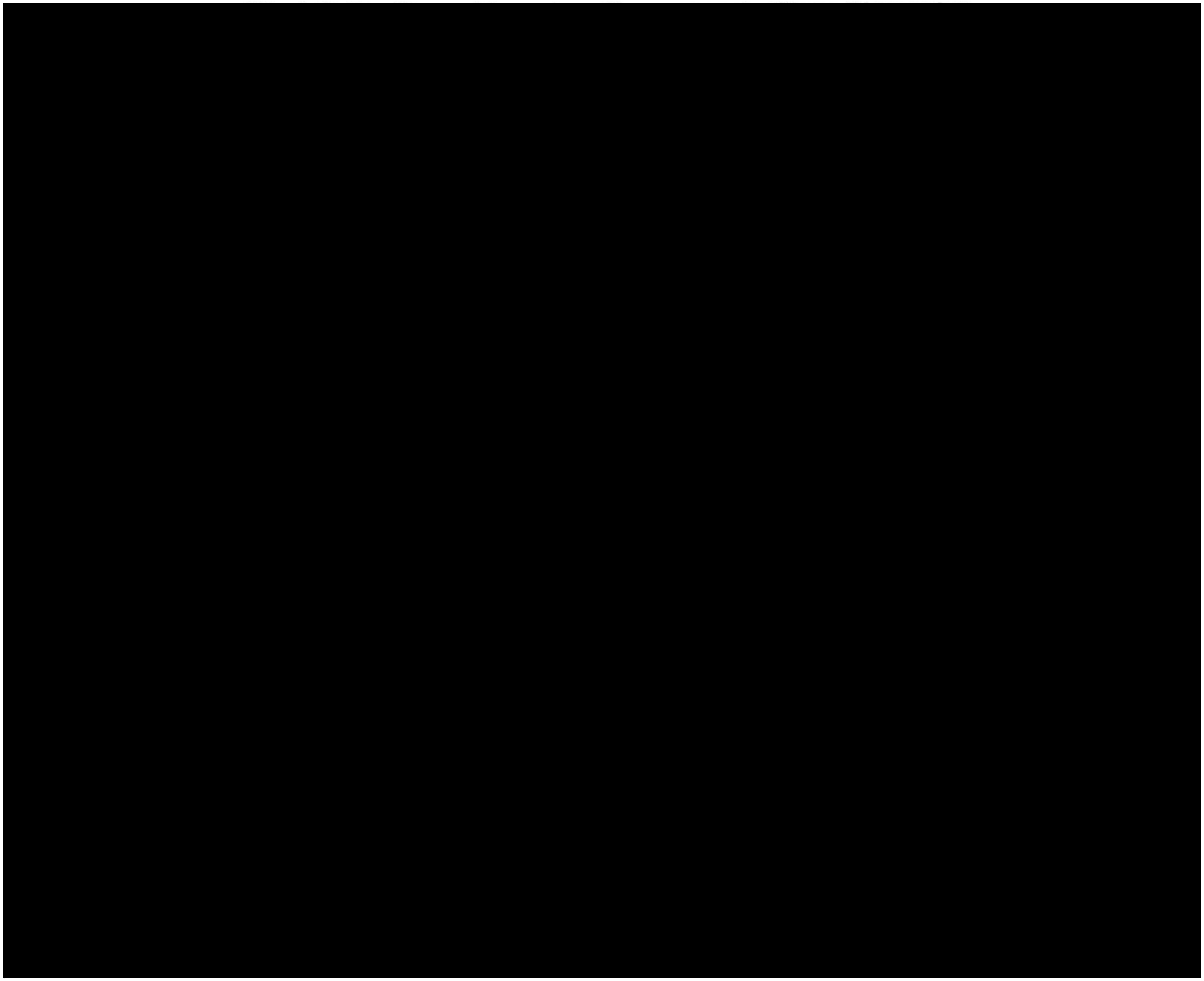


Week 6 Class Discussion

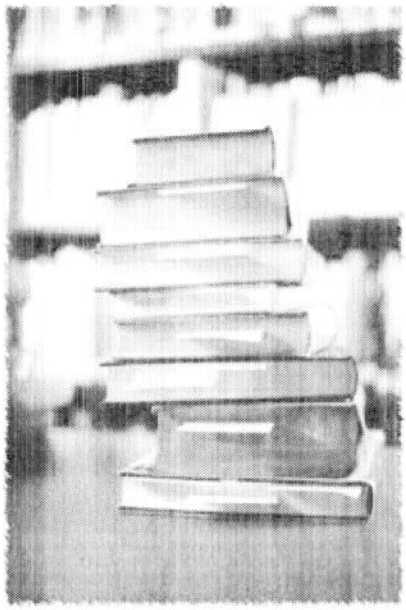
The weekly textbook concepts for our discussion this week are on supply chain processes are:

- Conformance Quality
- Total Quality Management
- Six Sigma
- Safety Stock
- Inventory Cost
- Record Post Inventory Costs

Select one of these concepts and find a related article at Workforce.com (go down to business administration and click on total quality management), at the New York Times:http://www.nytimes.com/ , or at the Wall Street Journal at www.wsj.com (you can use the Wall Street Journal every week in this course).

