April 14, 2020

Contents

Pharm D IV Year UNIT 2 Basic Statistics & Research Methodology

1 Basic Statistics

1.1 Measures of Central Tendency

Measures of central tendency, also known as measures of location, are typically among the first statistics computed for the continuous variables in a new data set.The main purpose of computing measures of central tendency is to give one an idea of what is a typical or common value for a given variable.The common measures of central tendency are 1) Arithmetic Mean 2) Median 3) Mode 4) Weighed Arithmetic Mean 5) Harmonic Mean 6) Geometric Mean .

1. **Arithmetic Mean** The arithmetic mean is calculated by adding up all the values and dividing by the number of values. The mean of a population is denoted by the Greek letter mu (μ) while the mean of a sample is typically denoted by a bar over the variable symbol: The mean of x would be designated $\bar{x}$ and pronounced "x-bar."
   For example, if we have the following values of the variable x: 93, 88, 97, 100, 103. We calculate the mean by adding them up and dividing by 5 (the number of values):
   $\boldsymbol{x = (93 + 88 + 97 + 100 + 103)/5 = 481/5 = 96.2}$
   Summation notation, $\sum$, which defines a statistic by expressing how it is calculated. The difference is the symbol for the mean itself Population mean μ and sample mean $\bar{x}$. The mean of a data set, as expressed in summation notation, is:

   $$\boxed{\bar{x} = 1/n \sum_{i=1}^{n} x_i} \tag{1.1}$$

2. **Median** The median of a data set is the middle value when the values are ranked in ascending or descending order. If there are n values, the median is formally defined as the ((n+1)/2)th value. If n = 7, the middle value is the ((7+1)/2)th or fourth value. If there is an even number of values, the median is the average of the two middle values. This is formally defined as the average of the (n/2)th and ((n/2)+1)th value. If there are six values, the median is the average of the (6/2)th and ((6/2)+1)th value, or the third and fourth values.:
   Odd number of values:
   1, 2, 3, 4, 5, 6, 7 median = 4
   Even number of values:
   1, 2, 3, 4, 5, 6 median = (3+4)/2 = 3.5
   so, for the above data, median is 97.
   The median is a better measure of central tendency than the mean for data that is asymmetrical or contains outliers. This is because the median is based on the ranks of data points rather than their actual values: 50 percent of the data values in a distribution lie below the median, and 50 percent above the median, without regard to the actual values in question. Therefore it does not matter if the data set contains some extremely large or small values, because they will not affect the median more than less extreme values.

3. **Mode** the mode, which refers to the most frequently occurring value. The mode is most useful in describing categorical data. For example, if the the numbers below reflect the favored news sources of a group of students, where 1 = english newspapers, 2 = local newspapers, 3 = television and 4 = Internet:
   1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 3, 4,4,4,4,4,4,4,4,4,4,4.

We can see that the Internet is the most popular source because 4 is the most common value in this data set. In a symmetrical distribution such as the normal distribution, the mean, median, and mode are identical. In an asymmetrical or skewed distribution they differ, and the amount by which they differ is one way to evaluate the skewness of a distribution.

4. **Weighted Arithmetic Mean** A weighted mean is a kind of average. Instead of each data point contributing equally to the final mean, some data points contribute more "weight" than others. If all the weights are equal, then the weighted mean equals the arithmetic mean. Weighted means are very common in statistics, especially when studying populations.
To find the weighted mean:

$$\boxed{\text{Weighted Mean} = \frac{\displaystyle\sum_{i=1}^{n}(x_i \times w_i)}{\displaystyle\sum_{i=1}^{n} w_i}} \tag{1.2}$$

The natural abundance of Carbon occurs as isotope-12, 99% and isotope-13, 1%. If the atomic weight of Carbon element is calculated as simple arithmetic mean, that is equal weightage for both isotopes, then it would be $\mathbf{12 + 13 = 12.5}$.
When atomic weight is computed giving weightage based on actual occurance, then using the weighted arithmetic mean formula: $\mathbf{[(99)(12) + (1)(13)]/100 = 12.01}$ The actual atomic weight of carbon is 12.01.

