

Proposal Analysis for A Local Farm

In the Sunrise farm, the founders (Maija and Natasha) want to improve the profitability by increasing the number of visitors and the number of flavors of ice cream without disturbing the commercial farming business. The farm is open 7 months a year, 7.5 hours a day, and entertains an average of 15,000 visitors each year. We assume that there are 4 weeks in a month (regardless of the impact of public holidays) and the farm is open 4 days a week (because 'midweek demand is too low to justify opening'). The report will first assess Natasha's proposal (achieving more profit margins through a 50% growth in the number of farm visitors in 2019) in the aspect of capacity constraints and other operating concerns. The decision of increasing 6 flavors of ice cream will be discussed in the second section.

Section 1: Evaluating the proposal

1.1 Main capacity constraints

1.1.1 Capital investment

Given a small return was made on the capital investment in 2018, the farm aims to increase its profitability without further capital employed in 2019. The growth of farm visitors brings about an increasing demand for farm services and manufacturing. The increase in farm visitors will lead to increasing demand for farm services and manufacturing, such as the need for more trailers for tourists and the need for more ice cream production for sale. Since there will be no investment in new trailers and manufacturing equipment in 2019, additional maintenance costs may be incurred to keep the equipment in good condition. This means new business initiatives toward a better margin will be conducted under constrained capital. The capital constraint may prevent the farm from getting more output, which also places pressure on how to make existing capital investments work better.

1.1.2 Parking space

The parking space can hold up to 400 people ($40 \times 4 + 6 \times 40 = 400$), which is mix dependent on the capacity of car spaces ($40 \times 4 = 160$) and coach spaces ($6 \times 40 = 240$). Given the number of visitors on weekend days is twice as that on Fridays and Mondays, the current average number of daily farm visitors on Saturday or Sunday $= ((15000 / (7 \times 4)) / (1 + 1 + 0.5 + 0.5)) = 179$ while the number of visitors on Monday or Friday $= ((15000 / (7 \times 4)) / (1 + 1 + 2 + 2)) = 89$. Correspondingly, the average number of farm visitors in 2019 increased to 107 people per day on weekdays and 268 people per day on weekend days (Table 1). The capacity of car spaces may not match the increase in farm visitors in 2019 if more than 40 cars arrive at the farm during a busy weekend. For example, with 41 cars arrivals, the utilization of the car spaces $= ((268 - 41 \times 4) / 4) / 40 = 1.15 (115\%)$. The bottleneck of car parking (maximum of 40 car spaces) will hinder the implementation of Natasha's proposal. In addition to the peak days, the analysis hasn't considered seasonal factors so far. Using case table 2 as an indicative information, the ratio of number of paying farm visitors in a year to the farm's annual number of visitors $= 14800 / 15000 = 0.9867$. The number of visitors in the peak month of February (3400) is 5.67 times that of the dullest month (April=600). With a 50% increase in the number of visitors, the parking space is projected to handle $3400 \times 1.5 / 0.9867 = 5169$ people, that is, $(5169 / 4) / (1 + 1 + 0.5 + 0.5) = 431$ people per weekend day and $(5159 / 4) / (1 + 1 + 2 + 2) = 215$ people per weekday. Obviously, in February 2019, the number of farm visitors on weekend days will exceed the maximum capacity of the parking space. In a month like this, there will be a significant problem in peak months (December, January, February).

Table 1 (Rounded to the nearest whole number)				
Time	Current		2019	
	Friday Monday	or Saturday Sunday	Friday Monday	or Saturday Sunday
arrive before 12.30 pm	89x (1-0.9) =9 arrivals	179x (1-0.9) =18 arrivals	9x (1+0.5) =13 arrivals	18x (1+0.5) =27 arrivals
leave before 3.30pm	89x0.2 =18 visitors	179x0.2=36 visitors	18x (1+0.5) =27 visitors	36x (1+0.5) =54 visitors
from 3.30pm to 6.30pm	89x (1-0.2) =71 visitors	179x (1-0.2) =143 visitors	71x (1+0.5) =107 visitors	143x (1+0.5) =214 visitors
Total arrivals	89	179	134	268