Week 6: Quality and Inventory Management [redacted]

[redacted]



[redacted]

[redacted]

Chapter 10: Problem 1 (page 341).

Chapter 11: Case: Inventory Management at Big10 Sweaters.com (page 395). Answer all 5 questions.

assembly phase and have to be replaced later. If all Part A's are inspected, one-third of the defectives will be found, thus raising the quality to 2 percent defectives.

a. Should the inspection be done if the cost of inspecting is \$0.01 per unit and the cost of replacing a defective in the final assembly is \$4.00?

b. Suppose the cost of inspecting is \$0.05 per unit rather than \$0.01. Would this change your answer in *a*?

Solution

Should Part A be inspected?

.03 defective with no inspection.

.02 defective with inspection.

a. This problem can be solved simply by looking at the opportunity for 1 percent improvement.

Benefit = .01(\$4.00) = \$0.04

Cost of inspection = \$0.01

Therefore, inspect and save \$0.03 per unit.

b. A cost of \$0.05 per unit to inspect would be \$0.01 greater than the savings, so inspection should not be performed.

Review and Discussion Questions

1 The capability index allows for some drifting of the process mean. Discuss what this means in terms of product quality output.

2 Discuss the purposes of and differences between *p* charts and $\overline{X}$- and *R*-charts.

3 In an agreement between a supplier and a customer, the supplier must ensure that all parts are within specification before shipment to the customer. What is the effect on the cost of quality to the customer?

4 In the situation described in question 3, what would be the effect on the cost of quality to the supplier?

5 Discuss the trade-off between achieving a zero AQL (acceptable quality level) and a positive AQL (such as an AQL of 2 percent).

Problems

1 A manager states that his process is really working well. Out of 1,500 parts, 1,477 were produced free of a particular defect and passed inspection. Based on Six Sigma theory, how would you rate this performance, other things being equal?

2 A company currently using an inspection process in its material receiving department is trying to install an overall cost reduction program. One possible reduction is the elimination of one inspection position. This position tests material that has a defective content on the average of 0.04. By inspecting all items, the inspector is able to remove all defects. The inspector can inspect 50 units per hour. The hourly rate including fringe benefits for this position is \$9. If the inspection position is eliminated, defects will go into product assembly and will have to be replaced later at a cost of \$10 each when they are detected in final product testing.

a. Should this inspection position be eliminated?

b. What is the cost to inspect each unit?

c. Is there benefit (or loss) from the current inspection process? How much?

3 A metal fabricator produces connecting rods with an outer diameter that has a $1 \pm .01$ inch specification. A machine operator takes several sample measurements over time and determines the sample mean outer diameter to be 1.002 inches with a standard deviation of .003 inch.

a. Calculate the process capability index for this example.

b. What does this figure tell you about the process?

and then to verify, by means of an audit conducted by an independent accredited third party, the compliance of those systems with the requirements of the standards.

The ISO 9000 standards are based on eight quality management principles. These principles focus on business processes related to different areas in the firm. These areas include (1) customer focus, (2) leadership, (3) involvement of people, (4) process approach, (5) system approach to management, (6) continual improvement, (7) factual approach to decision making, and (8) mutually beneficial supplier relationships. The ISO documents provide detailed requirements for meeting the standards and describe standard tools that are used for improving quality in the firm. These documents are intended to be generic and applicable to any organization producing products or services.

The ISO 14000 family of standards on environmental management addresses the need to be environmentally responsible. The standards define a three-pronged approach for dealing with environmental challenges. The first is the definition of more than 350 international standards for monitoring the quality of air, water, and soil. For many countries, these standards serve as the technical basis for environmental regulation. The second part of ISO 14000 is a strategic approach by defining the requirements of an environmental management system that can be implemented using the monitoring tools. Finally, the environmental standard encourages the inclusion of environment aspects in product design and encourages the development of profitable environment-friendly products and services.

