San Luis Obispo Public Winery Transit System

by

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Abstract

This project designs a small scale transit system that runs between five wineries in San Luis Obispo. San Luis Obispo County is known for its many wineries ranging up and down the central coast. Transportation options for wine tasters are limited to tour bus, limousine, taxi, and private cars. This does not leave an option for wine tasters who prefer a cheaper mode of transportation than limo, tour bus, or taxis, and do not want the hassle of driving and worrying about how much alcohol they consume. Selection criteria methods were used to choose bus stop locations at a specified number of wineries. In order to do this, a survey of Cal Poly students and surrounding wineries was taken and analyzed. Operations research techniques were used to select an optimal route for the bus that will reduce travel time and waiting time for passengers. Finally, a simulation verified the proposed solution and determined an optimal number of buses and ticket price. The final design is integrated with the San Luis Obispo Transit System by connecting with the Downtown Transit Center in the city. Five year projections show that implementation of this system will result in profits of $354,829 while offering San Luis Obispo community members a safer, cheaper, more convenient way to wine taste.

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Introduction

San Luis Obispo County is known for its vast amount of breathtaking wineries, from Paso Robles to San Luis Obispo City to Arroyo Grande. Visitors flock to the wineries, with the most popular customers being Cal Poly students, local community members, and tourists. However, deciding who wants to be the designated driver is often an issue associated with wine tasting, and calling a cab can be very pricy. Formal wine tours and limos are also expensive, and are not an option for people who choose to wine taste spur of the moment. This project will design and a permanent and reliable public transit system to run between a select number of wineries in the City of San Luis Obispo. The transit system will provide customers with the option to relax when tasting while still making smart and safe decisions.

The final design will include recommendations for the best route for the transit system. The route will stop at an optimal number of wineries in San Luis Obispo, choosing the most popular wineries. Since weekdays can be slow for wine tasting, the transit system may by more costly than beneficial on these days. The days of the week that would bring in a sufficient revenue should the transit system be used will be chosen. Also, number of vehicles and staffing will be analyzed and included in the economic analysis.

A variety of analytical techniques will be used to determine the best solution to this problem. Different topics in operations research, such as the greedy algorithm will be used to design the schedule of the system. A simulation will provide a full analysis of the system to determine flow of passengers through the system.

Background

Currently, transportation while wine tasting consists mostly of customers driving their own cars to and from wineries. However, there are alternate, but pricy, modes of transportation as well, including taxis, limos, and bus tours. This background will fully investigate the topics related to the public wine transportation design project, including current methods of transportation among wineries and the SLO Transit system.

Current Transportation among Local Wineries

While wine tasting, visitors can choose from among a few methods of transportation to get around: wine tours (bus or limousine), personal transportation such as a car, or cab. Wine tours can be extremely expensive, ranging from 50 to 200 dollars, depending on the mode of transportation.

Wine tours through a limousine company or tour bus company are very pricy. Listed below are some of the going rates for a limousine or tour bus in San Luis Obispo County:

- Central Coast Limousine Service- $70 to $90 per hour (limousine fits 10 people) [1]
- The Wine Wrangler- ½ day tours range from $52 to 59 per person [2]
- Crown Limousine LLC- $100 to $130 per hour with 4 hour minimum (limousine fits 10 to 15 people) [3]
- Central Coast Trolley Company
    - Five Hour Wine Tour- $68 to $75 per person [4]
    - Private Trolley Charter- $150 to $165 per hour (2 to 66 guests) [4]

    - Van Rental- $300 for first three hours, $75 per hour thereafter (2 to 10 guests) [4]
- Breakaway Tours and Event Planning- $109 to $129 per person [5]

As shown above, it is almost impossible to tour and wine taste at wineries around San Luis Obispo for less than $50 dollars.

Most people opt for a more laid back experience due to time and money restraints. They don't want to spend the money for a tour, only want to wine taste for one or two hours, or decide to taste spur of the moment. This requires driving in a personal car or finding someone to be the designated driver. However, a personal interview with Heather Rehnberg from Tolosa Winery confirmed that traffic through wineries is much higher on weekends (Friday, Saturday, and Sunday) than it is on weekdays [7]. After talking with Tolosa, Saucelito Canyon, and Baileyana-Tangent Wineries, a ballpark percentage of those who arrive to taste in a personal car on a Friday, Saturday, or Sunday are shown in Table 1 below. Furthermore, according to these same wineries, about one hundred and fifty people wine taste on an average Saturday, and about one hundred taste on an average Sunday [7].

Winery	%
Saucelito	**75-80 [6]**
Tolosa	**85-90 [7]**
Baileyana -Tangent	**87.5 [8]**

Table 1: Percentage of Wine Tasters who Arrive Using Private Car

Comparing the results from these three wineries shows that the majority of wine tasters arrive by a personal mode of transportation.

Another option available to wine tasters is a service called Destination Drivers, a fairly new service on the market. This service provides a designated driver (along with some complimentary snacks) to drive the customer's car around, with the idea that this allows the customer to be in the most comfortable transportation out there—his or her very own car. This service costs $30 per hour with a three hour minimum, totaling to no less than $90 [9].

The final mode of transportation for tasters is by taxi. This can also be costly, as a quote from 234 Taxi shows a pickup fee of $3.00, then $3.50 per mile after that [10]. Traveling one mile already costs $6.50, and the likelihood of only having to travel a mile is extremely low. Katherine Taylor from Saucelito Canyon estimates that less than 1% of wine tasters on the weekends travel by taxi [6].

The information given above shows the need for an inexpensive, efficient, and safe way to provide customers with the ultimate wine tasting experience.

SLO Transit

The City of San Luis Obispo Transit currently offers seven routes and a trolley that runs in the downtown area. The figure on the next page is taken from Short Range Transit Plan San Luis Obispo Transit Final Report, written in 2009, showing the mapped routes in San Luis Obispo [17].