5. **Harmonic Mean** Harmonic Mean is the reciprocal of the arithmetic mean of the reciprocals.It is the number of observations, divided by the sum of reciprocals of the observations. It is appropriate for situations when the average of rates is desired. The harmonic mean is involved in many situations where rates, ratios, geometry, trigonometry etc considered, the harmonic mean provides the truest average.The Harmonic mean is always the lowest mean.

$$\boxed{HM = \frac{N}{1/x_1 + 1/x_2 + 1/x_3 + \cdots + 1/x_n}} \tag{1.3}$$

Where, x_i= Individual score
N = Sample size (Number of scores)
To find the Harmonic Mean of 1,2,3,4,5,6,7,8.
So, Harmonic Mean = 2.94.

6. **Geometric Mean** The geometric mean is a type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values. The geometric mean is defined as the nth root of the product of n numbers.

$$\boxed{GM = \left\{\prod_{n=1}^{k} x_n\right\}^{1/k}} \tag{1.4}$$

What is the geometric mean of 3, 5 and 7?
$\sqrt[3]{3 \times 5 \times 7} = 4.72$
The PI symbol in statistics means to multiply a series of numbers. The definition

says to multiply k numbers and then take the kth root.The geometric mean only works with positive numbers. Negative numbers could result in imaginary results depending on how many negative numbers are in a set. Most uses of the geometric mean involve real data, such as the length of physical objects or the number of people responding to a survey.
If a measurement of population growth shows 50 at time 0, 100 after one day, and 200 after two days, the geometric mean (100) is more meaningful than the arithmetic mean (116.7).The geometric mean is always less than or equal to the arithmetic mean, and is meaningful for data with logarithmic relationships.

$$\sqrt[3]{\mathbf{50 \times 100 \times 200}} = [\text{log}\mathbf{50} + \text{log}\mathbf{100} + \text{log}\mathbf{200}]/\mathbf{3} = \text{antilog}[\mathbf{2}] = \mathbf{100} \quad (1.5)$$

1.2 Measures of Dispersion

Dispersion refers to how variable or "spread out" data values are: for this reason measures of dispersions are sometimes called "measures of variability" or "measures of spread."

1. **The Range** The range, which is the difference between the highest and lowest values. Often the minimum (smallest) and maximum (largest) values are reported as well as the range. For the data set (93, 88, 97, 100, 103), the minimum is 88, the maximum is 103, and the range is (103 - 88) = 15.

2. **The Variance and Standard Deviation** For continuous data, the most common measures of dispersion are the variance and standard deviation. Both describe how much the individual values in a data set vary from the mean or average value.The variance is the average of the squared deviations from the mean, and the standard deviation is the square root of the variance. The variance of a population is signified by $\boldsymbol{\sigma^2}$, and the standard deviation as $\boldsymbol{\sigma}$, while the sample variance and standard deviation are signified by $\boldsymbol{s^2}$ and s, respectively.
   Here for $\boldsymbol{\sigma^2}$ calculation $\bar{x}$ is assumed to be equal to $\boldsymbol{\mu}$ as it is calculated from large number of samples. Written in summation notation, the formula to calculate the sum of all deviations from the mean and squared for a data set with n observations and divide their sum by n, the number of cases, to get the average deviation or variance for a population:

$$\boxed{\boldsymbol{\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}} \quad (1.6)$$

   Another way to calculate $\boldsymbol{\sigma^2}$

$$\boxed{\boldsymbol{\sigma^2 = \frac{n(\sum x^2) - (\sum x)^2}{n^2}}} \quad (1.7)$$

   The sample formula for the variance requires dividing by n - 1 rather than n because we lose one degree of freedom when we calculate the mean. The formula for the variance of a sample, notated as $\boldsymbol{s^2}$, is therefore:

$$\boxed{\boldsymbol{s^2 = \frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \bar{x})^2}} \quad (1.8)$$

Another way to calculate sample variance s^2:

$$\boxed{s^2 = \frac{n(\sum x^2) - (\sum x)^2}{n(n-1)}} \tag{1.9}$$

The square root of the variance is called the standard deviation and is signified by σ for a population and s for a sample. The formula for a population standard deviation is:

$$\boxed{\sigma = \sqrt{\sigma^2} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}} \tag{1.10}$$

The formula for the sample standard deviation is:

$$\boxed{s = \sqrt{s^2} = \sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \bar{x})^2}} \tag{1.11}$$

3. **Degrees of Freedom:** In statistics, the number of degrees of freedom is the number of values in the final calculation of a statistic that are free to vary.