New ISO documents are being developed on an ongoing basis. ISO 26000, which offers guidance on socially responsible behavior, has recently been adopted. The standard encourages organizations to discuss the social responsibility issues and possible actions with relevant stakeholders. Although not a strict "standard," the document argues that being socially responsible is a requirement for both public and private sector organizations.

SIX SIGMA QUALITY

LO3

Six Sigma refers to the philosophy and methods companies such as General Electric and Motorola use to eliminate defects in their products and processes. A defect is simply any component that does not fall within the customer's specification limits. Each step or activity in a company represents an opportunity for defects to occur and Six Sigma programs seek to reduce the variation in the processes that lead to these defects. Indeed, Six Sigma advocates see variation as the enemy of quality, and much of the theory underlying Six Sigma is devoted to dealing with this problem. A process that is in Six Sigma control will produce no more than two defects out of every billion units. Often, this is stated as four defects per million units, which is true if the process is only running somewhere within 1.5 sigma of the target specification.

Six Sigma A statistical term to describe the quality goal of no more than four defects out of every million units. Also refers to a quality improvement philosophy and program.

One of the benefits of Six Sigma thinking is that it allows managers to readily describe the performance of a process in terms of its variability and to compare different processes using a common metric. This metric is **defects per million opportunities (DPMO)**. This calculation requires three pieces of data:

DPMO A metric used to describe the variability of a process.

1. **Unit.** The item produced or being serviced.
2. **Defect.** Any item or event that does not meet the customer's requirements.
3. **Opportunity.** A chance for a defect to occur.

A straightforward calculation is made using the following formula:

$$\text{DPMO} = \frac{\text{Number of defects}}{\text{Number of opportunities for error per unit} \times \text{Number of units}} \times 1{,}000{,}000$$

38 Palin's Muffler Shop has one standard muffler that fits a large variety of cars. The shop wishes to establish a *periodic review* system to manage inventory of this standard muffler. Use the information in the following table to determine the optimal inventory target level (or order-up-to level).

Annual demand	3,000 mufflers	Ordering cost	$50 per order
Standard deviation of daily demand	6 mufflers per working day	Service probability	90%
Item cost	$30 per muffler	Lead time	2 working days
Annual holding cost	25% of item value	Working days	300 per year
Review period	15 working days		

a. What is the optimal target level (order-up-to level)?

b. If the service probability requirement is 95 percent, the optimal target level (your answer in *a*) will (select one):

I. Increase.

II. Decrease.

III. Stay the same.

39 Daily demand for a certain product is normally distributed with a mean of 100 and a standard deviation of 15. The supplier is reliable and maintains a constant lead time of 5 days. The cost of placing an order is $10 and the cost of holding inventory is $0.50 per unit per year. There are no stock-out costs, and unfilled orders are filled as soon as the order arrives. Assume sales occur over 360 days of the year.

Your goal here is to find the order quantity and reorder point to satisfy a 90 percent probability of not stocking out during the lead time.

a. To manage inventory, the company is using (select one)

b. Find the order quantity.

c. Find the reorder point.

Analytics Exercise: Inventory Management at Big10Sweaters.com

Big10Sweaters.com is a new company started last year by two recent college graduates. The idea behind the company was simple. They will sell premium logo sweaters for Big Ten colleges with one major, unique feature. This unique feature is a special large monogram that has the customer's name, major, and year of graduation. The sweater is the perfect gift for graduating students and alumni, particularly avid football fans who want to show support during the football season. The company is off to a great start and had a successful first year while selling to only a few schools. This year they plan to expand to a few more schools and target the entire Big Ten Conference within three years.

You have been hired by Big10Sweaters.com and need to make a good impression by making good supply chain decisions. This is your big opportunity with a startup. There are only two people in the firm and you were hired with the prospect of possibly becoming a principal in the future. You majored in supply chain (operations) management in school and had a great internship at a big retailer that was getting into Internet sales. The experience was great, but now you are on your own and have none of the great support that the big company had. You need to find and analyze your own data and make some big decisions. Of course, Rhonda and Steve, the partners who started the company, are knowledgeable about this venture and they are going to help along the way.

Rhonda had the idea to start the company two years ago and talked her friend from business school, Steve, to join her. Rhonda is into web marketing, has a degree in computer science, and has been working on completing an online MBA. She is as much an artist as a techie. She can really make the website sing.

Steve majored in accounting and likes to pump the numbers. He has done a great job of keeping the books and selling the company to some small venture capital people in the area. Last year, he was successful in getting them to invest $2,000,000 in the company (a onetime investment). There were some significant strings attached to this investment in

that it stipulated that only $100,000 per year could go toward paying the salary of the two principals. The rest had to be spent on the website, advertising, and inventory. In addition, the venture capital company gets 25 percent of the company profits, before taxes, during the first four years of operation, assuming the company makes a profit.