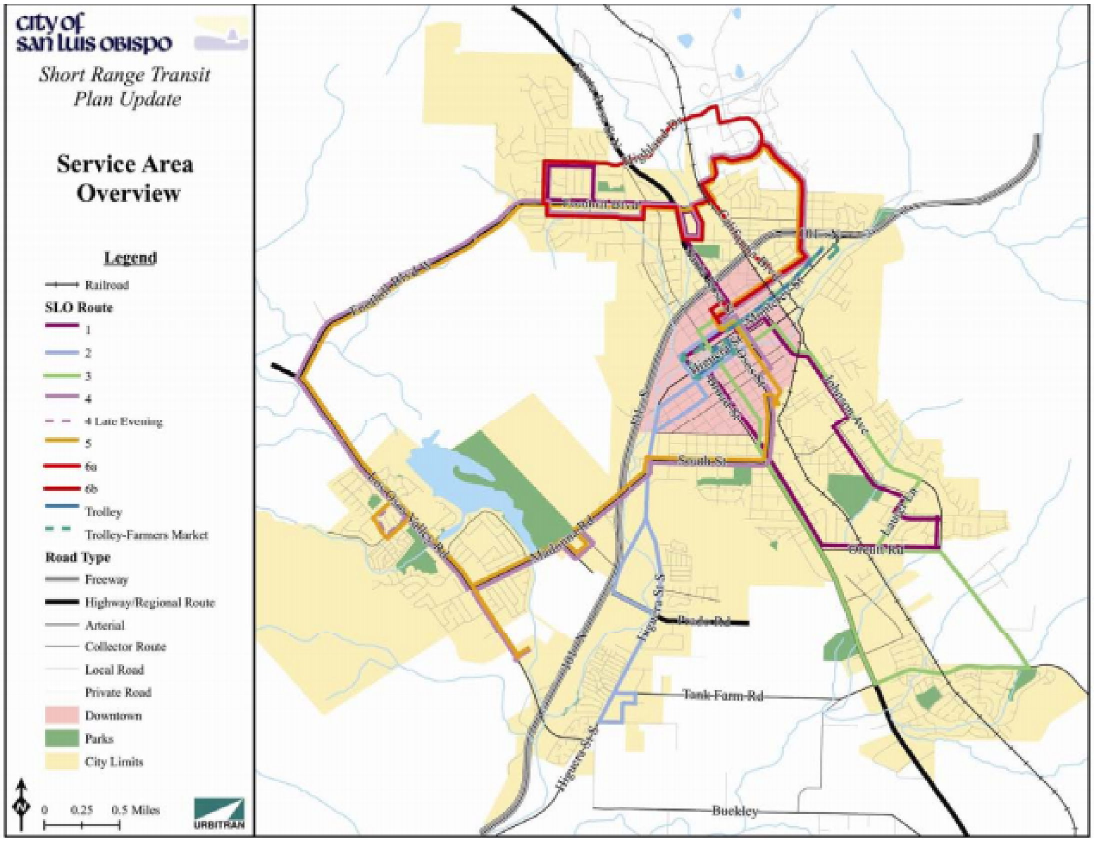


Figure 1: San Luis Obispo Transit Network [17]

Vehicles operate various hours on different days of the week. The table below shows the approximate daily operating hours given in the report mentioned above [17].

Day	Vehicle
Sunday	45
Monday	119
Tuesday	119
Wednesday	119
Thursday	125
Friday	115
Saturday	57

Table 2: Daily Hours of Vehicle Operation [17]

The trend is that hours of operation decrease significantly on Fridays, Saturdays, and Sundays. Peak number of vehicles on Friday is 8, and 7 on Saturdays and Sundays [17]. Thursday PM has the highest peak of the week, requiring 10 vehicles, meaning weekends do not use all available buses and trolleys [17]. The entire fleet size is 14 vehicles, which are stored, fueled, and maintained at 29 Prado Road in San Luis Obispo [17].

The regular fare for the bus is $1.00 and $0.25 for the trolley, however many discounts and packages are available to community members and students [17]. This $1.00 fee pays for a one way bus ticket on a route, unless other packages have been bought [17]. Discounts are offered for seniors, and the fare is prepaid for Cal Poly Students [17]. The report indicates that in 2006, only 17% of revenues came from passenger fare, and the largest source of revenue was state funding [17], as shown in Figure 2 on the right.

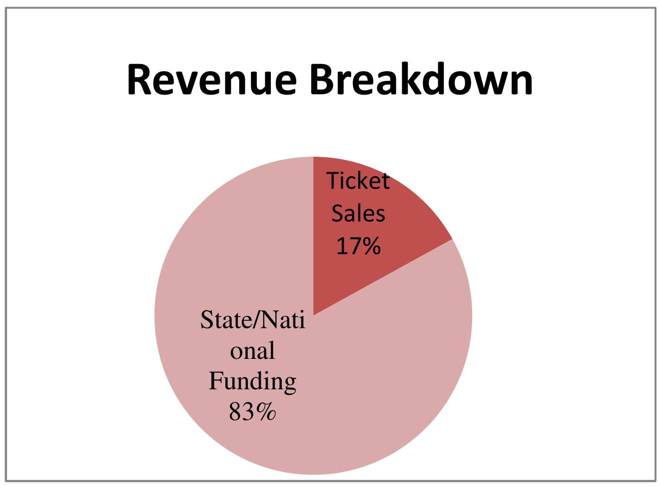


Figure 2: SLO Revenue Breakdown

The current SLO Transit System can be modeled when creating a new bus system because it provides insight on generation of revenue through the system and number of vehicles needed for routes depending on peak hours.

Literature Review

This literature review will investigate topics related to the public wine transit system, from the use of operations research in scheduling to simulation modeling of transit systems. The exploration of these topics aims to educate the reader with enough information to fully understand the context of this project.

Operations Research

Optimization within transportation systems has become known as the vehicle routing problem (VRP), a topic that has been extensively researched over the years, from Steenbrink (1974) [11] to Hillier et al. (2005) [12]. Topics such as linear programming and shortest-path methods have been used for route optimization, as well as many other algorithms contributing to VRP. Simulation is among the tools used to aid in analysis of transit systems.

Linear Programming

Steenbrink states the decision variables to be the number and location of stations, travel mode, route, pricing system, and parking facilities [11]. The purpose is known as the objective function, of which many different possibilities exist for transport network optimization problems [11]. A reasonable one would be to maximize the difference between benefits and costs [11]. Hillier et al. describes the objective function to be the final measure of the performance, whether it is customer satisfaction, maximize revenue, minimize costs, etc. [12].

Travelling Salesman Problem

The travelling salesman problem (TSP) is used in many applications for finding the shortest path given a list of locations that visits each location only once. A TSP can be either symmetric, meaning the distance from A to B equals the distance from B to A, or asymmetric, where the distance from A to B differs from B to A. An example of this is flight distances—travel routes are different because of wind directions and inability to fly close to other planes. When performing a TSP, it is assumed that the triangle inequality is always satisfied. This specifies that in all cases, distance from A directly to C will be shorter than taking A to B and then B to C. Heuristic solutions that exist to solve the TSP include pairwise exchange, k-opt, V-opt, greedy algorithm, Markov Chains, constant-factor approximation, Euclidian minimum spanning tree, and polynomial time-approximation scheme. A few of these will be discussed in further detail below.

An important application of the TSP is in manufacturing environments where one machine performs several different tasks throughout the day that require setup times. Using the TSP, total setup time can be minimized and the optimal order of the tasks can be determined.

Shortest-Path and Greedy Algorithm

Shortest-path method and greedy algorithm are typically used to find the shortest path among a known network. This includes finding the shortest path from one node to another node, finding shortest path from one node to all other nodes, or finding the shortest path between all nodes, according to Steenbrink [11]. The purpose of this is to minimize operating costs and costs for the user [11]. Over the years these algorithms have progressed and developed. Hillier et al. focuses on undirected, connected networks with the objective of finding the n^{th} nearest node to the origin, providing information on how to use Excel to solve relatively simple shortest-path

problems [12]. Other applications of the shortest-path include minimizing total cost and minimizing total time [12].

Other Algorithms

Many other methods have been analyzed and used to implement transit systems. Christodoulou uses the Entropy Maximization method to determine bus routes, while Bin Yu et al. discusses a genetic algorithm that generates optimal frequency for buses. Christodoulou's method consists of creating an algorithm that determines the traffic flow to different parts of the city (or desired location of study) [13]. Once this flow is determined it can be analyzed and optimal bus route and frequency can be chosen for implementation [13]. Yu's method uses a bi-level model—the lower level assigns transit trips based on optimal strategy while the upper level optimizes frequencies based on passenger assignment [14]. The result of this bi-level model is an increased service level and a minimum total travel time for passengers [14].

Simulation

Simulation is a decision support tool that aids improvement in service industries [15]. Harrell et al., in their book Simulation Using ProModel, point out many applications of simulation, such as capacity planning, staff and resource planning, layout analysis, resource scheduling, etc. [15]. When choosing a system to simulate, one must first adhere to the following criteria: a logical or quantitative decision is to be made, the process can be clearly defined and is repetitive, and it must be worth the cost of doing the simulation [15]. System elements are then clearly defined; the system is abstracted and simplified by drawing a logical model, data is collected, and finally the simulation is created [15].