1.1.3 Milking parlor

The milking parlor can cope with up to 80 customers per hour. In February 2019 (peak month), the milking parlor is expected to host 57 visitors each hour per weekday while admitting 115 visitors into the gallery each hour on a weekend day. As shown in Table 2, the utilization rate of the gallery on Saturday (Sunday) is greater than 100%. This will develop a long queue before 3.30 pm and during the exhibition hours (3.30 pm -6.30 pm), which can lead to customer dissatisfaction and consequently a decrease in revenue. From this point, the capacity of the milking parlor is not able to support Natasha's proposal.

Table 2: Daily figures for the milking parlor		
	Peak month: February (2019)	
	Monday or Friday	Saturday or Friday
number of visitors per hour	$((215 \times (1-0.2))/3 = 57$	$((431 \times (1-0.2))/3 = 115$
maximum capacity per hour	80	80
utilization rate per hour	$57/80 = 0.7179 (71.79\%)$	$115/80 = 1.4358 (143.58\%)$

1.1.4 Ice-cream factory

On a level capacity basis, the factory can produce up to $350 \times 48 \times 4 = 67200$ liters of ice cream per year. In 2018, total sales volume was $298000/6 + 108000/8 = 63,167$ liters, which accounted for 94.00% of the maximum capacity. According to case table 1, the sales volume in 2019 is predicted to be $260,000/6 + 160000/8 = 63334$ liters, which is 94.25% of the maximum capacity. Although a utilization rate of more than 90% may cause many problems for operations and machinery, a similar capacity utilization rate makes this forecasted production seem feasible. However, the forecast was based on a subjective view of projected forward, the effect of the competitor's marketing campaign, and the plan of increasing farm visitors by 50%. Therefore, this forecast is uncertain to be solely used as a credit reference. For example, the sales in retail shops were prone to grow each year over the past 5 years, it is unreasonable that this growth trend will change dramatically in the forecast without any determinative factors that could affect marketing channels. In case of that, we make a conservative assumption that the volume of ice cream sold by retail shops and the volume of ice cream sold to 'farm shop only' visitors will remain the same as in 2018. On average, each paying visitor to the farm buys 0.5 liters of ice cream (car customers buy 2/4 liters per person that equals to coach customers buy 1/2 liters per person on average), then 50% additional farm visitors in 2019 will bring about extra $14800 \times 0.5 \times 0.5 = 3700$ liters of sales. That will account for 99.50% $((63,167 + 3700)/67200 = 0.9950)$ of the maximum capacity. This is almost impossible since employees are only available for 4 days a week and the expansion of work hours negotiated will increase the cost of goods sold.

Apart from the constraint of fast-freezing capacity, the viability of Natasha's proposal is also constrained by the factory's storage capacity. Take Monthly figures for 2018(in case Table 2) as indicative data for investigating factory capacity. As shown in Table 3 (the green area), in the off-season (April to September), the monthly sales volume was consistently lower than the factory's average monthly output ($350 \times 4 \times 4 = 5600$ liters). This means that the remaining ice cream was continuously stored in the finished goods freezer. Since it is hard to maintain a good quality once the finished products are stored for more than 6 weeks in the factory, there will be a significant waste (the expired ice cream) generated during the off-season. Besides that, there was a stock of 3700 liters in the inventory by the end of June 2018, the remaining ice cream accumulated in the following two months ($3700 + 2520.83 + 2327.50 = 8458.33$ liters) exceeded the maximum capacity of the finished goods freezer (7000 liters). Moreover, the limited storage capacity also hindered the capability of building up inventory for coming with the surging demand in the peak season (pale orange area). For example, the gap in January was 2333.33 liters, which means that 2333.33 liters of sales came from storage. Similarly, extra 2087.50 liters of ice cream were needed to meet the sales demand in February. This seasonality has challenged the current inventory capacity in terms of the limited storage time and the maximum capacity of finished goods freezer. Natasha should tackle the existing capacity constraints before proceeding with her growth strategy.