4. **Coefficient of Variation**
   The coefficient of variation (CV), a measure of relative variability, and makes it possible to compare variability across variables measured in different units. . The CV is calculated by dividing the standard deviation by the mean, then multiplying by 100.

$$\boxed{CV = \frac{s}{\bar{x}} \times 100} \tag{1.12}$$

5. **Standard Error of Mean(SEM)**
   SEM is usually estimated by the sample standard deviation divided by the square root of the sample size.

$$\boxed{SE_{\bar{x}} = \frac{s}{\sqrt{n}}} \tag{1.13}$$

   This estimate may be compared with the formula for the true standard deviation of the sample mean:

$$\boxed{SE_{\bar{x}} = \frac{\sigma}{\sqrt{n}}} \tag{1.14}$$

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1.3 Checking it Out!

1. Calculate the measures of dispersion with following data:55, 48, 63, 39, 44.

Table 1.1: Measures of Dispersion Calculation

x data	$(x - \bar{x})$	$(x - \bar{x})^2$
55	5.2	27.04
48	-1.8	3.24
63	13.2	174.24
39	-10.8	116.64
44	-5.8	33.64
$\sum = \mathbf{249}$	$\sum = \mathbf{0}$	$\sum = \mathbf{354.8}$
$\bar{x} = \mathbf{49.8}$	0	$\sigma^2 = \mathbf{70.96}$
$\bar{x} = \mathbf{49.8}$	0	$\sigma = \mathbf{8.4237}$
$\bar{x} = \mathbf{49.8}$	0	$s^2 = \mathbf{88.7}$
$\bar{x} = \mathbf{49.8}$	0	$s = \mathbf{9.4180}$

2. For the following data: 119, 98, 101, 88, 104, 102, 108, 108, 93, 112. Calculate a) the mean, b) the standard deviation, c) the variance, d) the coefficient of variation, e) the range, and f) the median.

3. Compute the arithmetic mean, geometric mean, and harmonic mean of the following set of data. 3, 5, 7, 13, 17, 29 , 57.

4. If the weights are 2, 1, 1, 3, 3, and 2 for the numbers 5, 7, 8, 11, 14, and 44 compute the weighted average and variance.

1.4 Confidence Interval

A confidence interval, in statistics, refers to the probability that a population parameter will fall between two set values for a certain proportion of time. Confidence intervals measure the degree of uncertainty or certainty in a sampling method. A confidence interval can take any number of probabilities, with the most common being a 95% or 99% confidence level.
The extreme values of the interval are called the confidence limits. The term 'confidence' implies that we can assert with a given degree of confidence, i.e. a certain probability, that the confidence interval does include the true value. The size of the confidence interval will depend on how certain we want to be that it includes the true value: the greater the certainty, the greater the interval required.

Factors affecting the width of the confidence interval include the size of the sample, the confidence level, and the variability in the sample. A larger sample size normally will lead to a better estimate of the population parameter.
Figure 1.1 shows the sampling distribution of the mean for samples of size n. If we assume that this

distribution is normal, then 95% of the sample means will lie in the range given by:

$$\mu - 1.96(\sigma/\sqrt{n}) < \bar{x} < \mu + 1.96(\sigma/\sqrt{n}) \tag{1.15}$$

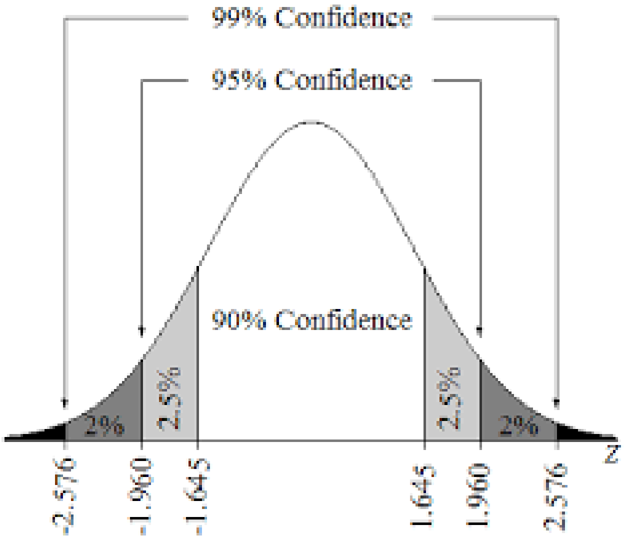

Figure 1.1: The sampling distribution of the mean, showing the range within which 95% of sample means lie.