Rabi Mishalani et al. discusses the use of simulation in the article Evaluating Real-Time Bus Arrival Information Systems. Mishalani uses a stochastic model [16], defined by Harrell et al. as one that has random inputs and outputs [15]. Real-time bus location provides accurate arrival times for busses, allowing for maximum utilization by passengers [16]. Simulation shows how the accuracy of this developing system is largely dependent on the type of real-time information that is available [16]. Simulation is used widely in VRP to reduce passenger wait times, total run times, total service time, and find optimal resource allocation.

These operations research and simulation methods are applicable to determining the bus route, frequency, and analysis of flow for this project; however, they have never been used in this particular manner before. Therefore these same techniques and methods used on city transit systems discussed above will be attempted but may not be exactly replicated.

Design

In this section the steps used to arrive at a proposed transit route design will be discussed in detail. This can be divided into initial winery selection, winery evaluation, and the greedy algorithm.

Initial Winery Selection

The first step in completing the project was to narrow down the number of wineries that will be analyzed in the project. A list of all the wineries in SLO and the surrounding cities was created, including information such as telephone number, address, tasting hours, contact person, and any additional information to note about the winery (See Appendix, Table 10). Full information regarding each winery was recorded for time saving purposes down the road—should a winery be chosen to add to the transit route at any time, the information about the winery is already stored. From there, the wineries were eliminated from the list if:

- They were located outside San Luis Obispo or edge of Arroyo Grande.
- They were not located on a vineyard.
- They did not have a tasting room.

As you can see from Table 10, the wineries highlighted in red were eliminated from further analysis based on the above criteria. These criteria were set based on two assumptions. The first is if a wine taster went out to the vineyards to wine taste, they would only make stops at vineyards. Some wineries had a tasting room in downtown San Luis Obispo or nearby in town; however, in this project, it is assumed that a wine taster will not make a stop at both a vineyard and a tasting room downtown—only vineyards. The second assumption is that a wine taster would not make a

stop at a winery that did not have a tasting room. Using these assumptions, the list of wineries was narrowed down significantly. The last of the three criteria used to narrow the scope was that a winery had to be located in San Luis Obispo or the very edge of Arroyo Grande to be considered. Using these criteria, the list of wineries to be analyzed as a possible stop for the transit system was narrowed to thirteen wineries, listed below. Also, refer to Figure 7 in the Appendix to see a map of these winery locations in San Luis Obispo.

Wineries	
•Baileyana/Tangent	•Per Bacco Cellars
•Chamisal Vineyards	•Salisbury Vineyards
•Claiborne & Churchill Winery	•Saucelito Canyon/Ortman Family Vineyards
•Edna Valley Vineyard	•Sextant
•Kelsey See Canyon Vineyards	•Talley Vineyards & Bishop's
•Kynsi Winery	•Tolosa Winery
•Wolff Vineyards	

Table 3: List of Wineries to Be Analyzed for Transit Route

Winery Evaluation

In order to narrow down from this list of thirteen wineries to a desired five wineries for the final transit route, different criteria to determine the best winery were brainstormed. These were criteria such as quality of wine, atmosphere, distance from home, service quality, etc. However, the problem with these criteria was that some were qualitative (wine quality, for example) and

some were quantitative (for example, distance from home), so a method of determining how to rate the wineries still needed to be defined.

Different possible methods to determine the best criteria were through surveys—two surveys types were considered in this process. For both surveys, the participant ranked the given criteria from one to six. A criterion that received a one meant that it played a large role in determining where that person would wine taste, while a criterion that received a score of six meant that it had little weight in determining where that person would taste. After the survey, each criterion would be given a weight of importance in determining what vineyards a person would go to.

The difference in the two survey types was the type of criteria being scored. The first survey asked about qualitative criteria, such as wine quality, indoor/outdoor atmosphere, friendliness of staff, etc. The survey would also need to include each surveyor's opinion of the criteria. Not only would it ask about what criteria are most important, but it would ask their opinion about wine quality, atmosphere, etc. on a scale of one to ten (one is best, ten is worst). The score for each winery's criteria would be multiplied by the weight of the criteria, then all added together to give a total score (lowest score is best). The second survey method would be to evaluate each winery based on quantitative criteria, such as distance from home, restaurant on site, size of seating area, etc. The surveyors would rate each criteria the same way as described in survey one. Then, each winery would be researched and given a score (one through three) for each criteria. This score would then be multiplied by the criterion weight and all added together to give the winery a total score.

The advantages and disadvantages of each type of survey were analyzed. An advantage of survey style one was that it did not require any further research once the survey was completed,

while survey style two required further research for all thirteen wineries. However, finding one hundred people to take the survey that were familiar enough with all thirteen wineries did not seem feasible. It would not be easy to find one hundred people who were familiar enough with all thirteen wineries so they could rate them on each criterion. For that reason, survey style two (quantitative criteria only) was chosen. The final six quantitative criteria are listed below.

1. Distance from Downtown Transit Center (DTC)
2. Tasting price
3. Restaurant on site
4. On-site tours available
5. Size of outdoor seating/picnic area
6. Outdoor activities offered (bocce ball, horseshoes, etc.

The survey asked to put the given criteria for choosing a winery in order from one to six, one being most important and six being least important. Refer to Figure 8 in the Appendix to view the questionnaire. The results of the survey are shown below in Figure 3 below.

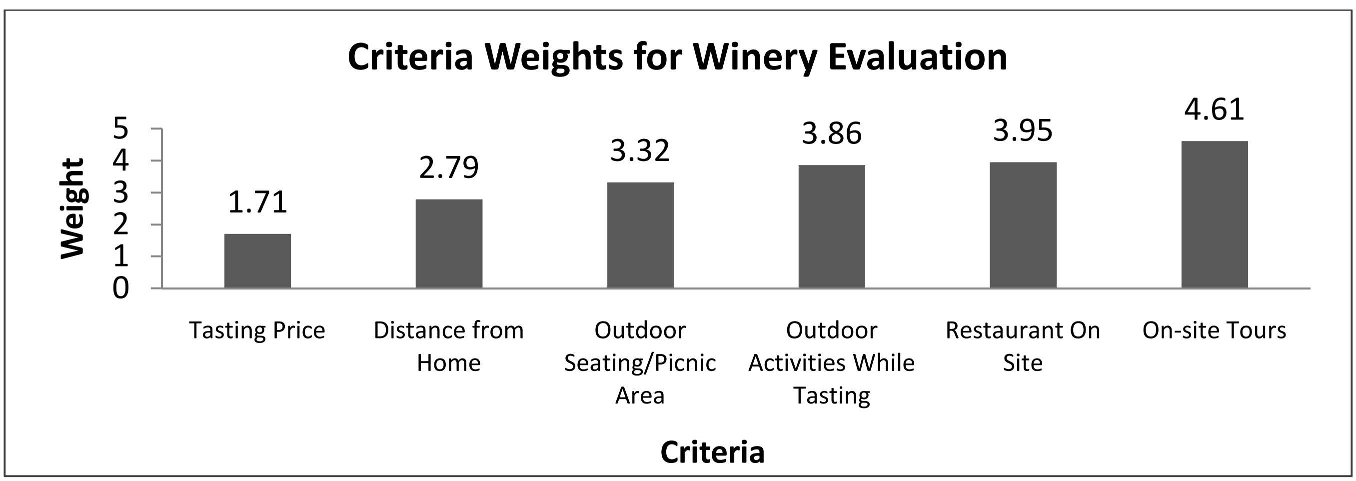


Figure 3: Final Criteria Weights

Among the criteria listed, tasting price was the factor that had the most importance when choosing where to wine taste. This was followed by distance from the DTC, then outdoor seating/picnic area size, outdoor activities offered while tasting, restaurant on site, and finally on-site tours.