Table 3						
sales volume > 5600 liters				sales volume < 5600 liters		
Month	Sales to retail shops (\$)	Sales to retail shops (liters)	Sales from farm shop (\$)	Sales from farm shop (\$)	Gap between supply and demand (liters)	Total sales (liters)
January	33800	$33800/6 = 5633.33$	18400	$18400/8 = 2300$	$5600 - 7933.33 = 2333.33$	7933.33
February	31200	5200.00	19900	2487.50	-2087.50	7687.50
March	29700	4950.00	9800	1225.00	-575.00	6175.00
April	19800	3300.00	6700	837.50	1462.50	4137.50
May	15200	2533.33	4400	550.00	2516.67	3083.33
June	14700	2450.00	3700	462.50	2687.50	2912.50
July	16300	2716.67	2900	362.50	2520.83	3079.17
August	16800	2800.00	4500	562.50	2237.50	3362.50
September	30100	5016.67	3800	475.00	108.33	5491.67
October	28300	4716.67	7200	900.00	-16.67	5616.67
November	27400	4566.67	10200	1275.00	-241.67	5841.67
December	34700	5783.33	16500	2062.50	-2245.83	7845.83

1.2 Considerations for promoting coach visits

Natasha wants to increase the total farm visitor number by 50% in 2019, from 15000 to 22500. This means on average the visitor will increase to 134 on Monday and Friday and 268 on Saturday and Sunday (Table 1). If the proportion of each month's visitors remains the same as 2018, in the busiest month (February), the visitor number will increase to 215 per day on weekdays and 431 on weekends. As discussed in previous paragraphs, this will cause huge pressure on the farm's capacity, and therefore it needs to be carefully selected which kinds of visitor should Natasha increase in order to maximize her revenue with limited capacity.

In terms of traditional coach visitors, we assume that all visitors in this group are individual visitors. For estimating increased ticket revenue, we first assume that the new 7500 visitors are all coach visitors without discount. Therefore, the farm can earn $7500 \times 10 = \$75000$ more from the admission fee. In addition, it can earn $0.5 \times 7500 \times 8 = \30000 from the additional ice cream

sale to coach visitors as one out of every two coach customers buys a 1-liter box of ice cream. This is a large revenue increase. However, to promote more coach visits, Natasha needs to offer an admission fee discount to tourist firms. This will decrease the revenue to some extent, but the accurate decreased amount is hard to calculate here with no further information about how much discount Natasha needs to give. In addition, besides the revenue, Natasha also needs to consider the characteristics of coach visitors and their impact on the farm's capacity. Because 40 coach visitors will come together on one coach and will leave together, many visitors may need to stay in the farm waiting for other members to finish their tour. This lump of demand may cause more pressure on the service capacity and make the farm crowded as there are too many people staying in the farm at same time, especially during 3.30 pm to 6.30 pm on busy weekends. This may also cause more parking time for a coach, and thus may cause the 6 coach park spaces (holding up to 240 people) to be insufficient during busy hours. However, one possible solution to this problem is that Natasha can contact the tourist firms to get the arrival schedule of coaches and prepare for it. She may even make arrangements with tourist firms to set the arrival time of coaches.

1.3 Considerations for promoting school parties and car visits

Another option to promote coach visits is inviting school parties for educational tours. In this situation, we assume that all tickets are sold at the price of individual tickets. Therefore, the additional entry fee revenue will be \$75000. Given that ice cream is more popular with school-age children compared to adults in general, we assume that these school party visitors will buy more ice-cream than traditional coach visitors. Therefore, the new ice cream sales revenue will increase more than \$30000. Besides some similar characteristics as traditional coach visitors, one special merit of school visitors is that most of the tour will be made on school days. This, and thus help to decrease the pressure on the firm's capacity. However, these special visitors may need help diverting visitors from the overcrowding weekends into Mondays and Fridays. To perform an educational tour for children, Natasha will need to ask her farm guides to do more work such as preparing more activities which suit children. In addition, school parties may be more difficult to attract because when selecting a tour destination, they will consider more factors such as the safety problem. Natasha may also need to give some discounts to schools in order to attract them, which will decrease the revenue.

