DOOLY COUNTY DOUGHNUTS

BACKGROUND AND CONTEXT

We analyzed Dooly County Doughnut’s situation to determine which area of the store’s business model to focus on. Currently, Dooly has ample demand, but it does not have an optimized process flow to efficiently meet its demand. Additionally, Dooly would like to explore the potential of introducing additional customization as a part of its value proposition. Therefore, we analyzed two possible options for Dooly to pursue: first, to find an optimal production setup to efficiently meet demand; second, to find an optimal production set up that accounts for the desired increase in customization. Furthermore, we used demand pacing to guide our analysis, as Dooly’s production is dictated by the shop’s demand.

BASELINE PROCESS

Dooly currently has a standard setup that it uses for the entire year despite the seasonality in demand. Figure 1 contains the Process Flow diagram, and Figure 2 shows the variability in seasonality. Under this setup, Dooly is unable to efficiently meet demand. For example, in Q1 that has relatively lower sales, Dooly’s probability of not meeting demand is 74.5%, which is high enough to negatively impact key relationships with supermarket customers and lead to forgone sales. In addition, the current bottleneck is the extruding task, which has the highest capacity utilization (115.38%) and lowest capacity (953 dozens per day).

Figure 1 - Baseline Process Flow Diagram

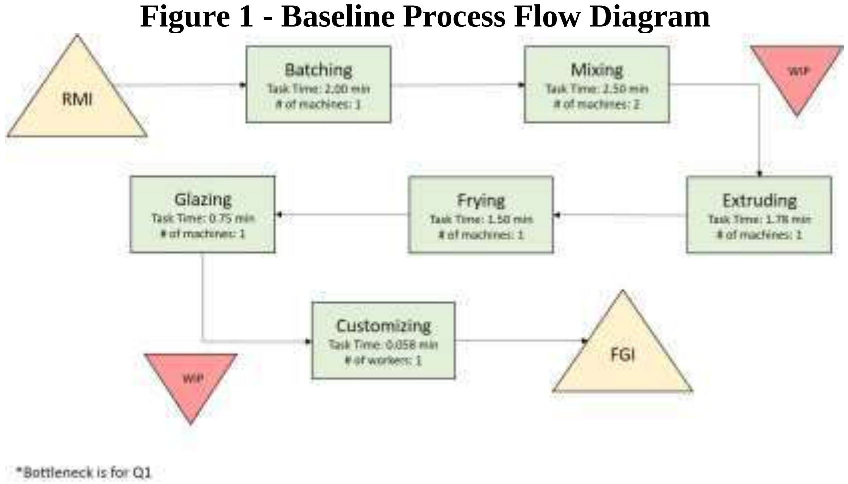
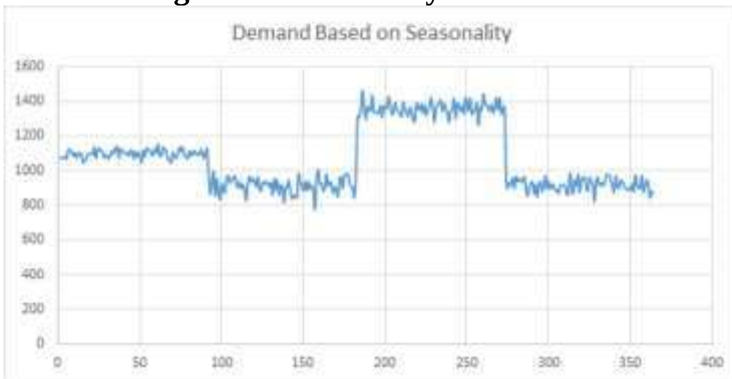


Figure 2 - Seasonality in Demand



STRATEGIC CONSIDERATIONS

If Dooly decides to pursue the first option, it would focus on operational excellence with an emphasis on three areas: cost, time, and quality. In other words, the first option would produce more doughnuts by efficiently using Dooly's current resources, thereby following lean management principles. Alternatively, with the second option, Dooly would align its core values around the customer. As part of its customer intimacy strategy, Dooly would offer a wider variety of customizable doughnuts. The shop would provide a higher level of flexibility for the customer, but the downside would be a higher cost for Dooly and an increase in production time. Due to the increase in variability caused by customization, there is a greater chance of defects and a higher likelihood of not meeting demand. However, if done correctly, the second option has the potential to yield higher profits, a stronger brand image, and better customer relationships.

