VICTORIAN PIZZA
10-MINUTE LUNCH GUARANTEE
PREDICTIVE ANALYSIS

Michael Bernier

SHA573 Course Project

March 7, 2019

Company Background

Victorian Pizza (VP) is a small pizzeria located near the campus of Big Western University (BWU) and is best known for offering quality pizza and drinks to college students and faculty at a fair price.

Project Scope

VP management is interested in encouraging increased pizza sales and is exploring several options. One of these options is to offer a guarantee during weekday lunch hours (11:30am-1:30pm Monday through Friday) that any order of four or fewer small pizzas, regardless of crust or selected toppings, will be ready in 10 minutes or less or the customer will receive their order free of charge. The guarantee would not apply to orders that include medium or large pizzas, or for orders of more than four small pizzas.

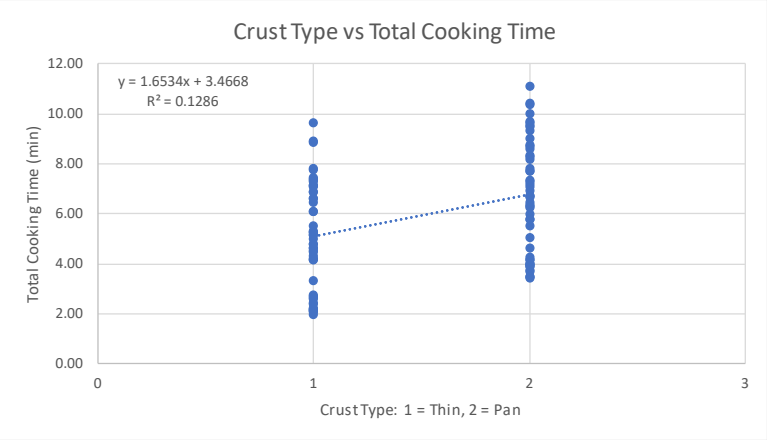
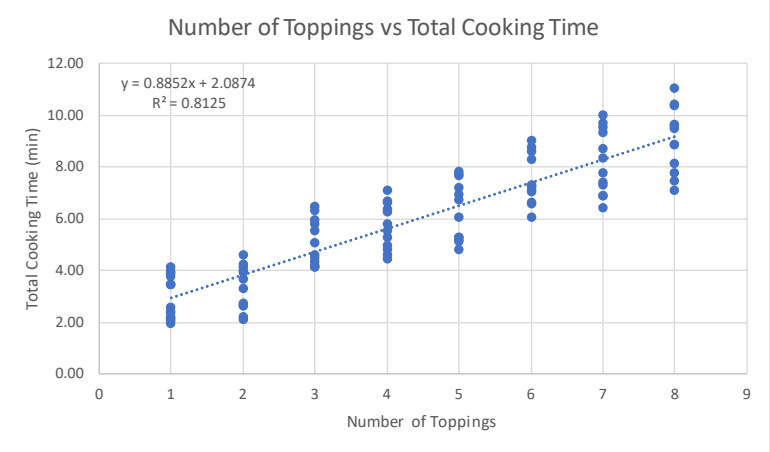
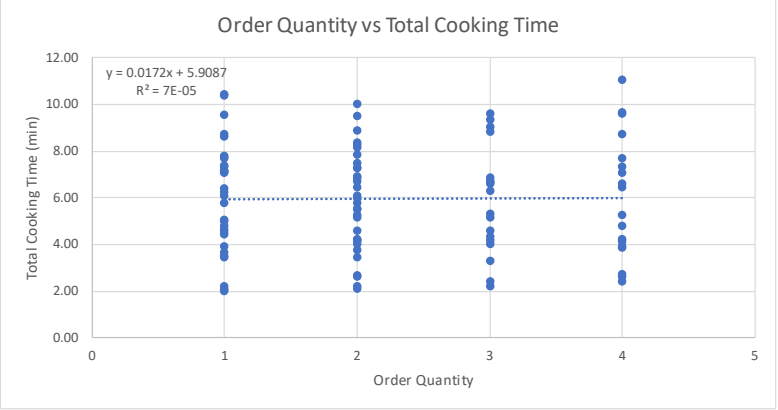
Part 1 – Identify a Focal Point and a Dependent Variable

Target Analysis: Is it possible to guarantee all orders placed for four or fewer small pizzas during weekday lunch hours will be ready in 10 minutes or less?