In terms of car visitors, we assume that there are 4 people in a car, and they are all family visitors. Therefore, if the new increased visitors are all car visitors, the farm can earn $7500/4 \times 25 = \$46875$ additional admission fee. This amount is almost 37.5% less than what can be earned by the option of promoting coach visits. For ice cream sales, because every car with four people buys 2 boxes of ice cream, new car visitors will bring $0.5 \times 7500 \times 8 = \30000 revenue which is the same as the amount of traditional coach visitors. Although the revenue created by car visitors is less than traditional coach visitors, they also have some merits. Car visitors come separately by their own cars, which means they have more flexibility than coach visitors on when to leave the farm. This leads to shorter visiting and staying time on the farm and will relieve the burden of parking on busy hours. However, there are also some problems. The arrival of car visitors cannot be arranged as coach visitors. As a result, there are also possibilities that they come in great numbers during milking hours and it's hard for Natasha to manage the capacity. In addition, although Natasha will not need to give discounts to travel agencies or schools, she will need to spend more on advertising expenses when she promotes the car visits by herself. This will also decrease the revenue and promotion result may not be as good as the result of tourist firms as they are experts.

Taking all above pros and cons of three different types of visitors into consideration, it is better for Natasha to choose promoting the school parties' visits. Although they need farm staff to

take more care of, school parties will create the highest revenue among the three kinds of visitors. It can also help to average the imbalance in visitor number between weekdays and weekends while the traditional coach visitors and car visitors will adversely put more pressure on the farm's capacity on weekends.

1.4 Managing capacity

Since Natasha is aiming to increase the profitability of her business without making any further capital investment, it is very critical to allocate the resource effectively and optimize the capacity. There are a few pieces of advice made for Natasha for better use of current capital investment.

Evaluate the return on investment in the past financial year of 2018. This can be done by comparing the Return on Equity of all operating units to detect underperforming activities. Natasha can get a better understanding of the current financial situation and it helps when making the future plan. It is a good way to review performance in the past year and develop a more accurate demand forecast for the following year.

Make a feasible budget plan against the constraints. To alleviate the operational pressure brought by capacity constraints, Natasha could put more effort into creating and continuously reviewing the budget plan to ensure the smooth functioning of bottlenecks. For example, prioritize resources allocation based on profitability and feasibility of relative application. After doing this, Natasha will feel more confident about increasing 50% visitors in the following 2019.

Regarding the constraint of parking spaces, two ways are available for Natasha to think about. Offering off-season discounts to increase admission revenue and manage fluctuations in demand. For example, Natasha could give a 10% or discount on entrance fee for people who visit farm during winter or weekdays, such as Friday or Monday. The total arrivals on Monday or Friday are expected to be 134 based on table 1. Assuming all visitors come individually, the discount offered to them on Monday and Friday is \$1 per ticket, and $\$1 \times 134 \times 2 = \270 (rounded) for one week. The price offered to these visitors is \$9 and it means $30(\$270/\$9)$ more customers per week or $30 \times 4 \times 6 = 720$ more customers per year need to cater to make a trade-off between the constraints and the profitability. In addition to this, visitors are encouraged to come before the busy period of a day (12:30pm) by taking the 10% discount on entry fee since 90% of visitors arrive later than 12:30pm. The customers are encouraged to come earlier so that they will be diverted from busy hours.

Promoting an online booking system to better predict customer flows and adjust business operations accordingly. That increases the visibility of the farm visits, for example, the business could offer a 5% admission discount to encourage group visitors to make reservations ahead of time, which would enable the business to make scheduling adjustments to reduce queue waiting time and enhance customer experience.