MODELS AND SOURCES OF VARIABILITY

To help Dooly decide which option to undertake, we created two models: one for option 1 and the other for option 2.

Model for Option 1: Meet Demand

Initially, we found that the inputs that could be altered were: batch size, number of mixers, number of cutters, and number of customization workers. With the intention of recommending an optimal outcome in the simplest way possible, we did not consider the frying and glazing steps as variable inputs, since these are standardized automated processes that are fairly difficult to change.

To set up our models, we first began with demand, which is a source of variability that was modeled as a normal distribution with a mean and standard deviation. The parameters used were dependent on whether we defined the distribution based on quarterly demand or demand for the entire year. We decided to optimize Dooly's process flow based on demand for each quarter because yearly demand has a higher variability (standard deviation of 184.8 dozens) as compared to quarterly demand (max standard deviation of 43.8 dozens). More importantly, if we set up Dooly's process flow based on yearly demand, the shop would have low utilization for the quarters with low demand and high utilization for the quarters with high demand. Whereas, the seasonal model allows us to select inputs so that utilization is always optimal.

In addition, we modified the model to add variability to the customization step, which is a human-worked process that is likely to have variability (Figure 3). Furthermore, we created the model in such a way that an increase from 3 cutters to 6 cutters would double the extruding setup time from 1.50 minutes to 3 minutes. Therefore, we had a model that would use the inputs to produce an output, which initially was capacity utilization, based on a simulation of 1000 iterations. Next, we replicated this model four times that were each defined by a given quarter's demand distribution.

Figure 3 - Variability for Customization

Distribution Table		
	X	P
Customization (per 2 donuts)	3.5	40%
	4.1	60%

For each of the four models, we needed a method to determine the optimal inputs that would produce the best output. However, a "best" capacity utilization is not a one-size-fits-all solution, as it depends on various factors such as degree of variability. In other words, it is not obvious whether we should target an 85% capacity utilization or a 90% capacity utilization. Therefore, we implemented a cost-benefit analysis through a quasi-income statement that considers the trade-off between the shortage cost of unmet demand and holding cost of excess capacity. Figure 4 contains the parameters, as provided by Johnson, which were used to create the cost-benefit model, and Figure 5 has the income statement. This income statement reduced net income by both holding costs and shortage costs, if applicable. Holding costs were assumed to be $0.50 per dozen of leftover inventory; these costs are meant to capture the carrying cost of unsold doughnuts. Shortage costs were modeled to be the sum of the fine paid to supermarkets for not meeting demand and the gross margin forgone from unmet demand. More specifically, the fine paid to supermarkets accounted for the fact that 70% of sales went to supermarkets on weekdays and 30% went to them on weekends. Since the net profit number accounted for excess and shortage, it gave us a method to build in the trade-offs and decide the optimal inputs. Also, the net profit accounted for the costs of hiring any additional customization workers.

Figure 4 - Cost-Benefit Inputs

Cost-Benefit Analysis	
Given:	
Revenue per dozen (Min)	$12
Revenue per dozen (Max)	$14
Penalty for not meeting supermarket demand for dozen (Min)	$4
Penalty for not meeting supermarket demand for dozen (Max)	$6
Holding Cost (Assumption) per dozen	$0.50
Percent Sales in Supermarket (Weekday)	70%
Percent Sales In-House (Weekday)	30%
Percent Sales in Supermarket (Weekend)	30%
Percent Sales In-House (Weekend)	70%
Cost per hour per worker	$7.25

Shortage Cost Componenent		
Supermarket Distributions		
SuperMarket Demand %	Probability	Comments
70%	0.71428571	(5 out of 7 days)
30%	0.28571429	(2 out of 7 days)
Discrete Distribution		
Penalty	5	
Supermarket %	0.7	

Figure 5 - Income Statement

MODEL		
Revenue per Dozen	$	13.00
Gross Profit	$	6.50
Produced (Dozens)		1,171
Demand (Dozens)		1100.00
Sales		1,100
Leftover		71
Unfilled Demand		-
Gross Margin		7150
Inventory Holding Cost		35.36585366
Shortage Cost		-
Net Profit $		7,114.63

With a method in place to optimize inputs, we created what-if scenarios for each of the four models that varied all four inputs simultaneously (one example in Figure 6). Then, for each of the four models, we selected the combination of inputs that would yield the highest expected net profit per day after 1000 simulations. In cases where there were multiple combinations that provided similar results, we picked those that made sense for Dooly's business context. For instance, we tried to keep the number of cutters and mixers the same throughout the year to simplify the transition process between quarters. It is interesting to note that these profit-maximizing inputs also produced capacity utilizations under each scenario that balanced the impacts of shortage costs and holding costs.

