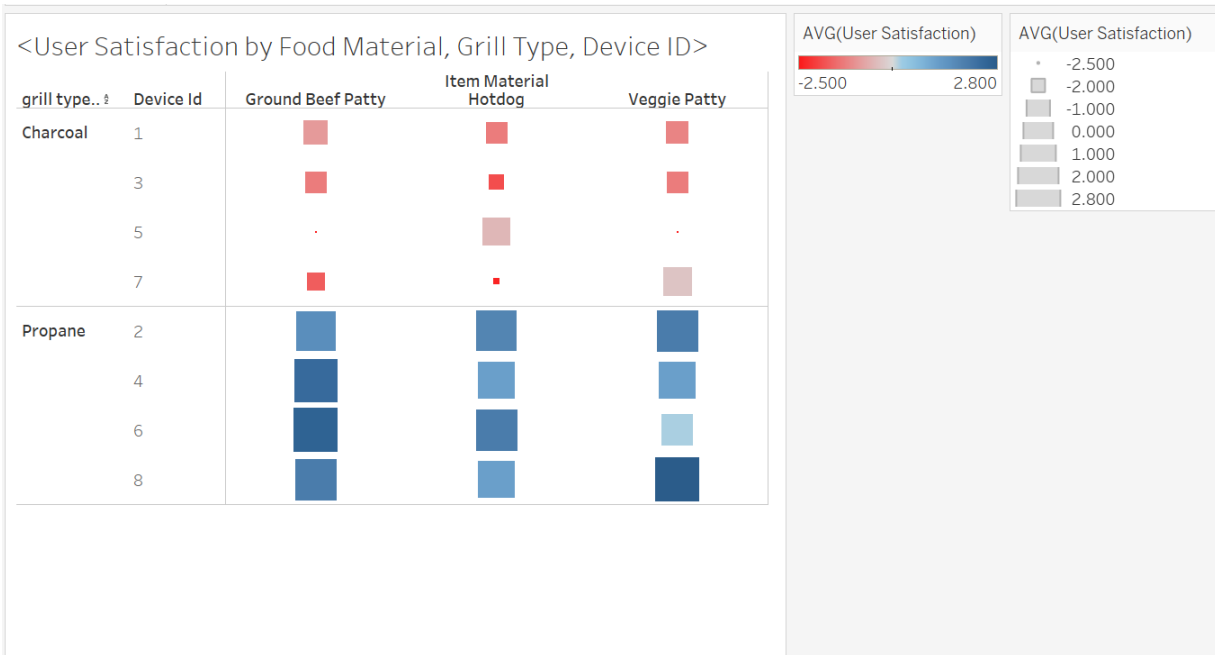


Figure 7: User Satisfaction Heat Map

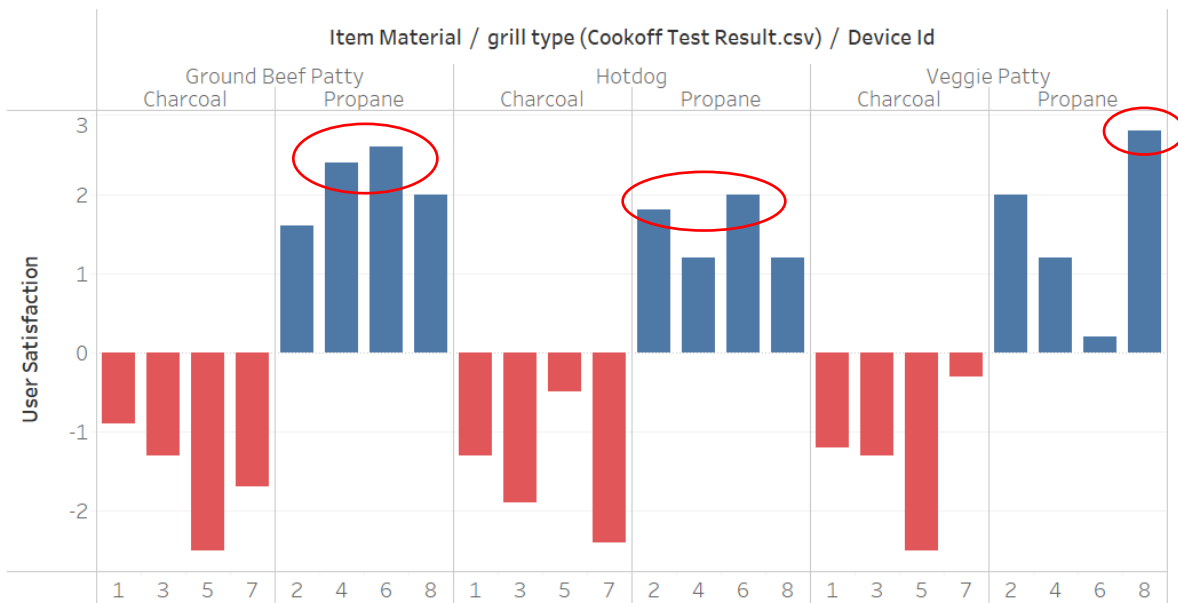


Figure 8: User Satisfaction Breakdown

I recommend manufacturer to produce more propane grill 6 and 8. By looking into the [2020 data survey](#) of Americans' preferences on grilled food, the statistics show that 1 in 3 consumers said their favorite grilled food is steak (34%). Hotdog only received 5% of votes and the veggie patty is not even on the top favorite list. The manufacturer should respond to most consumers' needs and produce more propane grill 6 and 8, which shows strong performance when cooking beef to boost sales and revenue.

For users, I recommend them to choose grill based on the food preferences of themselves or their families. If the customers are vegetarian, who plan to cook more veggie patties, I would suggest them to go with propane grill 8. If they plan to cook more beef, I recommend either propane grill 4 or 6. If the customers are hotdog fans, I recommend either propane grill 2 or 6. If they don't have stronger preference on specific food material over others, propane grill 2 is a good choice, as it shows robust and average performance no matter which food to cook.

### Consumer Taste Preferences Analysis

Charcoal grills perform better for Hotdog, while propane grills perform better for ground beef patty and veggie patty. (See **Figure 9**) This result is different from the conclusion from the video, which confirmed my assumption for the data quality issues.

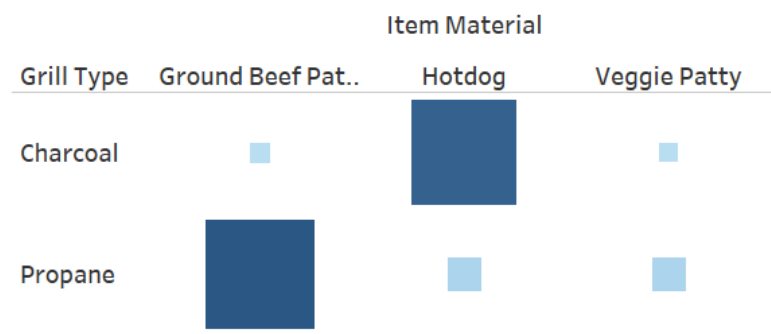


Figure 9: Taste preferences and food type relationship