The next step was to rate each winery with respect to each of the chosen criteria. In order to do this, information had to be collected on each of the wineries by online research and speaking directly with the wineries. An email was sent to each of the thirteen wineries asking them simple questions, located in the Appendix, under Winery Information Request Email. Also in the Appendix, Table 11 is a completed summary of information on all thirteen wineries for each criterion. From this table, the wineries were given a rating, described below.

For the first criterion, tasting price, the winery's price to wine taste was listed as their score. A lower price is better; then multiply that by the weight of the criterion to get a score. The next criterion looked at distance from DTC. To do this, the winery's distance in miles from the DTC (calculated by Google Maps) was listed as the score. This score multiplied by the weight of the criteria (lowest is best) gave the winery a score for that criterion. Third, each winery was scored on their outdoor seating and picnic area. The email sent to each winery asked them to state the size of their outdoor seating and compare it to other wineries. They were then scored a 1 (biggest), 2 (medium), or 3 (smallest) based on the winery's response to the question, and that number was multiplied by the criterion weight to receive a score. The same process was done for outdoor activities (score of 1 if they had two or more activities offered, score 2 if they had one activity, and score 3 if they offered none), and it was also done for restaurant on site (1 for full restaurant, 2 for light snacks, 3 for none). When scoring on-site tours available, it was assumed that the most desirable tour for passengers on the transit system was one that didn't need a reservation. It would

be difficult to time a tour with the transit system, and oftentimes passengers who are utilizing the system are "spur of the moment tasters", unlike those that reserve limos or take a tour. Therefore, wineries with walk-in tours available scored a 1, wineries with reservation only tours scored a 2, and wineries with no tour offerings scored a 3. See Table 4 below for an example of the score calculated for Baileyana/Tangent.

	Distance From DTC	**Tasting Price**	**On-site winery tours**	**Restaurant on site**	**Outdoor seating/picnic area**	**Outdoor activities**	
Weight	2.79	1.71	4.61	3.95	3.32	3.86	**Score**
Baileyana/Tangent	5.8	5	3	1	2	1	**53.01**

Table 4: Baileyana/Tangent Final Score Evaluation

The final score for Baileyana was 53.01 after multiplying each score by the weight of that criterion. Table 12 in the Appendix shows the full table with each winery and their final score.

The two wineries highlighted in red, Per Bacco Cellars and Salisbury Vineyards, both had very low scores. However, they were not chosen to be part of the final wineries. Their distance to DTC was very low and therefore resulted in a low total score, but this distance was in the other direction from the other cluster of wineries. Therefore, they were excluded and the next five wineries with the lowest scores were chosen. The final five wineries were:

- Baileyana/Tangent
- Edna Valley Vineyard
- Saucelito Canyon/Ortman Family Vineyards
- Tolosa Winery
- Wolff Vineyards

Greedy Algorithm

After choosing the five wineries at which the transit route will stop, the shortest route for the bus to take in order to reduce travel time must be determined. Reducing travel time not only reduces time for passengers on the bus to get to their destination, it decreases waiting time for people at bus stops as well as reduces gas and maintenance costs by traveling less total miles.

The first step is to complete a matrix that shows the measurement units between every location. This includes the five wineries and the DTC and measures the distance in miles between every location. This matrix is shown below in Table 5.

	SLO DTC	Baileyana/ Tangent	Edna Valley Vineyard	Saucelito Canyon	Tolosa Winery	Wolff Vineyards
SLO DTC	**0**	**5.8**	**6.2**	**6.5**	**4.4**	**6.6**
Baileyana/Tangent	**5.8**	**0**	**1.1**	**0.7**	**3**	**0.8**
Edna Valley Vineyard	**6.2**	**1.1**	**0**	**0.4**	**1.8**	**0.9**
Saucelito Canyon	**6.5**	**0.7**	**0.4**	**0**	**2.3**	**0.5**
Tolosa Winery	**4.4**	**3**	**1.8**	**2.3**	**0**	**2.8**
Wolff Vineyards	**6.6**	**0.8**	**0.9**	**0.5**	**2.8**	**0**

Table 5: Distance in Miles between Transit Route Locations

The next step is to perform the Greedy Algorithm. First, start with the DTC location and find the closest location—Tolosa Winery with a distance of 4.4 miles. Then start at Tolosa, and find the next closest location that has not yet been travelled to. This location is Edna Valley Vineyard with a distance of 1.8 miles. Repeat this iteration until all locations and been reached, then the last stop on the route will be back to the DTC. See Figure 4 on the next page for the designed order that the transit system will follow and Figure 5 just below that for the placement of the wineries on the San Luis Obispo Map. This algorithm was verified to be the optimal solution

by eliminated all other possibilities one by one when it is clear the solution is longer than the greedy-selected route.

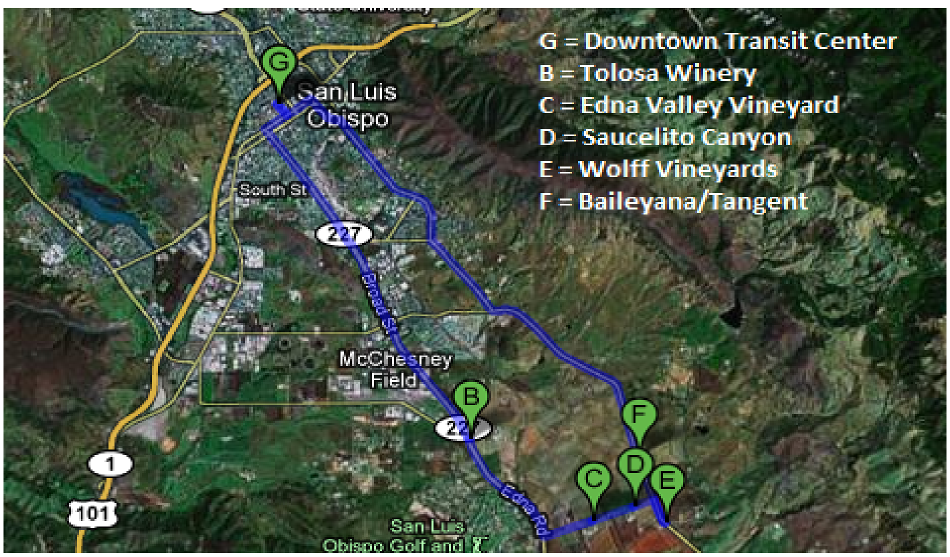


Figure 5: Final Transit Route Design

Methods

This section will discuss how the above design is analyzed and evaluated using a simulation and economic analysis in order to come to an economically sound and optimal solution. First, economic analysis will be detailed fully, and that will lead into the purpose of the simulation.