Figure 6 - What-If Scenarios for 1 Model

What-If Scenarios - 2 Mixer (1 Worker)											
	Batch Size (lbs of dough)										
	85%	2	4	6	8	10	12	14	16	18	20
Number of Cutters	3	286.60%	149.93%	114.11%	96.20%	85.45%	78.34%	78.34%	78.34%	78.34%	78.34%
	6	451.12%	236.18%	164.53%	128.70%	107.21%	92.88%	82.64%	78.34%	78.34%	78.34%

What-If Scenarios - 1 Mixer (1 Worker)											
	Batch Size (lbs of dough)										
	300%	2	4	6	8	10	12	14	16	18	20
Number of Cutters	3	358.23%	179.12%	119.42%	96.20%	85.45%	78.34%	78.34%	78.34%	78.34%	78.34%
	6	451.12%	236.18%	164.53%	128.70%	107.21%	92.88%	82.64%	78.34%	78.34%	78.34%

What-If Scenarios - 2 Mixer (2 Workers)											
	Batch Size (lbs of dough)										
	0%	2	4	6	8	10	12	14	16	18	20
Number of Cutters	3	286.60%	149.93%	114.11%	96.20%	85.45%	78.28%	73.17%	69.33%	66.34%	63.95%
	6	451.12%	236.18%	164.53%	128.70%	107.21%	92.88%	82.64%	74.97%	69.00%	64.22%

What-If Scenarios - 1 Mixer (2 Workers)											
	Batch Size (lbs of dough)										
	300%	2	4	6	8	10	12	14	16	18	20
Number of Cutters	3	358.25%	179.12%	119.42%	96.20%	85.45%	78.28%	73.17%	69.33%	66.34%	63.95%
	6	451.12%	236.18%	164.53%	128.70%	107.21%	92.88%	82.64%	74.97%	69.00%	64.22%

Model for Option 2: Customization

To model the second option, we used the previous model with three changes. First, we accounted for the increase in production time due to personal customization. We took into consideration that Dooly would not be customizing all its doughnuts, but only those that it sold in-house (30% of weekday sales, and 70% of weekend sales). In addition, we suggest that the best way to customize doughnuts is to use the same batch with different topping and flavor options, which would only increase the task time of the last process (customization). Therefore, we increased the customization task-time for all the in-house doughnuts produced from 3.5 or 4.1 seconds to 15 seconds (Figure 7).

