Three Rivers Pottery Studio Case Study

Background

Jamie opened Three Rivers Pottery Studio as a creative space for her community. It is a small pottery studio where customers can make clay pieces such as bowls, vases and decorative art. The studio has the space, tools, clay and glaze needed for customers to create their pieces. Glaze is a type of paint that will become hard and shiny when it is fired. The firing process hardens the clay or glaze through high-temperature heating. The business is small and operated solely by Jamie. During business hours Jamie checks customers in to make pieces out of clay or glaze their clay pieces or assists customers who are picking up their finished pieces.

To harden the clay pieces, they must be bisque fired in a kiln before they are glazed. After the pieces are glazed, they are glaze fired in the same kiln. Both the bisque fire and glaze fire processes are batch processes with long run times. After the store closes, Jamie empties the kiln from the previous day's fire and fills it up with pottery pieces for the next fire, so she can start the fire before leaving for the day and the pieces will have time to cool by the end of the next day. If the front desk is closed on a day that Jamie is willing to work, she can still unload and load the kiln on that day.

Problem Description

Jamie loves pottery and wants as many people in her community to enjoy the hobby as possible. She is willing to work up to 50 hours a week and wants the studio to be open to customers as much as she can. However, she will only work in the hours between 8 AM and 6 PM, Monday through Saturday. She can only unload and load the kiln while the front desk is closed, because she is not able to check guests in while loading or unloading the kiln. She needs to determine what time to close the store to have enough time to load the kiln without working more than 50 hours per week on average. She also needs to determine a good policy to decide which fire type to run on a given day.

System Description

Customers visit the studio three times to make a piece. The first visit is to make the piece out of clay. The customer can form the clay either by using a throwing wheel or by using hand tools at a table. When the customer makes the piece, the clay has enough water in it to be malleable. Therefore, the piece needs several days to dry and harden. After the clay piece is dry, it can be put into the kiln to be fired for the first time. After the clay is fired, it is hard and no longer water soluble. Because the process takes several days, the customer will go home after making the clay piece and is notified when their piece is fired. When the customer has time, he or she returns to the pottery studio to glaze the piece. After the piece is glazed it needs to be fired again. The customer goes home after their piece is glazed. When the glazed piece has been fired, the customer returns to pick up their finished piece.

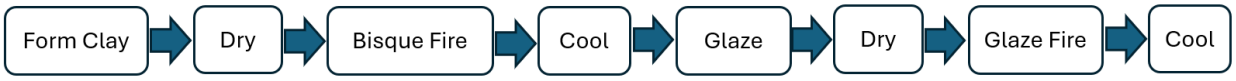

Figure A: The steps to making a ceramic piece.

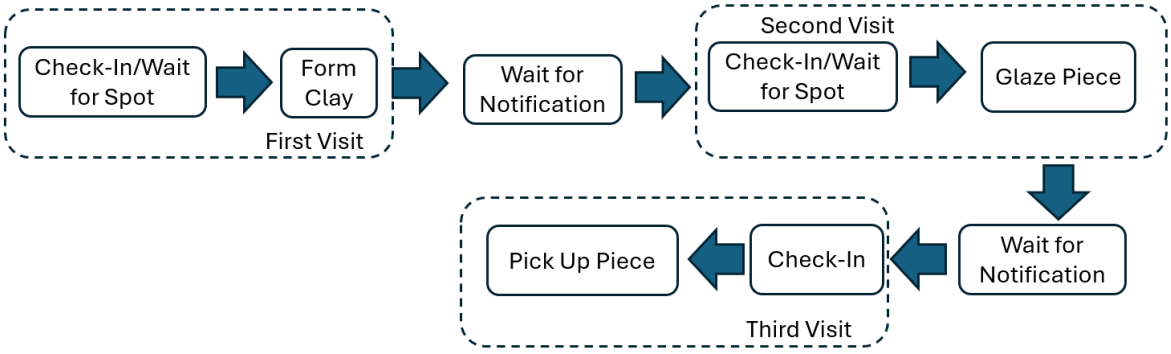

Figure B: The steps that the customer goes through to make a piece. It takes them three visits to complete their piece.

At the beginning of each visit to the store, the customer must check-in with Jamie at the front desk. If the customer is at the studio to make a piece out of clay, they either want to hand-build a piece or make a piece using the throwing wheel. If the customer has already made a piece out of clay, but not glazed the piece, they will only check-in and glaze their existing piece during the visit. If the customer has already glazed a piece, they will only check in and pick up their piece during the visit. There are three throwing wheels, one handmaking table and two glazing tables at the studio. There can only be one person throwing a piece on each wheel at a time. There can be four people at each of the tables at a time. The hand-building cannot be done at the glaze table and glazing cannot be done at the hand-building table. After checking in at the front desk, the customer stays in the front area of the store until there is a spot at the area for the activity they checked in for. The front area has space for 10 people. If the sum of the number of people checking in, waiting to check in and waiting for a spot at the area for their activity is equal to 10, additional customers arriving to the store will balk. Arriving customers will also balk if the front desk is closed. If a customer balks and it would have been their first visit, their business will be lost when they leave. For customers who are returning for their second or third visit, the customer will find another time to return to the store. After the front desk closes, Jamie will check in anyone who was already in the store at the time it closed, but will not check in anyone who has arrived after the front desk closing time.