Economic Analysis

This economic analysis will clearly portray the success of the Winery Transit System forecasted through the next five years based on two variables—ticket price and number of vehicles purchased. The initial hope of this project was that the Winery Transit System would be integrated with the SLO Transit System, possibly using public buses that aren't in use and sharing bus stops. According to John Webster, the Transportation Manager for the Transit System, it is not feasible to use SLO buses when they have down time. These buses were purchased with state and national funds for a public transit system, so any and all use of these vehicles must be for that system, meaning fares would need to be the same. For this project that is not an economically sound solution. However, Webster noted that number of vehicles operating on weekends is lower than all other days of the week, so integration of the Winery Transit System with the DTC is feasible. The economic analysis will assume that all buses must be purchased, but the use of the DTC is feasible and has no costs.

To begin, the following data regarding annual expenses were researched and assumed.

- Midsize Bus: $60,000 (variable)
- Storage Cost: $495
- Operation Hours: 600
- Labor: $15/hr (2% inc./yr)
- Gas & Maintenance: $0.80/mi

A midsize bus that could hold ten to sixteen people was around $60,000 to purchase. Buses will need a place to be stored when not in use; local storage areas cost about $500 to store a midsize bus outside for a year. Operation hours were determined by multiplying twelve operating hours per weekend (six on Saturday, six on Sunday) multiplied by the number of operating weekends, assume to be 50 (two holiday weekends) to total 500 hours. Labor for bus drivers was estimated to be $15 per hour with a 2% increase each year, and gas and maintenance was estimated at $0.80 per mile.

The following estimates were used to calculate projected revenue:

- 60 customers on Saturday (10% inc./yr)
- 50 customers on Sunday
- Ticket Price: $10-25 per person (variable)

When asked how many wine tasters a winery services on an average Saturday, most wineries replied an average of 150 people, as stated in the Background section above. Also stated in the Background section above, about 80% of all wine tasters arrive in a private car (instead of by tour bus, limo, or taxi). This translates to about 120 customers on an average Saturday who arrive in a private car. The SLO Winery Transit System aims to attract half of these customers to use the transit system instead of a car; meaning about 60 customers will ride the transit system on an average Saturday. This same process was completed for an average Sunday—a total of 50 customers. Ticket price will vary depending on number of buses purchased. Table 6 shows the breakdown for the five year projection with a ticket price of $15 and one bus purchase.

Economic Analysis for 1 Midsize Bus, Ticket Price $15									
Year 1		Year 2		Year 3		Year 4		Year 5	
Expense		*Expense*		*Expense*		*Expense*		*Expense*	
Overhead	$60,495.00	Overhead	$495.00	Overhead	$495.00	Overhead	$495.00	Overhead	$495.00
Labor	$9,000.00	Labor	$9,180.00	Labor	$9,363.60	Labor	$9,550.87	Labor	$9,741.89
Gas & Maintenance	$7,905.88	Gas & Maintenance	$7,905.88	Gas & Maintenance	$7,905.88	Gas & Maintenance	$7,905.88	Gas & Maintenance	$7,905.88
Total	$77,400.88	Total	$17,580.88	Total	$17,764.48	Total	$17,951.75	Total	$18,142.77
Revenue		*Revenue*		*Revenue*		*Revenue*		*Revenue*	
Ticket Sales	$82,500.00	Ticket Sales	$90,750.00	Ticket Sales	$99,825.00	Ticket Sales	$109,807.50	Ticket Sales	$120,788.25
Profit		*Profit*				*Profit*		*Profit*	
$5,099.12		$73,169.12		$82,060.52		$91,855.75		$102,645.48	
								Total Revenue	**$354,829.98**

Table 6: Summary of Revenue for 1 Midsize Bus & Ticket Price $15

As seen, total revenue is $354,829.98 for five years, a very profitable business for only operating twelve hours per weekend. However, further bus purchases may be necessary in order to service all the passengers in a timely manner. If this is so, ticket price must be increased in order to keep the business profitable. Below, Table 7 shows a summary of the five year profits for different ticket prices and number of bus purchases.

Price/# of Vehicles	1	2	3
$10	$186,939.73	($85,861.05)	($482,621.82)
$15	$354,829.98	$82,029.20	($314,731.57)
$20	$522,720.23	$249,919.45	($146,841.32)
$25	$690,610.48	$417,809.70	$21,048.93

Table 7: Projected Profits in Five Years with Variable Price and Bus Purchases

It is clear that with the increase in number of bus purchases, profit decreases dramatically. Therefore, it does not seem economically sound to buy more than one bus unless ticket price is raised significantly. However, this project aims to offer a cheaper solution to wine tasting in a limo or tour bus, so if ticket price is raised too much the transit system will lose customers. A simulation was built to determine necessary bus size, and to see whether more than one bus purchase is necessary. This will help determine final optimal ticket price for the transit system.

Simulation

As stated earlier, the purpose of this project is to design a transit system that will stop at an optimal number of wineries in San Luis Obispo for wine tasters on the weekends. A simulation was created to test the design discussed above and to help visualize the idea of the SLO Winery Transit System. The purpose of the simulation is to determine bus size and number of necessary buses. First, a few assumptions had to be made about the model before it could be created. The assumptions are:

- Nobody stops at zero wineries
- No one wants to backtrack to a winery
- No one gets an alternate ride leaving a winery

When creating a simulation, much data collection is required in order to begin. However, the SLO Winery Transit System has no historical data, nor is there any existing system similar to this one. Therefore, all data is approximated as best as possible. The first piece of data is entity arrival rate. Normally, a time study would be conducted on how often a customer arrives at the starting location. In this case, arrival rate was determined by the estimated number of customers per day divided by the total number of operating hours for that day. Stated above in the economic analysis, the Winery Transit System will aim to process about 60 customers on an average Saturday. Tasting hours for all five the wineries are from 11:00 AM to 5:00 PM, a total of six hours. The transit system will run for these six hours, and assuming that 60 people go through the system per day, that is about 10 passengers per hour or one passenger every six minutes. Historical data shows that customers arrive in a system at an exponential rate, and therefore the final arrival rate used in this simulation is an exponential distribution with one passenger every six minutes.

Number of occurrences for passenger arrival was set to sixty passengers to attempt to decrease number of passengers left behind at the wineries at the end of the simulation. See figure 6 below for the layout of this information in the ProModel program.

Arrivals

Entity...	Location...	Qty Each...	First Time...	Occurrences	Frequency
WineTaster	Bus_Stop	1	0	60	E(6)

Figure 6: Arrival Rate and Occurrences in ProModel

Next, the amount of time spent by a customer at each winery had to be set. The Winery Information Email in the Appendix asked how long customers usually stay at the wineries when wine tasting and the answers ranged from about thirty minutes to an hour and a half. Based off of this information, the distribution for each customer service time at a winery was set to a normal distribution with average of an hour and a standard deviation of eight minutes. After running the model, this gave a approximate range of numbers between thirty minutes and ninety minutes.

This model unfortunately does not model the real system very accurately, as the ProModel resource tool is limited in its capabilities. In a public transit system, a bus follows a set schedule and spends a designated amount of time at each stop—the desired waiting time for this system is 5 minutes at the DTC and 3 minutes at each winery. The resource tool does not allow the resource, the bus in this case, to wait at a location for a period of time. It will only move to a location if an entity is waiting or if the entity is utilizing the resource and on route to a location. Once at a location it will not wait unless that location is the resource's home (place to wait while idle). For this reason, the system was set to run with a warm-up period of twelve hours to distribute

customers evenly throughout the wineries, and then the next six hours were analyzed. This warm-up also required the number of occurrences for passenger arrival to triple to 180 arrivals, thus spread out over the three six hour time periods.

Results

Analyzing the simulation of the SLO Winery Transit System provided insight into how many buses are necessary to keep passenger waiting time low at all bus stops and minimize total travel time.