Figure 7 – Customization Distribution

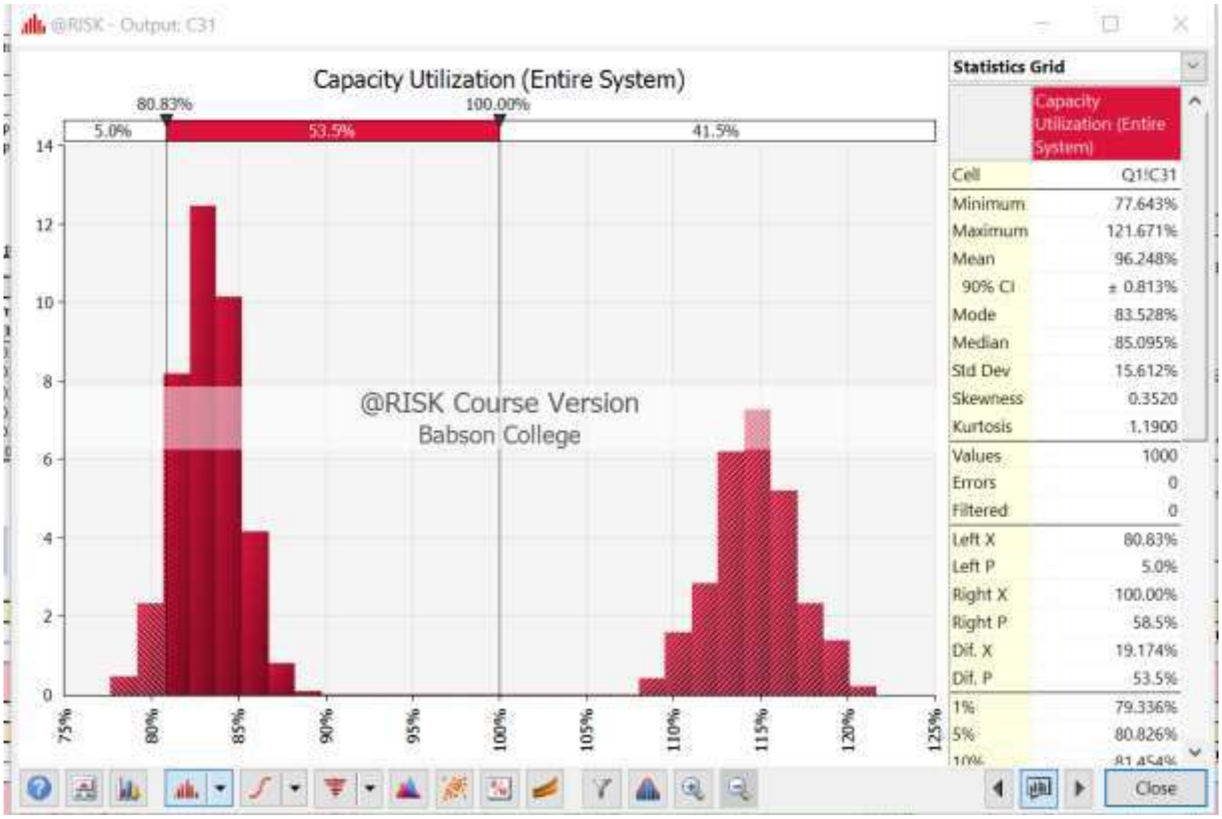
Customization			
	In-House Distributions		
In-House Demand %		Probability	Comments
	30%	0.71428571	(5 out of 7 days)
	70%	0.28571429	(2 out of 7 days)
Expected Value		0.41428571	

Distribution Table		
	X (seconds)	**P**
Customization (per 2 donuts)	3.5	25%
	4.1	34%
	15	41.43%
		100.000%

Second, we increased the prices for only those doughnuts that were customized (in-house sales) from $12 to $20 per dozen. This increase is slightly over 50%, amounting to a premium that is similar to those charged by its competitors. However, all the other non-customized doughnuts sold to the supermarkets were still priced at $12-$14 per dozen.

Third, when we ran our models, we found that the customization step was a massive bottleneck with over 350% utilization in certain iterations. Due to the in-house customization, Dooly would not be able to meet demand. Hence, we needed to increase the number of customization workers to 4 (for Q1, Q2, Q4) or 5 (for Q3). However, as seen in the distribution in Figure 8, the spike in in-house customization demand was only during the weekends when in-house sales were high and not during weekdays, where Dooly had excess capacity. Thus, we modeled having 2 workers during the week and a total of 4 (or 5) workers during the weekend to keep up with demand.

Figure 8 - Weekday and Weekend Demand Split



With these three changes, we selected inputs in a similar fashion as the previous model, which was by trying to maximize net profit and minimize the probability of not meeting demand. At the same time, we wanted to keep the inputs as consistent as possible throughout the year to simplify Dooly's transition from season to season.

RECOMMENDATION AND CAPACITY MANAGEMENT

Based on our analysis, we formulated optimal inputs for both options, which are highlighted in the tables below. The tables also show the expected capacity utilization of the process, probability of not meeting demand, mean net profit per day, mean holding cost per day, and mean shortage cost per day for all quarters.

Option 1 - Meet Demand

	Q1	Q2	Q3	Q4
Batch Size (lbs)	14	10	20	10
# of Mixers	1	1	1	1
# of Cutters	3	3	3	3
# of Cust. Workers	1	1	2	1
Mean Utilization Rate	93.96%	85.45%	94.91%	85.76%
Prob. of Unmet Demand	0.1%	0%	2.6%	0%
Mean Net Profit per day	$7102.32	$5882.49	$8803.12	$5906.20
Mean Holding Cost per day	$51.61	$78.09	$36.70	$76.42
Mean Shortage Cost per day	$0.00	$0.00	$3.89	$0.00