After the posted store hours, Jamie goes to the back of the store to unload and load the kiln. Loading the kiln is putting pieces into the kiln one by one. The kiln must be emptied completely before she can start loading it again. The first time a piece is fired is called a bisque fire. The second time the piece is fired, after it has been glazed, is called a glaze fire. The two fire types have different temperatures and durations, so Jamie will only load one type of piece (glazed or not glazed) into the kiln for each batch fire. After the store has closed and Jamie has finished checking customers in, Jamie will decide if she will load and unload the kiln that day and what type of fire to do. If the pieces in the kiln are still cooling, she must decide if she wants to wait at the shop until they are cool or leave for the rest of the day. If she stays to load and unload the kiln, she will do these activities until the kiln is full or it is past 6 PM. If the kiln is full, Jamie will start the kiln and close the shop. Once it's past 6 PM she will start the kiln even if it is not full. Assume she will load pieces until the clock strikes 6 and then, if she is in the middle of loading a piece, will finish loading that piece, but will not load any additional pieces. Once the firing starts, no more pieces can be added until it has finished firing and cooling and the kiln has been emptied. If Jamie decides not to load or unload the kiln for any reason she can leave early, but she must wait until all the customers have left the shop to leave for the day. If there are still customers in the store after Jamie has started the kiln, she will wait for them to exit the shop before going

home. If the front desk is closed on a day that Jamie is willing to work, she can go straight to unloading or loading the kiln when she starts working. If Jamie comes in to work just to unload/load the kiln, she can start working later than 8 AM, but must still stop working at 6 PM.

Data Collection

The Studio Contains:

- One front desk, where Jamie can check people in, one person at a time
- One hand-building table with space for four people
- Three throwing wheels
- Two glazing tables for a total number of 8 glazing spots
- One kiln, which can fit up to 100 pieces in each batch run

The front area of the shop can only fit 10 people. This includes anyone waiting to be checked in, checking in or waiting to go to the glaze table, wheel or hand-building table.

Customers who want to create new pieces out of clay arrive at the store during open hours with an average interarrival time of fifteen minutes. The interarrival times are approximately exponentially distributed.

The following times were collected and fit to distributions:

Activity	**Time Distribution**	**Units**
Check customer in	Triangular (min=1.5, mode=2, max=7)	minutes
Form clay (hand-building method)	Triangular (min=22, mode=34, max=60)	minutes
Form clay (wheel method)	Triangular (min=10, mode=18, max=40)	minutes
Glaze piece	Triangular (min=16, mode=24, max=46)	minutes
Load piece into kiln	Weibull (shape = 10, scale = 0.5) per piece	minutes
Unload piece from kiln	Weibull (shape = 10, scale = 0.5) per piece	minutes
Bisque fire and cooling	26 (Deterministic)	hours
Glaze fire and cooling	18 (Deterministic)	hours
Clay dries enough to be fired	Triangular (min=3, mode=4, max=7)	days
Glaze dries enough to be fired	Triangular (min=4, mode=4.5, max=5)	hours

Customers are sometimes busy with other things when they receive the notification that their piece is ready to glaze or pickup. Therefore, there can be a delay between receiving the notification and returning for the next visit. The delay can be characterized by a Triangular Distribution with a minimum time of 2 hours, a mode time of 15 hours and a maximum time of 25 hours. If a returning customer balks, they will need to come back and

the same distribution applies for the time before they return. You can assume that the notification is sent as soon as the piece is unloaded from the kiln.

Sixty percent of customers who arrive to start a new piece want to use the throwing wheel to create their piece and the other forty percent want to hand-build their piece.

Project Deliverables

Jamie would like you to model the system and determine what time she should close the front desk each day and if the front desk should be closed on any days other than Sunday. She also wants you to produce a policy that dictates if she will load and unload the kiln on any given day and which fire to start on that day. On average, she wants to work no more than 50 hours per week. She is willing to work Monday through Saturday in the hours of 8 AM to 6 PM. Your solution should not result in her working more than 50 hours per week on average. The solution must result in a less than one percent chance that she will stay later than 6:03 PM on any day that she is willing to work. You may assume that the shelves where pieces dry and wait to be glazed, fired or taken home have unlimited capacity. Choose an appropriate run duration and warm up time for your experiments. Use the number of pieces taken home to measure the performance of your solution, where more pieces taken home by the end of the run indicates a better solution.

Summary

Your task is to create a model that can be used to evaluate different schedules for the front desk and help Jamie determine what fire to do each day. Jamie will check customers in during the front desk open hours and unload or load the kiln after the front desk closes. Jamie will not load or unload another piece into the kiln after 6 PM on any given day and will not work on Sundays. If there are still customers in the store at 6 PM, Jamie will wait until the customers have left to close the shop and go home. The chosen schedule should maximize the number of pieces taken home without causing Jamie to have to work more than 50 hours a week on average. The resulting solution should not cause Jamie to leave later than 6:03 PM more than one percent of the time. Your solution should have two parts: the front desk business hours and an explanation of how Jamie decides which fire to begin loading the kiln for. The front desk business hours should specify for each day of the week if the front desk will be open and, if the front desk is open on that day, what time the front desk will close.

Hints

- The Counter Element can be used to track attribute-based counts of entities in the system.
- Seize Constraint Logic can be used to enforce additional requirements for a resource's capacity to be seized.