Dependent Variable: Time required to prepare, cook, and serve a small pizza order

Independent Variable		
Summary of independent variable	**Categorical or quantitative?**	**Argument for / description of the impact on the dependent variable**
Type of Crust (Pan or Thin)	Categorical	Pan crusts take longer to cook
Number of Toppings	Quantitative	A pizza with more than two toppings takes longer to cook
Quantity of Pizzas per Order	Quantitative	Orders for 3 or 4 pizzas require additional prep time than orders for 1 or 2

Part 2 – Map Decisions to Outcomes

Candidate Independent Variables		
Independent Variable	**Regression Equation**	**Screenshot of Scatterplot**
Type of Crust	$y = 1.6534x + 3.4668$	
Number of Toppings	$y = 0.8852x + 2.0874$	
Quantity Per Order	$y = 0.0172x + 5.9087$	

Discussion on Independent Variables

Type of Crust

Each type of crust is known to require different cooking times. For a small pizza with up to two toppings, cooking times at 800° F for thin crusts are approximately 1.5 minutes while pan crusts require twice as long (approximately 3 minutes). The observed cooking times support this, with the trendline generally reflecting the known difference between the crust types.

Number of Toppings

It is known that the number of toppings on a pizza can influence the cooking time. One or two toppings have little variance (i.e. two toppings cook as quickly as one), while each additional topping will require more time. Although Victorian Pizza offers 15 different toppings, small pizzas are limited to eight; more than eight generally results in overcooked crusts and/or undercooked centers. Observed cooking times and the plotted trendline were as expected, with pizzas containing larger quantities of toppings requiring longer cooking times. One noted observation shows pizzas at the high end of the range (6-8 toppings) tend to take up to or longer than the 10-minute limit set for this proposed sales campaign.

Quantity Per Order

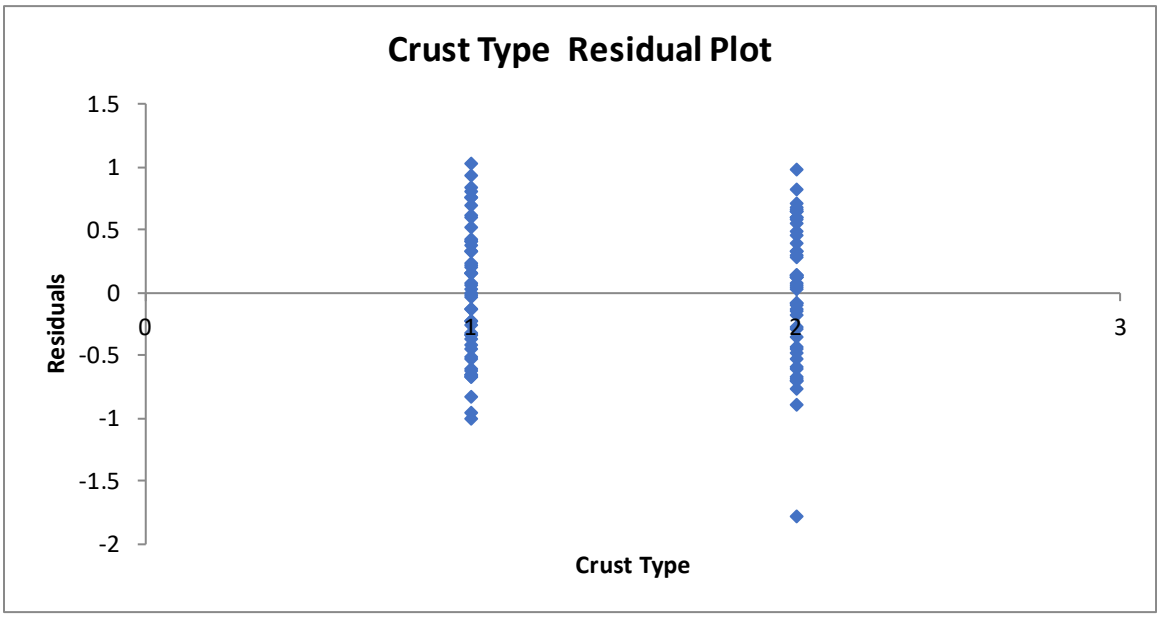
It is known that the process the staff uses in preparing and cooking pizzas is order-centric; i.e. all the individual pizzas in an order are prepared and cooked so they finish at roughly the same time. Therefore, the time required to prepare and cook larger orders (3-4 pizzas) should show only a marginal difference from smaller orders. The observed per-order cooking times support this, with a basically flat trendline indicating cooking time is consistent regardless of order size.