Making a reservation period system on parking is also available to reduce the pressure on parking. Natasha could design a period reservation schedule for visitors. For example, three hours parking in the morning period between 11am to 2pm with a cheaper entrance fee or a two hour parking time in the afternoon periods between 2:30pm-4:30pm and 4:30pm-6:30pm. The visitors are encouraged to check the schedule online and book the period which is the most convenient for them. They are able to make a reasonable schedule instead of all coming in peak hours.

Remove the bottleneck of the Milking operation to optimize the capacity. The 6 minutes of headphone listening is apparently a bottleneck in the milking parlor. The headphone devices could be replaced by tape replay, and broadcasting is a better choice for visitors in the waiting room. Broadcasting is a more attractive way to inform customers so that they can get a clear idea about the next step and feel interested in the milking parlor. Alternatively, the farm can rearrange the visiting period to divert customers. For instance, the 3 hours duration could be divided into 6 periods such as 3:30-4:00pm, 4:00-4:30pm....., 6:00-6:30pm. Customers would come to the gallery according to the period that they are assigned instead of waiting from the beginning. By doing so, the overcrowded scene can be eliminated, and the waiting time will be reduced accordingly. Additionally, installing TV devices in the waiting room would reduce the number of waiting visitors. Visitors in the waiting room can view the milking operation via the TV set instead of entering the gallery. In a nutshell, the service time will be reduced, and customer dissatisfaction caused by queuing will be avoided.

Higher capacity could be achieved in two ways for the production line. The first way is to shorten the overall freezing time. The current freezing machine cannot freeze more than 350 liters over a 24-hour period. Natasha should think about allocating the operating budget on either replacing the current freezer with a bigger one (>350 liters) or higher power. The other way is to increase the storage space for finished products. The stock rotation limits the amount of ice cream that could be stored in the freezer, which is 7,000 liters currently. Bigger storage space allows the factory to hold more inventories and it will increase relative ice cream revenue as well. Increasing the money allocation for better equipment will improve the capacity of ice cream production.

Extend the working time to cope with the increased demand of customers. For example, the farm can extend the working days to 5 days a week or extend the working months to 7 months, and it is reasonable to assume the extended working time will generate enough revenue to offset the additional labor cost.

Another way to increase visiting is the promotion to school parties. Natasha's appropriate choice to increase visitors in 2019 is to promote visiting school parties after considering three types of visitors. There are two options available. Natasha could work with local tourist agencies. This will cost a fixed annual contract fee, but it will be covered by increasing customer revenue. These agencies have better experience on arranging and managing activities and schedules. This time the target customers will be children and teachers, and farm visiting could also be something like a group picnic where kids will visit milking and tasting ice cream. On the other hand, Natasha can do this on her own in another way. She can build a cooperating relationship with schools directly by offering them a 10% discount on entry fee.

1.5 Helpful information for making these decisions

- a. Work with an accounting manager to have a clear vision about the business and future operational priorities. The farm is assumed to have an accountant who has an extensive knowledge about the company's financial performance. Talking to the accountant about revenue generation for each segment and budget allocation for operations. For example, it is necessary for Natasha to find out the revenue proportion between paying farm visitors and 'farm shop only' visitors. The variation of the demand regarding the different customer segments. This also makes it unclear for the revenue contribution about each segment, thus leads to the inaccuracy of the demand forecasting as well as the marketing promotions.

- b. Making online promotions to target customers. Natasha should do the market research by evaluating the promoting strategy of the farm tourism industry and comparing prices with competitors to find out how much discount is suitable to maintain the profit margins. This should be aligned to the break-even point and the financial expectation of the farm. Meanwhile, Natasha should take initiatives to increase the visibility of the ongoing promotion among target audiences. Putting advertisements on tourist websites is a good way since people are used to doing online research when making a visiting plan. Advertising in local supermarkets or printing brochures are also available because people are easier to see.
 - c. Marketing research for better demand forecasting to achieve the optimal allocation of scarce resources and gain better inventory control. For example, people are more likely to visit farms in summer and ice cream is especially popular due to the weather. However, the ice cream production needs to be controlled otherwise it could cause pressure to sell so that unsold products would become deadstock of the inventory and lead to the increase of inventory carry costs. In addition, proper marketing research will help with resource scheduling. For example, Natasha can assign more workers to deal with surge demand or reduce the working hours in a particular month if there is expected to witness a demand drop.
- After gathering the information, Natasha will get a clearer understanding about how to implement decisions on managing capacity and hopefully the number of visitors will increase in the following 2019.