The simulation was unable to model the transit system in that the bus could not wait at a location for a specific amount of time. To analyze the size of the bus necessary to keep passengers moving through the system, the maximum number of entities waiting at a location was considered. See Table 8 below.

Name	Scheduled Time (HR)	Capacity	Total Entries	Avg Time Per Entry (MIN)	Avg Contents	Maximum Contents
Tolosa q	6.00	999999.00	46.00	33.53	4.28	11.00
Enda q	6.00	999999.00	46.00	38.67	4.94	10.00
Saucelito q	6.00	999999.00	51.00	32.06	4.54	12.00
Wolff q	6.00	999999.00	51.00	52.54	7.44	13.00
Baileyana q	6.00	999999.00	51.00	31.31	4.44	10.00

Table 8: ProModel Results of Location Queues

Maximum contents show that no more than 13 passengers waited at a winery at any time in the six hour period that was analyzed. This means that one bus is sufficient for the predicted arrival rate and the number of passengers that will use the SLO Winery Transit System.

This model was set up so that the bus did not wait at any location; it picked up the first group of waiting passengers and moved on. Therefore, it may be beneficial to also look at how many loops the bus made. Table 9 below shows the number of times the bus stopped at each node (location).

WineriesModel.MOD (Normal Run - Rep. 1)			
Node Name	**Path Name**	**Total Entries**	**Blocked Entries**
N1	Road	12.00	0.00
N2	Road	11.00	0.00
N3	Road	11.00	0.00
N4	Road	11.00	0.00
N5	Road	11.00	0.00
N6	Road	11.00	0.00

Table 9: Number of Entries at Each Location

The bus stopped at each winery, N2 through N6, eleven times in the six operating hours, and it stopped at the DTC twelve times, since it started at ended the loop there. If the system were to add in a three minute waiting time at each winery and a five minute waiting time at the DTC, the number of loops would be reduced. However, this is only twenty minutes extra to each loop, so it would go down to about six or seven loops. This is a good number of loops to keep passengers flowing through the system at a constant rate.

Conclusions

San Luis Obispo County offers various modes of transportation to wine tasters, from tour bus to limousine to taxi. Wine tasters also have the option to drive their own car, and data shows that the majority of people choose this method. However, these options can be pricy, inconvenient, and at times unsafe. The SLO Public Winery Transit System targets these three problems—it is a cheaper alternative to a limo or tour bus, it is conveniently integrated with the SLO Transit system at the DTC, and it reduces intoxicated driving through the city.

- Transit system will run Saturday and Sunday 11:00 AM to 5:00 PM
- Start at DTC in SLO and make 5 stops in the following order:
    1. Tolosa Winery
    2. Edna Valley Vineyard
    3. Saucelito Canyon
    4. Wolff Vineyards
    5. Baileyana/Tangent
- One midsize bus purchase and a ticket price of $15
- Greedy Algorithm proved to be a good method of determining bus route, but in more complicated problems a more sophisticated algorithm can be used for better results.
- Model was very difficult to model with simulation, many assumptions had to be made

This project designed a very small scale, simple transit system in San Luis Obispo. Results show that the business would be profitable while still keeping ticket price fairly low. Currently, no middle ground exists for wine tasters who don't want to drive but want a cheaper alternative than a tour bus or a limo. Since Cal Poly is located in San Luis Obispo, the number of 21 and over college students creates a high demand for a system such as this one.

Once the system is in place and running, there is much potential for growth. Many wineries were excluded from the transit route, suggesting that many more possible transit routes exist. As business grows and word spreads about the transit system, endless possibilities with transit routes exist, and more buses can be purchased. The economic analysis shows that with the purchase of more than even one bus, profit will be extremely low or negative. But with a booming business and expansion into many more winery transit routes, the purchase of more buses becomes feasible and the profit becomes very attractive.

Appendix

Winery Information and Narrowing the Scope

List of Wineries/Information

Winery	Address	Phone	Tasting Hours	Contact	Additional Comments
Baileyana/Tangent	5828 Orcutt Rd., San Luis Obispo, CA 93401	(805) 269-8200	Daily 10 AM – 5 PM	http://www.baileyana.com/contact_us.php	
Cerro Caliente Cellars	831-A Via Esteban, San Luis Obispo, CA 93401	(805) 544-2942	Fri-Sun 11 AM - 5 PM	http://www.cerrocalientecellars.com/home.html	not a vineyard
Chamisal Vineyards	7525 Orcutt Rd., San Luis Obispo, CA 93401	(805) 541-9463	Daily 10 AM – 5 PM	http://www.chamisalvineyards.com/contact.html	
Claiborne & Churchill Winery	2649 Carpenter Canyon Rd., San Luis Obispo, CA 93401	(805) 544-4066	Daily 11 AM – 5 PM	http://www.claibornechurchill.com/contact_us/	
Edna Valley Vineyard	2585 Biddle Ranch Rd., San Luis Obispo, CA 93405	(805) 544-5855	Daily 10 AM - 5 PM	http://www.ednavalleyvineyard.com	
Kelsey See Canyon Vineyards	1947 See Canyon Rd., San Luis Obispo, CA 93405	(805) 595-9700	M-Th 11-5:30,F 11-6,Sat/Sun	http://www.kelseywine.com/index.php/Contact-Us/Kelsey-See-Canyon-Vineyards.html	
Kynsi Winery	2212 Corbett Canyon Rd., Arroyo Grande, CA 93420	(805) 544-8461	Thurs-Mon. 11 AM - 5 PM	http://kynsi.com/cm/contact/Contact%20Us.html	
Laverne Vineyards	3490 Sacramento Dr., San Luis Obispo, CA	(805) 547-0616	Weekends 12 PM - 4 PM	call for tastings	not a vineyard
Per Bacco Cellars	1800 Calle Joaquin, San Luis Obispo, CA 93405	(805) 787-0485	Daily 11 AM – 5 PM	http://www.perbaccocellars.com/Contact	
Piedra Creek Winery	6425 Mira Cielo Dr., San Luis Obispo, CA 93401	(805) 541-1281	appt only	http://www.piedracreek.com/Contact.html	
Pithy Little Wine Co.	1037 Chorro Street, San Luis Obispo, CA 93401	(805) 546-1059	M,F,Sat 12-6, Th 12-9, Sun 12	http://www.pithywine.com/Contact	not a vineyard
Refugio Vineyard Company	1691 See Canyon Rd., San Luis Obispo, CA 93405	(805) 595-9515	appt only	no source	
Salisbury Vineyards	6985 Ontario Road, San Luis Obispo, CA 93405	805.595.946	M-Th 12-5, F-Sun 11-6	http://www.salisburyvineyards.com/contact-us/	edge or range
Saucelito Canyon/Ortman Family Vineyards	3080 Biddle Ranch Rd., San Luis Obispo, CA 93401	(805) 543-2111 /(805)787-0810	Daily 10 AM – 5 PM	http://www.saucelitocanyon.com/contact	
Sextant	1653 Old Price Canyon, San Luis Obispo, CA	(805) 542-0133	M-F 10-4 ,Sat-Sun 10-5	http://www.sextantwines.com/index.cfm?fuseaction=category_detail&category_id_int=17841	
Sinor LaVallee	Sinor-Lavallee Wine Co.	(805) 801-2502	N/A	http://www.sinorlavallee.com/Contact	No tasting room
Stephen Ross Wine Cellars	178 Suburban Rd., San Luis Obispo, CA	(805) 594-1318	Thurs-Sun 11AM-5 PM	http://www.stephenrosswine.com/emailus.html	
Talley Vineyards & Bishop's	3031 Lopez Dr., Arroyo Grande, CA 93420	(805) 489-0446	Daily 10:30 AM – 4:30 PM	http://talleyvineyards.com/cm/visit_talley_vineyards/contact_us.html	
Tolosa Winery	4910 Edna Rd., San Luis Obispo, CA 93401	(805) 782-0500 ext 10	Daily 11 AM – 5 PM	http://www.tolosawinery.com/contact/	
Wedell Cellars	44 Equestrian Way, Arroyo Grande, CA	(805) 489-0596	appt only	http://www.wedellcellars.com/contact.php	
Windemere/Cathy MacGregor Wines	3536 S. Higuera, Su. 240B., San Luis Obispo, CA 93401	(805) 542-0133	Fri.-Sun. 11:30 AM – 5 PM	http://www.wine-searcher.com/merchant/4538	not a vineyard
Wolff Vineyards	6238 Orcutt Rd., San Luis Obispo, CA	(805) 781-0448	Open daily 11am to 5pm	http://www.wolffvineyards.com/contactus.php	