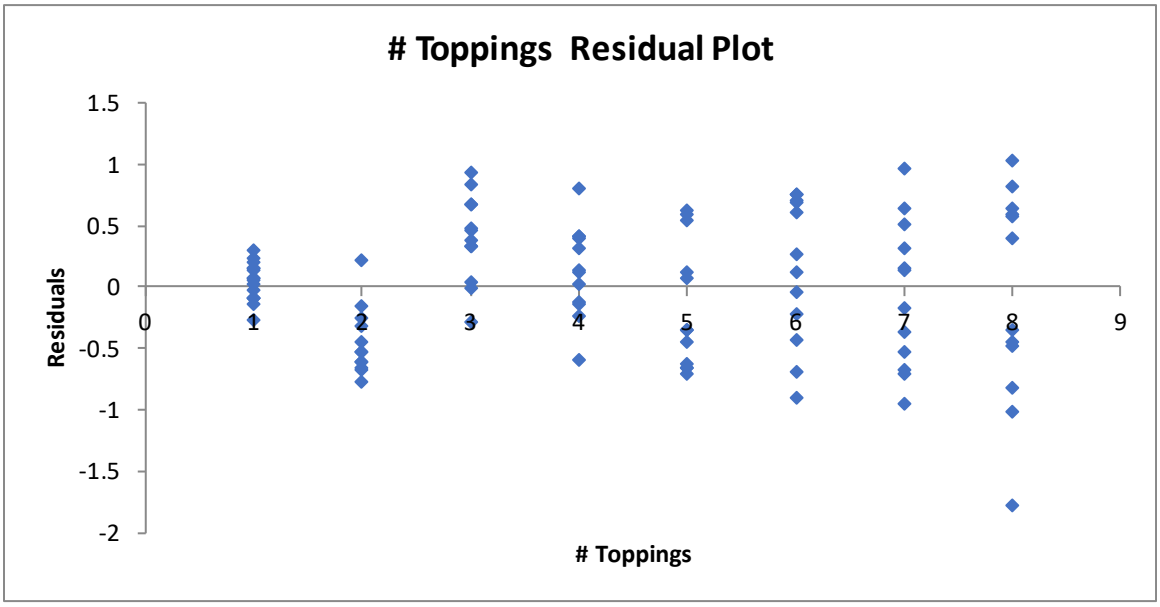
Multiple Regression

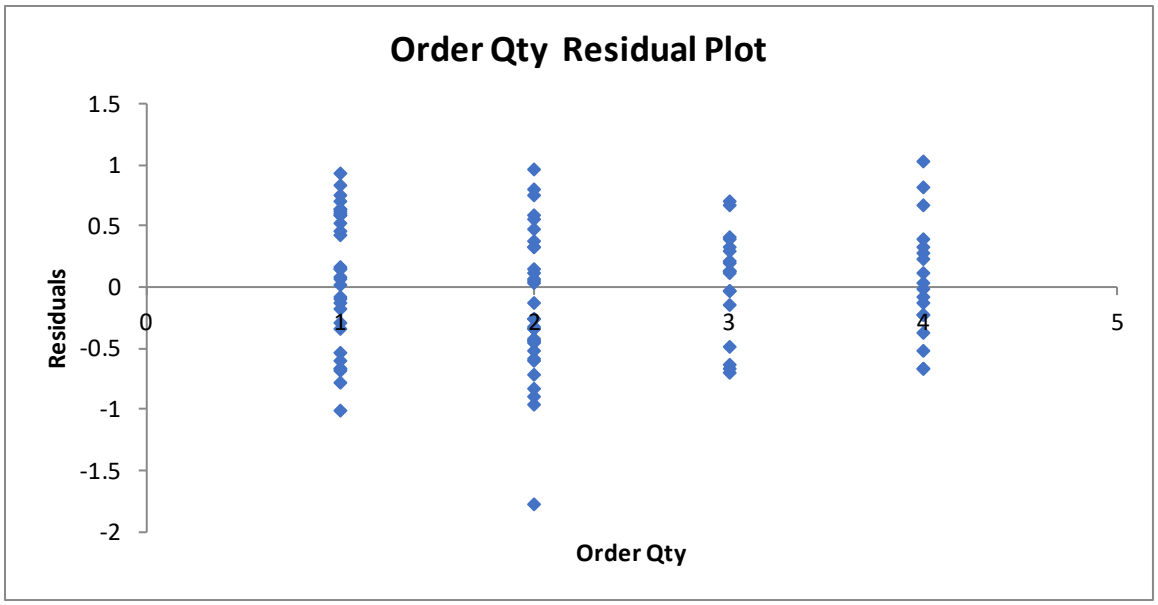
SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.972773065							
R Square	0.946287436							
Adjusted R Square	0.944608919							
Standard Error	0.545279439							
Observations	100							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	502.871091	167.623697	563.7637816	8.47911E-61			
Residual	96	28.54364796	0.297329666					