Section 2: Impacting factors for ice cream line extension

Raw material stock is closely linked to the line extension. Short stocks and unwanted stocks of raw materials for new flavors will cause production disruptions or unnecessary cash expenditures. Given the uncertain demand for new flavors of ice cream, the farm is unlikely to get the new ingredients restocked on a fixed timespan. In other words, the farm may order those ingredients according to the operatives on an ad hoc basis until demand for these new flavors is roughly determined. The use of ad hoc replenishment is likely to cause shortages or backlogs, which then limits the capability of responding to unpredicted demands. Also, the farm may be unable to get the advantage of price discounts on a large order on an ad hoc replenishment basis. Thus, how to control the raw material stock properly would be an essential factor in the decision of line extension.

Production line plays a key role in supporting the line extension. The current capacity constraint of the production line has prevented the factory from supporting Natasha's growth strategy and the line extension. As discussed in Q1.1, the factory cannot meet the additional demand (3700 liters) under current working conditions. Besides, increasing the number of flavors to ten would lead to longer throughput times for the production (as only one flavor can be produced on one day). The longer throughput times would decrease the effective capacity and cause the queue, which may push the retailers away from the factory to other ice-cream makers. Moreover, some flavors of ice cream that are less popular may be ordered less frequently or in a smaller amount, which may cause a stockout of these flavors or lead to a waste of production capacity due to the existence of capacity constraints. In case of that, attempting to increase the number of flavors may not be viable except the capacity constraint is eliminated and the farm has a better understanding of the demand for each flavor.

Inventory control for the finished products has an effect on the line extension. It is not easy for the factory to have enough products in stock to fulfill orders and avoid having any overstock since it suffers the capacity constraint of the finished goods freezer. In particular, the uncertainty of demand for new flavors increases the complexity of ABC classification and hinders the judgment on suitable safety stock levels. The least popular flavor of ice cream may become deadstock to the inventory while it is likely that there may be missed unit sales if a certain flavor is popular, or more than four flavors are ordered in larger amounts during the peak season. Any shortage of finished products may result in loss of revenues, and any dead stock would lead to increased inventory carrying costs and the abolishment cost of expired ice cream. The farms should solve the problem of the limited capacity of the finished freezer before expanding the product line and reclassifying its inventory items based on more accurate demand forecasts.

Cost control is critical to the farm's profitability and thus impacts the feasibility of increasing the number of ice cream flavors. The increased number of flavors would result in a smaller amount of ice cream production since not all flavors are popular on sales and retailers may order small quantities of less popular products. This will lead to an increase in the fixed cost per unit produced and erode the profit margins. Besides, the increased number of flavors brings about the additional cost caused by frequent switching items. Switching from one flavor production to another takes one hour for the staff to clean out the container to secure the original specification of the new-made flavor. Workers need to devote more effort to cope with these frequent changes and thus lower productivity and increase operating expenses. In addition, the line extension increases the possibility of stockout or overstock in both raw materials and finished products due to the unsolved problems of its production line and inventory control. The risk of stockout or deadstock would lead to the loss of sales, or the higher inventory carry costs, which reduces the profit margins accordingly. Obviously, cost control is subject to capacity constraints and tied to the line extension in terms of profitability.