Option 2 - Customization

	Q1	Q2	Q3	Q4
Batch Size (lbs)	14	10	20	10
# of Mixers	1	1	1	1
# of Cutters	3	3	3	3
# of Cust. Workers	2/4	2/4	2/5	2/4
Mean Utilization Rate	87.06%	85.45%	94.91%	85.76%
Prob. of Unmet Demand	0%	0%	2.8%	0%
Mean Net Profit per day	$8,614.67	$7,146.41	$10,704.45	$7,172.71
Mean Holding Cost per day	$76.42	$78.10	$36.70	$76.41
Mean Shortage Cost per day	$0.00	$0.00	$4.66	$0.00

We recommend Dooly to pursue Option 2 (customization), which focuses on customer intimacy. Customization is the best option for Dooly for three main reasons. First, it yields a higher net profit. Figure 8 below shows that Option 2 is more lucrative, as the expected annual net profits are higher for Option 2 (roughly $3 million) as compared to Option 1 (roughly $2.5 million). Second, this option gives Dooly a competitive advantage, as customers are likely to value the ability to order customized doughnuts. Third, Dooly is likely to improve its long-term relationships with customers, as it would accommodate customer preferences.

Figure 8 – Dollar Impact Comparison of Both Options

Dollar Impact			
Expected Net Profit - Option #1	$ 2,527,089.36	Expected Net Profit - Option #2	$ 3,069,489.40
Expected Net Profit - Baseline	$ 1,672,579.65	Expected Net Profit - Baseline	$ 1,672,579.65
Difference	***$ 854,509.71***	***Difference***	***$ 1,396,909.75***
Percent Difference	***51%***	***Percent Difference***	***84%***

A summary of our quarterly recommendations is as follows:

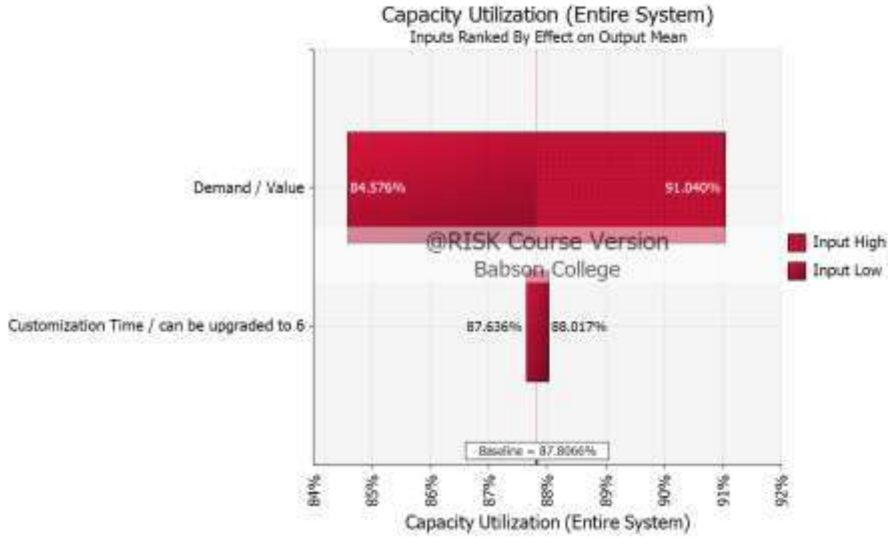
***Q1**:* 14 lb (batch), 1 mixer, 3 cutters, 2 weekday & 4 weekend customization workers
Q2: 10 lb (batch), 1 mixer, 3 cutters, 2 weekday & 4 weekend customization workers
Q3: 20 lb (batch), 1 mixer, 3 cutters, 2 weekday & 5 weekend customization workers
Q4: 10 lb (batch): 1 mixer, 3 cutters, 2 weekday & 4 weekend customization workers