I tried to clean the third dataset by casting all the data into range 0-0.6, as I assume people followed 4 different rating systems for some reason, which are 0-0.6, 0.7-1.3, 5.0-5.6 and 5.7-6.3. The reason that I assume that there are 4 rating systems instead of 2 is because I noticed the taste rate for Charcoal only falls into 0-0.6 and 5.0-5.6. After data cleaning, **Figure 10** shows that propane performs the best on all kinds of food, which is still not consistent with the conclusions in the video. This dataset needs to be cleaned in other ways.

```
df3['thumbs_up_score']=df3['thumbs_up_score'].replace([0.7,0.8,0.9,1.0,1.1,1.2,1.3],[0,0.1,0.2,0.3,0.4,0.5,0.6])
df3['thumbs_up_score']=df3['thumbs_up_score'].replace([5.0,5.1,5.2,5.3,5.4,5.5,5.6],[0,0.1,0.2,0.3,0.4,0.5,0.6])
df3['thumbs_up_score']=df3['thumbs_up_score'].replace([5.7,5.8,5.9,6.0,6.1,6.2,6.3],[0,0.1,0.2,0.3,0.4,0.5,0.6])
```

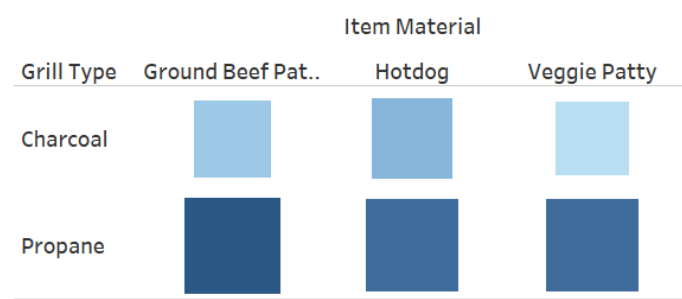


Figure 10: Taste preferences and food type relationship after data cleaning



89% of taste test volunteers guessed correctly.

```
df3['guess_grill_correct'].value_counts()
```

```
True    643
False    77
Name: guess_grill_correct, dtype: int64
```

```
sum(df3['guess_grill_correct'])/len(df3['guess_grill_correct'])
```

```
0.8930555555555556
```

Another interesting finding on the consumers' behavior is that consumers tend to rate higher score when they guessed the grill type correctly, which indicates confirmation bias. (see **Figure 11**) I recommend the marketing and sales team to provide food samples to offset bias and increase sales.