(When we use z- table to check that the proportion of values between z = -1.96 and z = 1.96 is 0.95 - looking it up in reverse). In reality we are unlikely to know σ exactly. When the sample is large, σ can be replaced by its estimate, 's'. Other confidence limits are sometimes used, in particular the 99% and 99.7% confidence limits.
For large samples, the confidence limits of the mean are given by

$$\bar{x} \pm zs/\sqrt{n} \tag{1.16}$$

where the value of z depends on the degree of confidence required. For 95% confidence limits, z = 1.96 For 99% confidence limits, z = 2.58 For 99.7% confidence limits, z = 2.97

1.5 Tests of Significance or Hypothesis Testing

Hypothesis testing is an act in statistics whereby an analyst/statistician/researcher tests an assumption regarding a population parameter.
Every test of significance begins with a null hypothesis H_0. For a new drug testing, the null hypothesis might be that the new drug is no better, on average, than the current drug. We would write H_0: there is **no difference** between the two drugs on average.
The alternative hypothesis might be that the new drug has a different effect, on average, compared to that of the current drug. We could write H_a: the two drugs have different effects, on average - **it could be better or worse.** - But, it should be remembered that the test decision (better or worse) should be 'priori' before setting experiment.
The final conclusion once the test has been carried out is always given in terms of the null hypothesis. We either "reject H_0 in favor of H_a" or "do not reject H_0"; we never conclude "reject H_a", or even

"accept H_a". The significance level for a given hypothesis test is a value for which a P-value less than or equal to is considered statistically significant. Typical values for are 0.1, 0.05, and 0.01. Type I error, is rejecting a null hypothesis when it is actually correct and accepting alternate hypothesis. Type II error is accepting a null hypothesis when the alternate hypothesis should have been accepted. To minimize the probability of Type I error, the significance level is generally chosen to be small.

1.6 t-tests [paired, unpaired]

Comparison of an experimental mean with a known value

$$t = \frac{(\bar{x} - \mu)\sqrt{n}}{s} \tag{1.17}$$

If |t| (i.e. the calculated value of 't' without regard to sign) exceeds a certain critical value then the null hypothesis is rejected. The critical value of t for a given significance level can be found from t - table.

where $\bar{x}$ = sample mean, s = sample standard deviation and n = sample size.

Problem:

In a new method for determining Tramadol (pain reliever & habit forming drug) in tablets with label claim the following values were obtained:

50.9, 50.7, 48.1, 49.6, 49.1 mg/tablet

Is there any evidence of systematic error?

The mean of these values is 49.68 and the standard deviation is 1.16. Adopting the null hypothesis that there is no systematic error, i.e. that μ = 50, Eq. (1.17) gives:

$$t = \frac{(49.68 - 50)\sqrt{5}}{1.16} = -0.6168$$

From Table , the critical value is $t_{4,0.05}$ = 2.78. Since the observed/calculated value of | t | is lesser than the critical value the null hypothesis is retained: there is no evidence of systematic error.

Comparison of two experimental means

Problem:

In a comparison of two methods for the determination of Lorazepam (treatment of anxiety)in tablet dosage forms, the following results mg/tablet were obtained. A new analytical method is tested by comparing it with those obtained by using a standard/regular method.:

Method 1: 1.1, 1.3, 0.9, 0.8, 1.1 mean = 1.04; standard deviation 0.1949

Method 2: 0.8, 0.9, 09, 0.7, 0.8 mean = 0.82 ; standard deviation 0.0836

For each method five determinations were made. Do these two methods give results which differ significantly at P = 0.05?