Workforce Scheduling

To increase ice cream flavors from four to ten, the ice cream factory is expected to have increased uncertainty, disruption and unforeseen cost in employee scheduling. First of all, the newly added flavors will pose a challenge for employees to keep up with the recorded rate of production. For example, employees might spend more time at the material preparation and weighting section due to unfamiliarity with the new recipe, have human errors disrupting the operating process more often, or the new flavors require extended time to mix and freeze. Since the first line workers need a better understanding of the workflow and better coordination to deal with the elevated complexity in the manufacturing procedure, the factory will need to put more effort into training, scheduling and supervision based on the skill set of each employee.

Moreover, the factory might have severe difficulties in utilizing the current working arrangements to meet the demand forecast. As explained in Q1.1.4, the ice cream factory is operating at near capacity, if Natasha could successfully increase the farm visitors by 50% in 2019, It is almost impossible for the factory to avoid stock shortage. In this circumstance, adding more flavors of ice cream is highly likely to result in a decrease in the effective capacity for the entire product line, a decrease in output volume for all flavors and a further increase in possibilities of stock out for fast selling flavors. Therefore, the factory will need to make a trade-off between stockout cost and additional labor cost. For instance, the factory could schedule night shifts on a fixed basis for employees to work overtime and replenish the stock of ice cream flavor which falls below the safety stock level aiming to prevent inventory depletion and customer churn.

Operation Scheduling

Secondly, the factory should consider whether they need to adjust operation layout, operation process and job assignment to accommodate the product line extension. Currently, the ice cream factory is organized by the process layout and operates as a batch process. Allowing Natasha's proposal to increase ice cream flavors from four to ten would substantially increase the variety of product offerings. However, the volume of products will not see a proportional increase because the owners are reluctant to make additional capital investments to overcome the capital constraints. With that being considered, the factory needs to re-examine the pros and cons of its current operation arrangements. For example, the factory could incorporate the attributes of the line process into the production of best-selling flavors, alternatively, the factory could experiment with the cell layout to reduce setup time and errors.

Furthermore, it appears normal for shop floor employees to be disorganized and inefficient when dealing with the newly introduced changes in operating procedure. Hence the ice cream factory needs to take precautionary measures in operation scheduling to avoid quality failures disappointing customers. For example, the manager should be sensible about employees' job assignments. To ensure the manufacturing process achieves its optimal efficiency, the best-performing employee should be assigned to prepare and weigh raw materials on a fixed basis to become skilled at the procedures, as another option, the manager may assign an employee to perform quality control testing to ensure the finished products are of satisfactory quality.

Demand Scheduling

Lastly, the ice cream factory is supposed to take account of the demand forecast, demand dynamic and the factory's ability to fulfil customer demand when deciding to increase the number of ice cream flavors. To begin with the demand forecast, as explained in Q1.1, the projected total sales of ice cream in 2019 is revised to provide a realistic outlook for the business. Compared with the historical data, the ice cream factory is expected to see a 6% growth in sales for next year, which is deemed to be a favorable factor to expand flavor offerings. Nevertheless, the factory has a quite limited understanding of customers' preferences towards different ice cream flavors, and the lack of information could diminish the confidence to launch line extensions.

Besides, not knowing the relative popularity of ice cream flavors presents problems in demand scheduling. To elaborate, the discrepancy in sales volume between the best-selling and the least-selling ice cream when having ten available flavors is supposedly larger than having four flavors, which raises the question of how to determine manufacturing priority and whether an equal batch size should be applied to all of the ice cream flavors.

In addition, the ice cream factory needs to consider how to meet the challenge of demand variability given the prolonged lead time. Based on the monthly sales figure for 2018, the demand for ice cream experienced significant fluctuation throughout the year. Due to the limited storage time, it is unfeasible to build up inventory during off-seasons. And the factory will be exposed to an even more varying demand schedule as the demand for different ice cream flavors also have seasonality, for example, more customers might choose eggnog flavor around the holiday season. Therefore, the manufacturer is required to have great flexibility in operation to manage the uncertain demand. However, in the case of the ice cream factory, the forecasted demand accounts for 99.5% of the maximum capacity, leaving a very small capacity cushion and inventory in response to the demand dynamic.