How much Ice do You need?

Final Presentation

Participants:
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JHU AMS 2012 FALL

Last Complied on November 27, 2012

Outline

Sponsor: McDonald's Corporation

- McDonald's Corporation is the world's largest chain of hamburger fastfood restaurants, serving around 68 million customers daily in 119 countries.
- Mcdonald's primarily sells hamburgers, cheeseburgers, chicken, French fries, breakfast items, soft drinks, milkshakes and desserts.

Sponsor: McDonald's Corporation

- In response to healthier consumer taste, the company has expanded its menu to include salads, wraps, smoothies and fruits.
- No meal is complete without a drink; and from Diet Coke to low-fat milk to fresh-brewed, hot coffee, McDonald's serves many different varieties of beverages

Problem Statement

- Selling soft drinks is a complement to any meal that a customer purchases at McDonald's.
- However, the server is not accustomed to putting much thought in measuring the amount of ice put in the cup.
- This often results in a overly diluted, or overly cold drink for the customer. This is likely to lower overall customer satisfaction, since a drink is a significant complement to a meal.
- Thus, customers are likely to appreciate if the right amount of ice was added for optimal satisfaction.

Problem Statement

- To further define this problem, the exogenous variables are the proportion of ice to put in a drink.
- The endogenous variable would be the resulting temperature and concentration of the drink, as we are assuming that a customer's satisfaction is affected only by the temperature and concentration of the drink.

Deliverables - From Team to Sponsor

- A table of optimal ice proportions/ratios for each different type of soda (namely Coca Cola, Sprite, Fanta Orange, Diet Coke),
- Matlab code with complete set of documentations that resulting temperature and dilution based on specific heat capacities and ice proportions,
- Numerical experiment results reporting success rate of different ice proportions,
- Technical report and presentations summarizing the work.

Deliverables - From Sponsor to Team

- Sufficient supply of the 4 different sodas we are concentrating on,
- Sufficient supply of cups used by McDonald's
- Computing resources,
- Timely responses to inquiries.

Timeline

- Work Statement due date, Sep 28, 2012,
- Midterm Presentation due date, Oct 17, 2012,
- Progress Report due date, Oct 26, 2012,
- Final Presentation due date, Nov 28, 2012,
- Final Report due date, Dec 3, 2012.

Most of the experiments and coding have been done from mid-October to mid-November.

Approach Assumptions

- Consumer's taste depends entirely on the dilution and temperature factors.
- Dilution and temperature of drink come hand-in-hand and rely entirely on the ice proportion.
- Sample group accurately represents the population's preferred combinations of temperature and dilution.
- The different time parameters which we perform the experiment is sufficient to represent the overall satisfaction the customer has with the drink.

Approach 1: Experimental

- Experimenting with different types of soda - namely McDonald's Coca Cola, Sprite, Fanta Orange, and Diet Coke.
- By experiment, we will test out which ice proportion will yield the highest satisfaction from the test subjects.

Approach 1: Experimental

- We will provide 3 different cups of the same soda (different ice proportions) for the test subject to drink and they will indicate their preference.
- The ice will be left in the drink for a time period of t (t=0.5mins, 2 mins, 5 mins, 30 mins). The different experiments for the time parameters will be spaced an hour apart.
- This will be repeated for 3 more days for the other 3 drinks.

Approach 1: Experimental

- This will be a blind test and the subject will not know what ice proportions the cups A, B, C have.

Ice Proportion	A	B	C
t=0.5mins			
t=2mins			
t=5mins			
t=30mins			

Table: Sample form each test subject will need to fill out for each drink

Approach 1: Experimental

- Subject will be required to rank preference of the labelled cups for each time parameter t (3 is most favorite).

Ice Proportion	A	B	C
t=0.5mins	3	2	1
t=2mins	1	3	2
t=5mins	2	3	1
t=30mins	1	2	3

Table: Example of a response

Approach 2: Physics-based

- Utilizing the specific heat capacities of soda and ice (already found as specific values), we can calculate the different temperatures and dilution that the resulting drink will have.
- This will be used mainly as a support tool since it's just mathematical calculation, to see how much ice proportion actually affects dilution as well as resulting temperature

Results - Experimental approach

	40%	60%	75%
t=0.5 mins	15	25	32
t=2 mins	14	24	34
t=5 mins	14	27	31
t=30 mins	18	36	18