The two methods give two sample means, $\bar{x}_1$ and $\bar{x}_2$. The null hypothesis is that the two methods give the same result, i.e. H_0 : $\mu_1 = \mu_2$, or $\mu_1 - \mu_2 = 0$, so we need to test whether $(\bar{x}_1 - \bar{x}_2)$ differs significantly from zero. If these standard deviations are not significantly different, a pooled estimate, s, of the standard deviation can first be calculated using the equation:

$$s^2 = \frac{(n_1 - 1){s^2}_1 + (n_2 - 1){s^2}_2}{(n_1 + n_2) - 2} \tag{1.18}$$

To decide whether the difference between the two means, $\bar{x}_1$ and $\bar{x}_2$, is significant, i.e. to test the null hypothesis, $H_0 : \mu_1 = \mu_2$, the statistic 't' is calculated from:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{s\sqrt{1/n_1 + 1/n_2}} \tag{1.19}$$

where t has $(n_1 + n_2 - 2)$ degrees of freedom.

From Eq. (1.18), the pooled value of the standard deviation is given by:

$$s^2 = \frac{(|4 \times 0.1949^2)|+|4 \times 0.0836^2)|}{(5+5)-2} = 0.02248$$

so s = 0.1499.
From Eq. (1.19):

$$t = \frac{(1.04 - 0.82)}{0.1499\sqrt{1/5 + 1/5}} = 2.38$$

There are eight degrees of freedom, the critical value is $t_{8,0.05} = 2.31$. Since the experimental value of |t| is greater (very slightly) than table value, the difference between the two results is significant at the 5% level and the null hypothesis is rejected.

Paired t-test:

The paired sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample t-test, each subject or entity is measured twice, resulting in pairs of observations.

Problem:

Two analytical methods are compared by analysing with both the methods, the table gives the results of determining the drug XXX concentration (% w/w) in tablets. Tablets from five different batches were analysed to see whether the results obtained by the two methods differed. Each batch is giving **a pair** of measurements, that is one value for each method. By taking the difference, d, between each pair of results given by the two methods, and testing whether n paired results are drawn from the same population, that is $H_0 : \mu\_d = 0$.

$$t = \frac{\bar{d}\sqrt{n}}{s_d} \tag{1.20}$$

where $\bar{d}$ and s_d are the mean and standard deviation respectively of d values, the differences between the paired values. (Eq.(1.20) is similar to Eq. (1.17).) The number of degrees of freedom of t is n - 1.

Test whether there is a significant difference between the results obtained by the two methods in table 1.2.

These differences have mean, $\bar{d} = -3.024$, and standard deviation, $s_d = 1.3688$. Substituting in Eq. (1.20), with n = 5, gives |t| = 4.9399. The table value is $t_4 = 2.7763$ (P = 0.05). Since the calculated value of | t | is greater than table value the null hypothesis is regected: the methods do give significantly different results for the XXX concentration.

Table 1.2: Analysis Data

Batch	Method 1	Method 2	Difference(I-II)
1	185.17	189.29	- 4.12
2	186.19	190.66	-4.47
3	187.12	189.73	-2.61
4	188.33	191.23	-2.9
5	188.41	189.43	-1.02

2 Statistics: Online Video Links

Links from youtube on statistics learning in hyperlink format.
Click the colored box & Watch.

Documents

1. Lisa Sulivan - Nonparametric Tests

Sites to look for complete statistics learning resources

1. Khan Academy - Statistics - 67 videos

On Line Videos

1. Types of Data: Nominal, Ordinal, Interval/Ratio - Statistics Help
2. Introduction to Statistics (1.1)
3. Types of Sampling Methods (4.1)
4. Bar Charts, Pie Charts, Histograms, Stemplots, Timeplots (1.2)
5. Causation vs Association, and an Introduction to Experiments (3.1)
6. Statistics 101: ANOVA, A Visual Introduction
7. Statistics 101: One-way ANOVA, A Visual Tutorial
8. Statistics 101: One-way ANOVA, Understanding the Calculation
9. Linear Regression - Fun and Easy Machine Learning
10. Correlation & Regression: Concepts with Illustrative examples
11. Statistics made easy ! ! ! Learn about the t-test, the chi square test, the p value and more
12. Mode, Median, Mean, Range, and Standard Deviation (1.3)
13. The Normal Distribution and the 68-95-99.7 Rule (5.2)
14. A Gentle Introduction to Non-Parametric Statistics (15-1)