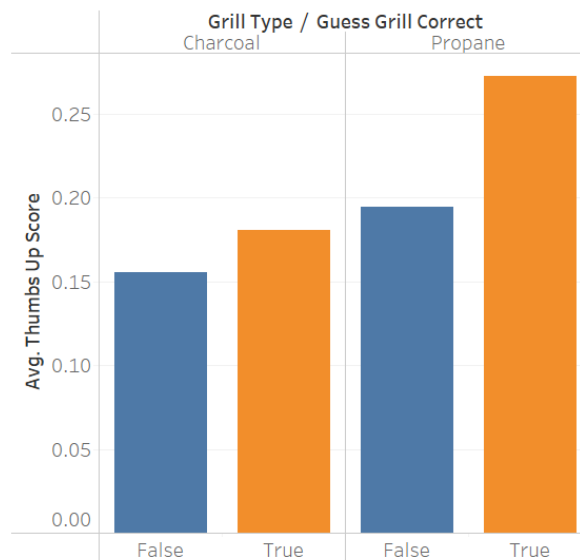


Figure 11: Thumbs Up Score and Grill Guess Relationship

Bonus question:

I used Python to transform SheetC json file into SheetC csv file. As this json file has nested dictionaries inside, so could not be directly transformed into pandas dataframe with built-in tools. Instead, I used json library to load the json file and accessed the value of the nested dictionaries. I iterated through different rows of data by unique dictionary keys with for loops, retrieved and stored the data that we want into a list. Finally I transformed the list into a pandas dataframe and then export it into a csv file, which is ready to be analyzed.

The script that I wrote could be for future use to transform other json files into csv files with minor adaption. Please find the jupyter notebook in the folder.

```
In [1]: # import libraries
import pandas as pd
import json
import csv
```

```
In [2]: # open Json file, load the data
f = open('SheetC.json')
data = json.load(f) # List
f.close()
data
```

```
In [3]: # Access nested dictionaries
dic = json.loads(data[0]['test_result'])
dic
```

```
Out[3]: {'1': {'meta_data': {'grill_type': 'Propane',
    'is_frozen': 'false',
    'item_material': 'Hotdog'},
    'sample_item_index': 1,
    'survey_result': {'guess_grill_correct': 'true', 'thumbs_up_score': '0.4'}},
    '10': {'meta_data': {'grill_type': 'Propane',
    'is_frozen': 'true',
    'item_material': 'Hotdog'},
    'sample_item_index': 10,
    'survey_result': {'guess_grill_correct': 'true', 'thumbs_up_score': '1.0'}},
    '100': {'meta_data': {'grill_type': 'Propane',
    'is_frozen': 'true',
    'item_material': 'Hotdog'},
    'sample_item_index': 10,
    'survey_result': {'guess_grill_correct': 'true', 'thumbs_up_score': '0.0'}},
    '101': {'meta_data': {'grill_type': 'Propane',
    'is_frozen': 'false',
    'item_material': 'Hotdog'},
    'sample_item_index': 11,
    'survey_result': {'guess_grill_correct': 'true', 'thumbs_up_score': '0.0'}}
```

```
In [4]: # Retrieve the data from dictionary value, store it into a List
records=[]
for key in dic.keys():
    temp=[]
    temp.extend([dic[key]['sample_item_index'],
        dic[key]['meta_data']['item_material'],
        dic[key]['meta_data']['is_frozen'],
        dic[key]['meta_data']['grill_type'],
        dic[key]['survey_result']['thumbs_up_score'],
        dic[key]['survey_result']['guess_grill_correct']])
    records.append(temp)
```

```
In [5]: # Convert the List into pandas dataframe, export it into a csv file
df=pd.DataFrame(records,columns=['sample_item_index','item_material','is_frozen','grill_type','thumbs_up_score','guess_grill_correct'])
df.to_csv('SheetC.csv',index=False)
```

```
In [6]: df
```

```
Out[6]:
```

	sample_item_index	item_material	is_frozen	grill_type	thumbs_up_score	guess_grill_correct
0	1	Hotdog	false	Propane	0.4	true
1	10	Hotdog	true	Propane	1.0	true
2	10	Hotdog	true	Propane	0.0	true
3	11	Hotdog	false	Propane	0.0	true
4	12	Hotdog	true	Propane	0.4	true
...	...	...	...	...	...	...
715	5	Hotdog	false	Propane	0.2	true
716	6	Hotdog	true	Propane	0.3	true
717	7	Hotdog	false	Propane	0.2	true
718	8	Hotdog	true	Propane	0.9	true
719	9	Hotdog	false	Propane	0.7	true

720 rows × 6 columns