Table: Experiment results for Coke

Results - Experimental approach

	40%	60%	75%
t=0.5 mins	15	27	30
t=2 mins	20	19	33
t=5 mins	14	29	29
t=30 mins	17	30	25

Table: Experiment results for Sprite

Results - Experimental approach

	40%	60%	75%
t=0.5 mins	15	23	34
t=2 mins	19	23	30
t=5 mins	18	27	27
t=30 mins	12	35	25

Table: Experiment results for Fanta Orange

Results - Experimental approach

	40%	60%	75%
t=0.5 mins	15	24	33
t=2 mins	21	19	32
t=5 mins	16	24	32
t=30 mins	18	22	32

Table: Experiment results for Diet Coke

Results - Physics-based approach

Volume of ice to volume of soda	Dilution	Temperature (Celsius)
1/10	0.09	16.2
1/8	0.11	14.3
1/6	0.15	11.2
1/5	0.18	8.8
1/4	0.23	5.5

Table: Calculated dilution and temperature for difference ice volumes

Analysis - Experimental approach

	40%	60%	75%	p-value	significance?
t=0.5 mins	15	25	32	0.047	significant
t=2 mins	14	24	34	0.016	significant
t=5 mins	14	27	31	0.037	significant
t=30 mins	18	36	18	0.011	significant

Table: Experiment results for Coke

- 'Good' set of data, given that the data set are all considered significant by the Chi-Squared Test
- As time elapses, subjects tend to choose the cup with less ice, but not the least ice

Analysis - Experimental approach

	40%	60%	75%	p-value	significance?
t=0.5 mins	15	27	30	0.072	not significant
t=2 mins	20	19	33	0.079	not significant
t=5 mins	14	29	29	0.044	significant
t=30 mins	17	30	25	0.011	significant

Table: Experiment results for Sprite

- The p-values for t=0.5 mins and t = 2 mins are marginally above 0.05, but is still considered insignificant
- Ignoring those row of values, we see that at t = 5 mins and t = 30 mins, there is a strong preference towards 60% and 75%

Analysis - Experimental approach

	40%	60%	75%	p-value	significance?
t=0.5 mins	15	23	34	0.022	significant
t=2 mins	19	23	30	0.275	not significant
t=5 mins	18	27	27	0.325	not significant
t=30 mins	12	35	25	0.004	significant

Table: Experiment results for Fanta Orange

- P-values for t = 2 mins and t = 5 mins are quite significantly above our accepted significance levels
- t = 30 has a very low p-value, indicating a strong lack of randomness

Analysis - Experimental approach

	40%	60%	75%	p-value	significance?
t=0.5 mins	15	24	33	0.034	significant
t=2 mins	21	19	32	0.130	not significant
t=5 mins	16	24	32	0.069	not significant
t=30 mins	18	22	32	0.115	not significant

Table: Experiment results for Diet Coke

- There is much more 'randomness' in this set of data
- Diet Coke's effect on ice/melting points?

Analysis - Physics-based approach

Volume of ice to volume of soda	Dilution	Temperature (Celsius)
1/10	0.09	16.2
1/8	0.11	14.3
1/6	0.15	11.2
1/5	0.18	8.8
1/4	0.23	5.5

Table: Calculated dilution and temperature for difference ice volumes

- Dilution / Temperature equilibrium

Deliverables - From Team to Sponsor

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Advantages

- Utilizing the specific heat capacities of soda and ice, we can calculate the different combinations of temperatures and dilution of the drink.
- By surveying our sample group (which should be a accurate presentation of the population), we can determine which is the most popular combination of temperature and dilution and thus the optimal combination of ice proportion.
- We are able to use physics calculations to compare the accuracy of the experiments.

Disadvantages

- Assumption that all customers have the same taste regarding temperature and dilution is probably false, yet we only offer one optimal ice proportion for each drink.
- Desired temperature of drink may also depend on location of branch and climate.
- Different types of Soda may have differing effects on ice and their melting points

Disadvantages

- Physics-based calculation might not be as accurate since it assumes that there is no inteference with the environment, which is not true in reality.
- It is more likely that a customer starts sipping the drink once he/she gets it, rather than waiting for the ice to completely melt.

Further Recommendations

- Perform experiments on different days with different climates.
- Larger subject population
- Specificity in project objectives
- Split sample group based on gender and age.
- Perform experiments such that test subject starts drinking once he receives it.

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