Video Links from zstastics.com

1. Categorical Data I: Proportions testing | Z test | Chi Squared test
2. Teach me STATISTICS in half an hour!
3. Descriptive Statistics: The Mean
4. Arithmetic Mean | Geometric Mean | Harmonic Mean

5. Descriptive Statistics: The median
6. Descriptive Statistics: The Mode
7. Variance and Std Deviation | Why divide by n-1?
8. Standard Error (of the sample mean) | Sampling | Confidence Intervals | Proportions
9. What is the Coefficient Of Variation?? (+ examples!)
10. What is skewness? A detailed explanation (with moments!)
11. What is Kurtosis? (+ the "peakedness" controversy!)
12. What are Quartiles? Percentiles? Deciles?
13. What are "moments" in statistics? An intuitive video!
14. Range | Interquartile Range (IQR) | Box and whisker plot
15. What are degrees of freedom?!? Seriously.
16. What is Regression? | SSE, SSR, SST | R-squared | Errors
17. Regression II - Degrees of Freedom EXPLAINED | Adjusted R-Squared
18. Regression Output Explained
19. Likelihood | Log likelihood | Sufficiency | Multiple parameters
20. Maximum Likelihood Estimation (MLE) | Score equation | Information | Invariance
21. Hypothesis testing (ALL YOU NEED TO KNOW!)
22. ANOVA: One-way analysis of variance
23. Non-parametric tests - Sign test, Wilcoxon signed rank, Mann-Whitney

3 References

1. Fundamentals of Analytical Chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch.
2. J C Miller and J N Miller Statistics for analytical chemistry
3. Sanford Bolton, Charles Bon Pharmaceutical Statistics Practical and Clinical Applications
4. Digital, Web Resources to Stimulate & Enhance: The Understanding & Learning Process.
5. www.wikipedia.org

Role of computer in inventory control

Inventory control is a very tedious job. It does not take a lot of brain power but a lot of organization. When managing inventory in a business, computers make tracking what is coming in and out of the warehouse or store much simpler, specially if there is a lot of data involved. The probabilities of a computer getting numbers wrong are too low. In fact, a computer is crucial to get the exact numbers of an inventory. Though, a very expensive computer is not necessary.

Uses of Computers in Inventory Control

Computers offer many advantages that cannot be realized with a manual inventory control system. The principal consideration in determining your need for computerized inventory control is the number of products you need to count and control.

Computerization has revolutionized inventory management, as technologies ranging from automatic scanners to radio frequency identification chips now allow businesses to track their inventory from the moment a company buys it wholesale to the moment the products leave the building in the hands of a customer.

Managing Stock Levels

Computers, tied to your point of sale registers, subtract items sold from inventory and add incoming stock to products on hand in a perpetual inventory system. You can create flags within the system to notify buyers when to reorder items for stock. This type of control prevents stock depletion and out-of-stock items.

Flexible Control

Items you want to add to your inventory are easily entered into the system on the fly. No need to wait for a billing period or cycle to end before making stock additions. This allows you to include new merchandise as you receive it, add it to stocks and put it out for sale.

Pricing Flexibility

Computers give you the ability to make pricing changes across the board for all items in stock, for a group of items, or for specific items. This aids in stock reduction and control for seasonal or cyclical inventory items.

Item Management

You can use a computerized inventory control system to manage warehoused items. Numbering systems and bar coding allow departmental controls that guide the management process of reviewing product profitability, individually or for groups of items. Update product information quickly and easily with a computerized system.

Sales Tracking

You can track sales using any number of selection criteria. Size, price, quantity and oldest items are just a few of your options with a computer. This tight control of sales information improves profitability and reduces lost sales.

Portable Computers

If your number of stock items is quite large, use portable computers to make on-shelf inventory counts. Use a hand-held computer to check stock on the shelves and enter them into a mobile database. When the shelf check is complete, the information is fed into a main computer and integrated with existing information.

Efficient Aduit

Your accounting staff will welcome computers as the inventory control system for your business. Computers are faster, more accurate, and offer the flexibility of printed reports and summaries that aid auditors in determining the profitability of your business.