Your first job is to focus on the firm's inventory. The company is centered on selling the premium sweaters to college football fans through a website. Your analysis is important since a significant portion of the company's assets is the inventory that it carries.

The business is cyclic, and sales are concentrated during the period leading up to the college football season, which runs between late August and the end of each year. For the upcoming season, the firm wants to sell sweaters to only a few of the largest schools in the Midwest region of the United States. In particular, they are targeting The Ohio State University (OSU), the University of Michigan (UM), Michigan State University (MSU), Purdue University (PU), and Indiana University (IU). These five schools have major football programs and a loyal fan base.

The firm has considered the idea of making the sweaters in their own factory, but for now they purchase them from a supplier in China. The prices are great, but service is a problem since the supplier has a 20-week lead time for each order and the minimum order size is 5,000 sweaters. The order can consist of a mix of the different logos, such as 2,000 for OSU, 1,500 for UM, 750 for MSU, 500 for PU, and 250 for IU. Within each logo sub lot, sizes are allocated based on percentages and the supplier suggests 20 percent X-large, 50 percent large, 20 percent medium, and 10 percent small based on their historical data.

Once an order is received, a local subcontractor applies the monograms and ships the sweaters to the customer. They store the inventory of sweaters for the company in a small warehouse area located at the subcontractor.

This is the company's second year of operation. Last year they only sold sweaters for three of the schools, OSU, MU, and PU. They ordered the minimum 5,000 sweaters and sold all of them, but the experience was painful since they had too many MU sweaters and not enough for OSU fans. Last year they ordered 2,300 OSU, 1,800 MU, and 900 PU sweaters. Of the 5,000 sweaters, 342 had to be sold at a steep discount on eBay after the season. They were hoping not to do this again.

For the next year, you have collected some data relevant to the decision. Exhibit 11.12 shows cost information for the product when purchased from the supplier in China. Here we see that the cost for each sweater, delivered to the warehouse of our monogramming subcontractor, is $60.88. This price is valid for any quantity that we order above 5,000 sweaters. This order can be a mix of sweaters for each of the five schools we are targeting. The supplier needs 20 weeks to process the order, so the order needs to be placed around April 1 for the upcoming football season.

Our monogramming subcontractor gets $13 for each sweater. Shipping cost is paid by the customer when the order is placed.

In addition to the cost data, you also have some demand information, as shown in Exhibit 11.13. The exact sales numbers for last year are given. The exhibit indicates the retail or "full price" sales for the sweaters. Sweaters that we had at the end of the season were sold through eBay for $50 each and were not monogrammed. Keep in mind that the retail sales

exhibit 11.12 Cost Information for the Big Ten Sweaters

China supplier cost		
Material	$32.00	
Labor	10.50	
Overhead	1.25	
Transportation within China	1.00	
Supplier profit	8.95	
Agent's fee	2.68	
Freight (ocean carrier)	1.50	
Duty, insurance, etc.	3.00	
Total supplier cost		$60.88
Domestic subcontractor cost		
Monogram Material	$5.00	
Labor	8.00	
Total subcontractor cost		$13.00
Total (per sweater)		$73.88

Forecast Data for the Big Ten Sweaters

exhibit 11.13

	Average Football Game Attendance	Last Year's Actual Sales (full price)	Rhonda's Forecast for Next Year	Steve's Forecast for Next Year	Market Research Forecast for Next Year	Average Forecast	Standard Deviation
Ohio State	105,261	2,300	2,500	2,200	2,800	2,500	300
Michigan	108,933	1,468	1,800	1,500	2,000	1,767	252
Purdue	50,457	890	1,000	900	1,100	1,000	100
Michigan State	74,741	—	1,750	1,500	1,600	1,617	126
Indiana	41,833	—	600	500	450	517	76
Penn State	107,008						
Wisconsin	80,109						
Iowa	70,214						
Illinois	59,545						
Minnesota	50,805						
Northwestern	24,190						
Nebraska	85,071						
Total		4,658*	7,650	6,600	7,950	7,400	430**

*342 sweaters were sold through eBay for $50 each (the customer pays shipping on all orders).

**Calculated assuming the demand at each school is independent $= \sqrt{\sum_{i=1}^{N} \sigma_i^2}$

numbers do not accurately reflect actual demand since they stocked out of the OSU sweaters toward the end of the season.

As for advertising the sweaters for next season, Rhonda is committed to using the same approach used last year. The firm placed ads in the football program sold at each game. These worked very well for reaching those attending the games, but she realized there may be ways to advertise that may open sales to more alumni. She has hired a market research firm to help identify other advertising outlets but has decided to wait at least another year to try something different.