Total	99	531.414739						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.754939088	0.232845286	-3.2422348	0.001631359	-1.217133326	-0.292744849	-1.217133326	-0.292744849
Crust Type	1.6534	0.109055888	15.1610338	3.21625E-27	1.436925774	1.869874226	1.436925774	1.869874226
# Toppings	0.890189879	0.02328683	38.22718238	6.88834E-60	0.843965888	0.936413871	0.843965888	0.936413871
Order Qty	0.15338343	0.050502426	3.037149708	0.003075377	0.053136906	0.253629954	0.053136906	0.253629954

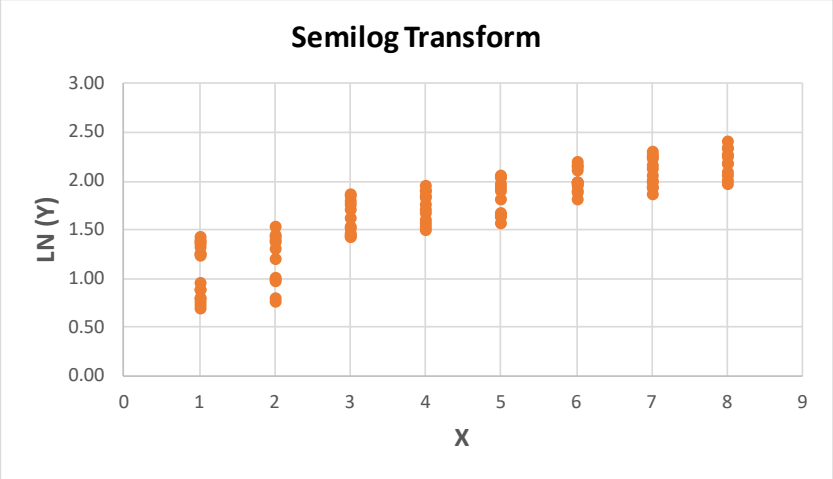
Part 3 – Generate a Revised Regression Equation