Product Planning

The combined advantages offered by computerized inventory control systems allow review of sales and product movement at any moment. This enhances your overall product planning strategy.

Receipt of Goods
A retail store or a central warehouse uses bar code or radio-frequency identification scanning at the point of receipt of goods. Scanning individual items or shipment pallets allows a company to itemize all shipments from the supplier, which can be compared against the purchase order for errors or losses in transit. When your business ships these goods out of the warehouse to their point of sale, a second scan can automatically tally the remaining stock in the warehouse, and send messages to the purchasing managers indicating that it is time to reorder.

Retail Turnover
Many businesses use similar scanning techniques at the point of checkout. As of 2010, bar code scanners are more popular than RFID for this purpose. Both will automatically enter the correct price at the register and prevent data entry errors. They also can create a perfect real-time record of how much stock remains on the shelves, how much is available in on-site storage, and whether a new shipment is necessary from the warehouse. Combine this information with warehousing data, and your business can create additional alerts to key management when a bottleneck occurs. For example, if a dozen retail stores anticipate needing restocking, but the warehouse does not have sufficient goods on hand, your business can place a rush order to fill the need.

Stock Management and Cost Reduction
The process of moving goods through a company pipeline is always economically inefficient. The purchase of the goods represents an investment of company capital, which your business cannot recoup until you sell your inventory. Warehousing of goods before sale introduces the possibility of inventory shrinkage in value from theft, damage, deterioration or changes in customer taste. Moving goods from warehouses to the point of sale involves shipping costs, especially if the shipment is incorrect, or if the internal shipping process is inefficient. Computerization provides a real-time picture of this entire work flow process, and allows managers to reduce purchasing costs through minimizing inventory, increase the efficiency of internal shipping systems, and reduce the possibility of theft or damage by being able to track each item down to the individual staffer who takes responsibility for it.

Computerized Inventory Control Procedures

Inventory Cycle
Establishing an annual inventory cycle ensures items are reviewed annually and adjusted according to an inventory cycle schedule. Schedules are created by management using the system to establish time frames to physically count items and establish proper stock levels.

Inventory Accuracy
Inventory accuracy is critical to computerized inventory control systems. Accuracy is achieved by the computer "flagging" or providing a notification of "out of balance" items. Reverse post flags are created by management through the software system for inventory items that may need a special inventory performed.

Order Quantity Process
Inventory control procedures are used by management to ensure correct order quantities. The system automatically requests an item to be ordered when an inventory threshold set in the system by management is reached. Order quantities are adjusted according to inventory records reflecting the estimated date of shipping and the due date of the item into inventory.

Exception Reporting
Exception reports provide information on inventory items that may have been affected by a transaction. The report includes codes established by management reflecting the history of an item. Various types of reports provided by an inventory control system are daily, monthly, quarterly, annual and specialized inventory control reports.

Inventory Adjustment Procedures
Problems do occur with inventory items. If an inventory adjustment is needed, management can implement several kinds of adjustments. Procedural codes are written into the software by management to affect correction against item records. Changes to any type of item are reflected on a transaction report.

Product Quantities
Computers are most useful in your inventory control if you have a great many items you need to order, count and replenish as stock. A hardware store is a good example of an enterprise that can make good use of computerized inventory control, especially when you consider the hundreds--even thousands--of items maintained in stock. Grocery stores are another example.

Benefits of a Computerized Inventory System
Considerations
Implementing a computerized inventory system requires a number of considerations. The buyer must consider ease of implementation and use, vendor reputation, system expansion, training, vendor support and budget constraints.

Financial benefits
Industry averages suggest that a 20 percent reduction in inventory is achievable with a computerized inventory control system.

Other benefits
A computerized inventory system helps management control the inventories, in turn lowering overall operating costs in the areas of labor, facilities and logistics. A computerized inventory system also improves customer-service metrics and fulfillment rates.

Best practices
To fully realize these benefits the company must institute best practices in planning and setup, collaboration, inbound merchandise and inventory management and fulfillment.

Cost concerns
The cost of implementing the system goes far beyond the cost of the software package itself. The effort and time could be as high as 5 to 10 times the cost of the package. But the benefits of the system would still far outweigh the costs for a typical company.