Table 10: List of Wineries/Information

Initial Winery Selection

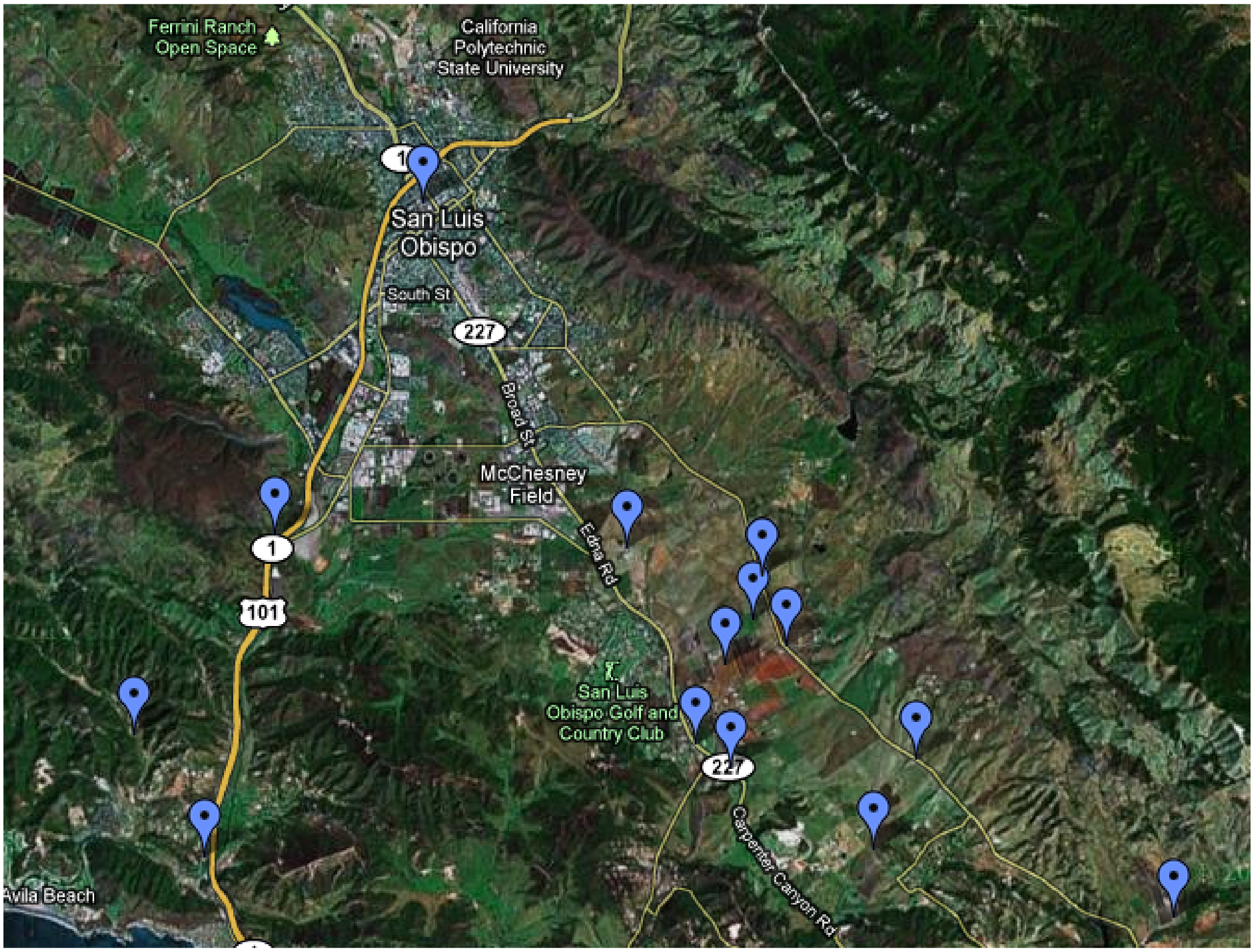
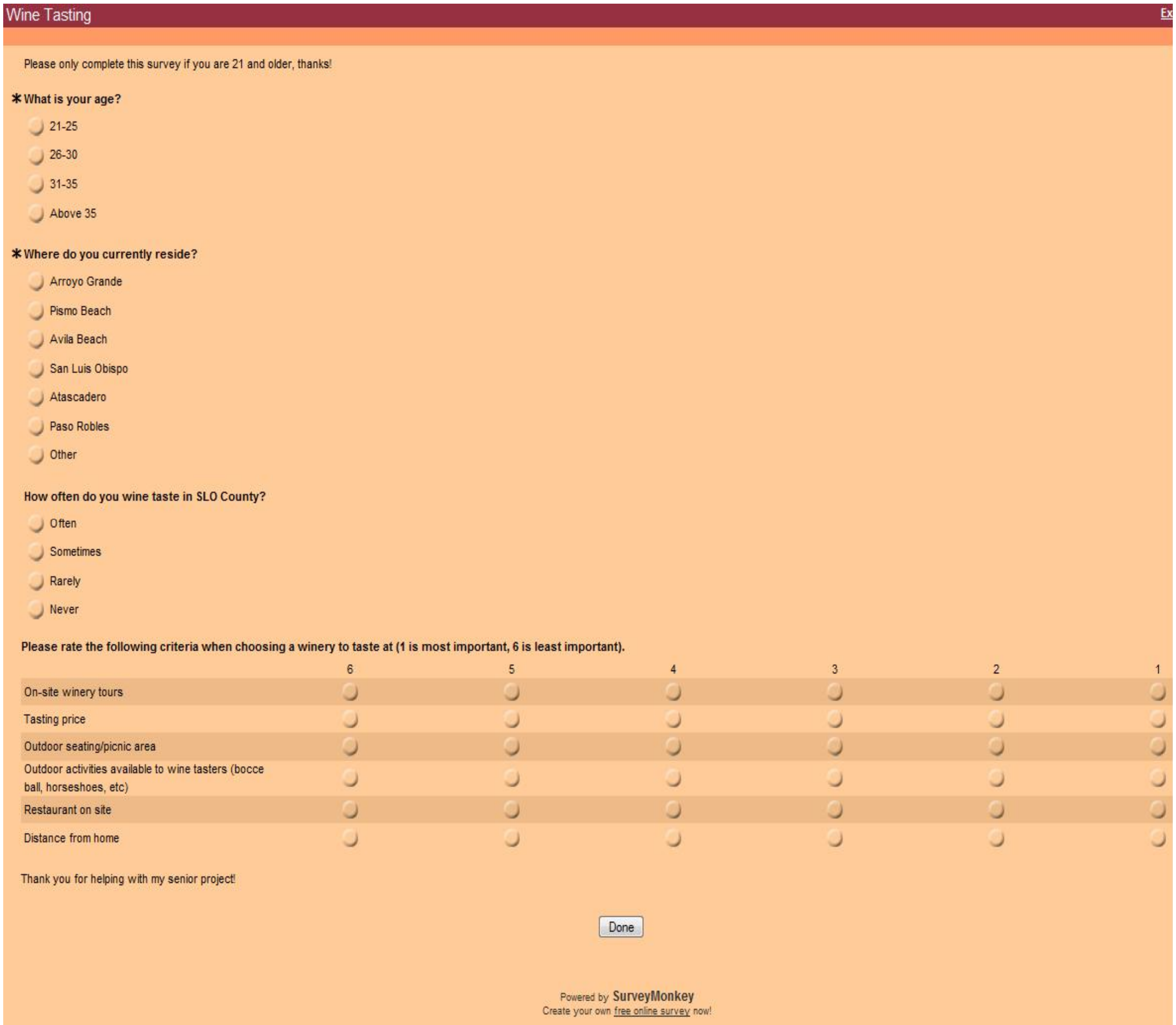