Forecasting demand is a major problem for the company. You have asked Rhonda and Steve to predict what they think sales might be next year. You have also asked the market research firm to apply their forecasting tools. Data on these forecasts are given in Exhibit 11.13. To generate some statistics you have averaged the forecasts and calculated the standard deviation for each school and in total.

Based on advice from the market research firm, you have decided to use the aggregate demand forecast and standard deviation for the aggregate demand. The aggregate demand was calculated by adding the average forecast for each item. The aggregate standard deviation was calculated by squaring the standard deviation for each item (this is the variance), summing the variance for each item, and then taking the square root of this sum. This assumes that the demand for each school is independent, meaning that the demand for Ohio State is totally unrelated to the demand at Michigan and the other schools.

You will allocate your aggregate order to the individual schools based on their expected percentage of total demand. You discussed your analysis with Rhonda and Steve and they are OK with your analysis. They would like to see what the order quantities would be if each school was considered individually.

You have a spreadsheet set up with all the data from the exhibits called Big10Sweater.xls and you are ready to do some calculations.

Questions

1. You are curious as to how much Rhonda and Steve made in their business last year. You do not have all the data, but you know that most of their expenses relate to buying the sweaters and having them monogrammed. You know they paid themselves $50,000 each and you know the rent, utilities, insurance, and a benefit package for the business was about $20,000. About how much do you think they made "before taxes" last year? If they must make their payment to the venture capital firm, and then pay 50% in taxes, what was their increase in cash last year?
2. What was your reasoning behind using the aggregate demand forecast when determining the size of your order rather than the individual school forecasts? Should you rethink this or is there a sound basis for doing it this way?
3. How many sweaters should you order this year? Break down your order by individual school. Document your calculations in your spreadsheet. Calculate this based on the aggregate forecast and also the forecast by individual school.

4 What do you think they could make this year? They are paying you $40,000 and you expect your benefit package addition would be about $1,000 per year. Assume that they order based on the aggregate forecast.

5 How should the business be developed in the future? Be specific and consider changes related to your supplier, the monogramming subcontractor, target customers, and products.

Super Quiz

1 Model most appropriate for making a one-time purchase of an item.
2 Model most appropriate when inventory is replenished only in fixed intervals of time, for example, on the first Monday of each month.
3 Model most appropriate when a fixed amount must be purchased each time an order is placed.
4 Based on an EOQ-type ordering criterion, what cost must be taken to zero if the desire is to have an order quantity of a single unit?
5 Term used to describe demand that can be accurately calculated to meet the need of a production schedule, for example.
6 Term used to describe demand that is uncertain and needs to be forecast.
7 We are ordering T-shirts for the spring party and are selling them for twice what we paid for them. We expect to sell 100 shirts and the standard deviation associated with our forecast is 10 shirts. How many shirts should we order?
8 We have an item that we stock in our store that has fairly steady demand. Our supplier insists that we buy 1,200 units at a time. The lead time is very short on the item, since the supplier is only a few blocks away and we can pick up another 1,200 units when we run out. How many units do you expect to have in inventory on average?
9 For the item described in question 8, if we expect to sell approximately 15,600 units next year, how many trips will we need to make to the supplier over the year?
10 If we decide to carry 10 units of safety stock for the item described in questions 8 and 9, and we implemented this by going to our supplier when we had 10 units left, how much inventory would you expect to have on average now?
11 We are being evaluated based on the percentage of total demand met in a year (not the probability of stocking out as used in the chapter). Consider an item that we are managing using a fixed-order quantity model with safety stock. We decide to double the order quantity but leave the reorder point the same. Would you expect the percent of total demand met next year to go up or down? Why?
12 Consider an item for which we have 120 units currently in inventory. The average demand for the item is 60 units per week. The lead time for the item is exactly 2 weeks and we carry 16 units for safety stock. What is the probability of running out of the item if we order right now?
13 If we take advantage of a quantity discount, would you expect your average inventory to go up or down? Assume that the probability of stocking out criterion stays the same.
14 This is an inventory auditing technique where inventory levels are checked more frequently than one time a year.

1. Single-period model 2. Fixed–time period model 3. Fixed–order quantity model 4. Setup or ordering cost 5. Dependent demand 6. Independent demand 7. 100 shirts 8. 600 units 9. 13 times 10. 610 units 11. Go up (we are taking fewer chances of running out) 12. 50 percent 13. Will probably go up if the probability of stocking out stays the same 14. Cycle counting

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