Nonlinear Relationship Analysis







Possible Nonlinearities		
Independent Variable	**Transform used (Log or Semilog)**	**Screenshot of Transform Plot**
# Toppings	Semilog	

Independent variable # Toppings appears to have a slight nonlinear relationship to the dependent variable.

Multicollinearity Analysis

Correlation Table

	Crust Type	*# Toppings*	*Order Qty*	*Total Cook Time*
Crust Type	1			
# Toppings	0	1		
Order Qty	-4.1028E-18	-0.070527219	1	
Total Cook Time	0.35861722	0.901398962	0.008088309	1

Findings:

Independent variable # Toppings exhibits a high correlation to the dependent variable Total Cook Time. This appears to correspond with the known influence that a pizza with more toppings requires a longer cooking time.

Crust Type shows some correlation to Total Cook Time. This appears to correspond with the known fact that one crust type requires twice as long to cook as the other.

Quantity Ordered (Order Qty) shows no significant correlation to Total Cook Time. This appears to correspond with the order-centric nature of the fulfillment process in which all pizzas in an order are prepared and cooked at the same time.

Part 4 – Validate the Model

Victorian Pizza management wanted to determine the feasibility of offering a guarantee in which all orders placed for 4 or fewer small size pizzas during lunch hours would be ready in 10 minutes or less.

The dependent variable in this case is the total time required to cook a pizza order, referred to as Total Cook Time. Based on prior experience, three independent factors (variables) were identified as having the greatest effect on the total cooking time:

- Type of Crust (thin or pan)
- Number of Toppings
- Order Quantity (the number of pizzas in a single order)

A sample of 100 orders for four or fewer small size pizzas were collected and analyzed. A multiple regression test of the independent variables showed a strong R square value, large coefficients for both type of crust and number of toppings compared to order quantities, and acceptable P-values all below the 0.05 confidence threshold. These findings were mostly in line with pre-analysis knowledge and expectations for each variable:

- Type of Crust – pan crusts require twice as long to cook as thin crusts
- Number of Toppings – higher numbers of toppings require longer cooking times
- Order Quantity – not expected to be a factor due to all pizzas for any single order always being prepared and cooked as a group

However, the regression's intercept coefficient was slightly negative, bringing into question whether the combination of all three independent variables made sense. Single regressions identified the Order Quantity as having the least effect on Total Cook Time, and a correlation test also indicated Order Quantity had little influence on the overall model. When Order Quantity was removed and the multiple regression model run again, the R square value changed only slightly but the intercept coefficient significantly improved (but still stayed slightly negative), indicating the Order Quantity was not a significant factor in Total Cook Time and could be set aside.

Turning back to the remaining independent variables, it was noted that the Number of Toppings had the strongest correlation with Total Cook Time, with pizzas containing more than six toppings pushing the Total Cook TIme up to and beyond the 10-minute limit stipulated by the proposed guarantee. Combined with a moderately strong correlation of Type of Crust to Total Cook Time and observed measurements of orders with pan crusts taking up to and over 10 minutes, there is good confidence that orders with both pan crusts and more than six toppings are most at risk of exceeding the 10-minute time limit.

One additional factor that could help with this analysis but was not available is the frequency of orders being placed that include both pan crusts and larger numbers of toppings; having this would help in further defining the amount of financial risk involved (i.e. what percentage of orders could be expected to exceed the time limit and result in loss of revenue); depending on those volumes, management may decide the risk is acceptable and move forward with the guarantee as proposed. In the absence of such data, our recommendation is to place an additional limit on the number of toppings to six or less.