Figure 7: Map of Initial 13 Wineries Chosen for Analysis

Online Survey



Wine Tasting

Please only complete this survey if you are 21 and older, thanks!

* What is your age?
- 21-25
- 26-30
- 31-35
- Above 35

* Where do you currently reside?
- Arroyo Grande
- Pismo Beach
- Avila Beach
- San Luis Obispo
- Atascadero
- Paso Robles
- Other

How often do you wine taste in SLO County?
- Often
- Sometimes
- Rarely
- Never

Please rate the following criteria when choosing a winery to taste at (1 is most important, 6 is least important).

	6	5	4	3	2	1
On-site winery tours						
Tasting price						
Outdoor seating/picnic area						
Outdoor activities available to wine tasters (bocce ball, horseshoes, etc)						
Restaurant on site						
Distance from home						

Thank you for helping with my senior project!

Done

Powered by SurveyMonkey
Create your own free online survey now!

Figure 8: Survey Given to 100 Cal Poly Students

Winery Information Request Email

To Whom It May Concern,

My name is Amanda Crissman and I'm a fourth year Industrial Engineering student at Cal Poly working on my senior project. My project is to design a small-scale transit system for public use that would run solely on Friday, Saturday, and Sunday to select wineries in the city of San Luis Obispo, and to perform an economic analysis of the system. The purpose of the Winery Transit System is to encourage safety while wine tasting, increase tourism and business for local wineries, and encourage use of the SLO Transit System on the weekends. The aim is not to detract from other transportation modes such as taxis, limos, and tour buses, but only to offer wider variety to the public while promoting safety and economic growth for the city.

In order to design the system and choose the wineries that the transit system will stop at, I would really appreciate your help in answering a few questions that will only take 5-10 minutes, listed below. If you do not have an answer to a question or do not feel comfortable giving out that information that is no problem— please just say so.

1. What is the price of wine tasting?
2. How many visitors do you get on an average:
   Friday?
   Saturday?
   Sunday?
3. What is the distribution of customers throughout the day?
4. How long, on average, do customers stay at your winery when wine tasting? (If possible, a range would be helpful!)
5. Does your winery offer wine tours? If so, how much does it cost? Are they by reservation only or is it available to walk-in customers?
6. Does your winery serve food while customers wine taste? Is it a full restaurant or is it just snacks?
7. Do you have an outdoor seating area? Do you have a picnic area? How large is it in comparison to other wineries?
8. Do you offer any outdoor games for wine tasters? (Bocce ball, horseshoes, etc.)

If this is not the correct contact for this information, could you please pass this email along to the correct person or let me know who to contact instead?

Please feel free to contact me by email with any questions you may have. Thank you so much for your time and help in completing my senior project! I look forward to hearing back from you soon.

Sincerely,
Amanda Crissman
Industrial Engineering Student, Cal Poly

Criteria Information for Each Winery

Winery Evaluation

	Distance From DTC	Tasting Price	On-site winery tours	Restaurant on site	outdoor seating/picnic area	Outdoor activities while tasting	Friday	Saturday	Sunday	lenth of stay (min)	extra
aileyana/Tangent	5.8	$5	none	food available	medium	bocce ball, croquet					
hamisal Vineyards	8.6	$9, $15	no	no	medium/small	none	30-50	150	75-100	30	
laiborne & Churchill Winery	7	$5	no	crackers/bread sticks	lawn, patio, pavillion. 30-40 people	none	30-45	80-120	30-50	20-30	
dna Valley Vineyard	6.2	$5	on the hour on weekends 1-3	yes	superior picnic area						
elsey See Canyon Vineyard	8.5	$5	yes	no	medium	no					
ynsi Winery	8.2	$5, $10	no	no	picnic area	no					
er Bacco Cellars	3.9	$5	informal, free to all	crackers/chocolate	picnic area	bocce ball, horseshoes	30	75	50	20-60	
alisbury Vineyards	7.5	$7	rarely unless by reservation	lunch sandwiches	seating and large picnic area for 100	bocce ball, horseshoes	50	100	80-150 (seasonal	60-120	
aucelito Canyon/Ortman amily Vineyards	6.5	$5	no	no	lots of outdoor seating	thinking of putting horseshoes in the front					
extant	6.7	$3, $12	reservation only, $75 per person, $90 w/ food	Gourmet Deli (10)	no	none					
alley Vineyards & Bishop's	12.9	$5 reg, $12 dist. Menu	Yes, no reservations	no	large seating area	no					
olosa Winery	4.4	$3, $12	complimentary self-guided tour, special tours by appt only	snacks available for purchase	large lawn, outdoor seating for 40	bocce ball	100	200	150	30-45	wine and cheese pairing ($20) reservation recommended but not required
Volff Vineyards	6.6	$5	tour available/not sure	no	large seating area, picnics encouraged	none					

Table 11: Complete Table Summary of Winery Criteria

Criteria Score for Each Winery

	Distance From DTC	Tasting Price	On-site winery tours	Restaurant on site	outdoor seating/picnic area	Outdoor activities while tasting	
Rating	2.79	1.71	4.61	3.95	3.32	3.86	Score
Baileyana/Tangent	5.8	5	3	1	2	1	53.012
Chamisal Vineyards	3.6	9	3	3	2.5	3	84.944
Claiborne & Churchill Winery	7	5	3	2	2	3	68.03
Edna Valley Vineyard	6.2	5	1	1	1	3	49.308
Kelsey See Canyon Vineyards	3.5	5	2	3	2	3	71.555
Kynsi Winery	3.2	5	3	3	2	3	75.328
Per Bacco Cellars	3.9	5	1	2	2	1	42.441
Salisbury Vineyards	7.5	7	2	1	1	1	53.245
Saucelito Canyon/Ortman Family Vineyards	6.5	5	3	3	1	2.75	66.3
Sextant	6.7	3	2	1	3	3	67.083
Talley Vineyards & Bishop's	12.9	6	1	3	1	3	77.611
Tolosa Winery	4.4	8	1	2	2	2	52.826
Wolff Vineyards	6.6	5	2	3	1	3	62.934

Table 12: Evaluation and Final Score for Each Winery

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