IMPLICATIONS OF RECOMMENDATION

- A high utilization under each quarter might overuse the mixers and cause them to break down. Therefore, using only one mixer would ensure that a spare mixer is always available while the broken mixer is sent to be fixed. Additionally, the increase in profitability from the second option outweighs the potential costs of fixing mixers.
- It is feasible to recommend weekend workers, as Dooly would be able to hire students or professionals who are willing to work during the weekend. In addition, it is also reasonable to hire an extra weekend worker only for Q3, as this quarter falls during the summer months of July to September. Consequently, the extra worker could be a college student who is willing to work only during the summer.
- Since our recommendation keeps the number of cutters and mixers constant throughout the year, no additional time or cost is added to the setup process.
- The task of changing batch sizes from quarter to quarter is unlikely to cause an increase in costs due to the nature of the task. In addition, we expect an increase in batch size to cause a negligible, if any, increase in task time.
- Having a low probability of not meeting demand would allow Dooly to bolster its service quality and reliability. More specifically, the store would have better relationships with the grocery stores as well as its in-store customers.
- While the increase in customization is likely to cause more defects, Dooly will still have excess capacity using our recommended setups to deal with these defects without affecting subsequent demand.
- We recommend using the same base dough for different customization options, as changing the dough for different batches would reduce machine availability for all processes to 80%. We modeled this for Q1 and found that Dooly would not meet demand 95% of the time (Appendix A), which makes this customization method undesirable.
- Also, our model assumed that the customized doughnuts would take 15 seconds for the customization step. However, this number is an estimate and is variable. Therefore, Dooly should make sure to keep the task time as close to 15 seconds as possible.

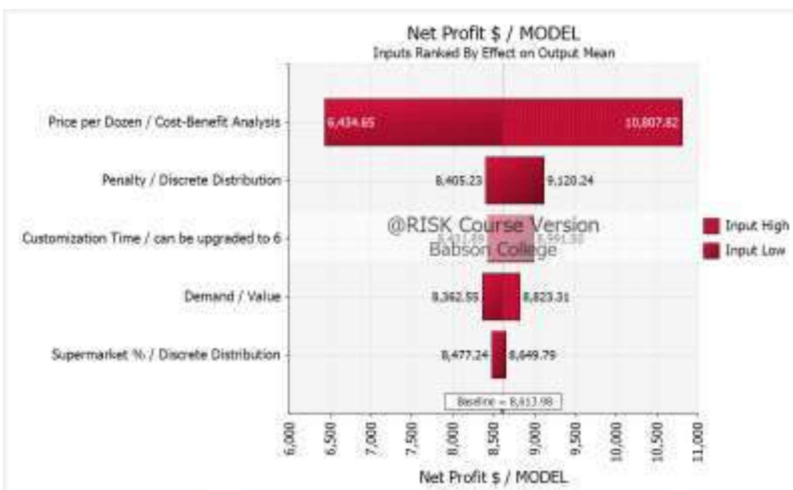
SENSITIVITY ANALYSIS

Figure 9 – Sensitivity Analysis for Capacity Utilization



The sensitivity graph above shows that demand has the highest effect on capacity utilization. The second most important variable, in terms of impact on capacity utilization, is the amount of time it takes for the customization step.

Figure 10 – Sensitivity Analysis for Net Profit



The sensitivity graph above shows that the price per dozen of donuts has the highest impact on net profit, and the amount of penalty imposed by the supermarket has the second-highest impact on net profit.

CONCLUSION

In summary, we determined that the best option for Dooly was to introduce customization in a manner that simultaneously kept up with demand. This step would help Dooly increase profits and would help the shop enhance its value proposition. Another factor we used to inform our recommendation was the relationship between Dooly Doughnuts and their grocery store partners. We believe that it is crucial to prevent stockouts not only due to their impact on profits but also to preserve long-term relationships with end-customers and business customers.

FURTHER CONSIDERATIONS

Although we recommend that Johnson's priority should be to introduce customization in an efficient manner that meets demand, we also highlight the following steps that could be taken to improve Dooly's business.

- Demand could potentially be increased to Q3 levels for other quarters using appropriate marketing campaigns and promotions because Dooly has the operational capacity to meet such demand. However, for this to be economically feasible, the cost of the marketing promotions should be lesser than the difference in profits between Q3 and the other quarters respectively.
- Another consideration could include the introduction of a specialty product specific to a season, as limited time offer, so as to increase demand in Q1, Q2, and Q4 (to match Q3). One example could be the introduction of a peppermint-filled doughnut for the winter quarter, which can be sustained by the flexibility in the customization process.
- Dooly can create a mobile application, kiosk, or a website to facilitate online orders, which would decrease the variation in its service rate, as Dooly would have more information about customer orders beforehand.
- In the future, Dooly could also consider using an automated process for customization instead of manual labor. While this option could decrease the time taken for the customization step, it requires a high capital cost of purchasing machinery and inhibits flexibility.
- To combat the potential increase in defects, Dooly could hire another worker who could work as a quality control measure. Considered an appraisal cost, the worker would increase the company's overall product quality.

APPENDIX

Appendix A - Customization with 80% Machine Availability