CHAPTER 2 (Comp., Strategic Planning, Prod.)

Competitiveness – "Ability and performance of an organization in the marketplace compared to other organizations that offer similar goods"

Key Purchasing Criteria
- Any customer will consider 4 criteria when purchasing something.
- Price, Quality, Variety, Timeliness

Complex Purchases
- **Order Qualifiers** – "Purchasing criteria that customers perceive as minimum standards of acceptability for purchase" (allow product to be considered)
- **Order Winners** – "Purchasing criteria that cause the organization to be perceived as better than the competition" (allow product to be purchased)

Businesses Compete on 4 Criteria
- Cost, Quality, Flexibility, Timeliness

Strategic Planning – "Process of determining long-term plans that will set a direction for the organization and implementing it through allocation of resources"

Strategic Planning (hierarchical)
- **Mission** – "Where the org. is going now"
- **Vision** – "Where the organization desires to be in the future"
- **Values** – "Shared beliefs of the organization's stakeholders"
- **Goals / Obj.** – "Provide detail and scope of the company's mission"
- **Strategies** – "Plans that determine direction for achieving org. goals"
- **Tactics / Action Plans** – "Methods and actions taken to accomplish strategies"

Operations Strategy – "The approach that is used to guide the operations function"
- Should be consistent with org. strategy
- Should support competitive priorities

Strategic Decision Categories – Companies focus on these 9 categories to implement operations strategies:
- Facility
- Capacity
- Vertical Integration
- Vendor Relations
- Product Mix and New Products
- Process Type and Technology
- Human Resources
- Quality
- Operations Infrastructure and Systems

Formulation of an Operations Strategy
- **1)** Determine operations requirements
- **2)** Categorize customers into types and choose competitive priority emphasis
- **3)** Group product lines into types
- **4)** Assess strengths/weaknesses and competitive position
- **5)** Assess degree of plant focus
- **6)** Develop and deploy strategy for each decision cat. (obj., policies, action plans)

Generic Operations Strategies – "Common operations improvement programs"
- **Low Labour Cost** (after WWII)
- **Scale-Based** (economies of scale – 1960s)
- **Focused Factories** (smaller factories with narrow product lines – 1970s)
- **Flexible Factories** (flexible equipment allowed product variety – 1980s)
- **Continuous Improvement** (1990s)

Newer "Generic Operations Strategies"
- **Time-Based Competition** – "Focuses on the reduction of time needed to accomplish various tasks"
- **Outsourcing** – "Buying a part of a good/ service or segment of a production/ service process from another company"

Productivity – "A measure of the effective use of resources"
- **Productivity** = $\frac{Outputs}{Inputs}$
- **Productivity Growth** = $\frac{Current\ Period\ Prod. - Previous\ Period\ Prod.}{Previous\ Period\ Prod.}$

Other Measure of Productivity
- **Partial Measures** = $\frac{Output}{(Single\ Input)}$
  i.e. Output / Labour, Output / Capital
- **Multi-Factor Measure** = $\frac{Output}{(Multiple\ Inputs)}$
  i.e. Output / Labour + Capital + Energy
- **Total Measure** = $\frac{Output}{(Total\ Inputs)}$
  i.e. Goods Produced / All Required Inputs
- **Ensure all denominators are in same unit**

Keep in Mind…
- **Productivity** (use of overall resources) ≠ **Efficiency** (use of fixed set of resources)
- It is difficult to measure productivity of **services** (intangible, intellectual act., etc.)

Factors That Affect Productivity
- Methods, Management, Tech., Labour

CHAPTER 3 (Demand Forecasting)

Demand Forecasting – "An estimate of demand expected over a future period of time"

Three Uses of Forecasts
- **1) Design the system** (annual plans about product lines, capacity, equipment)
- **2) Use the system** (monthly plans about inventory, workforce levels, prod.)
- **3) Schedule the system** (daily/wk. plans about purchasing mater., staff scheduling)

Elements of a Good Forecast
- Accurate, Reliable, Meaningful, Easy Use

Steps in the Forecasting Process
- **1)** Determine purpose of forecast
- **2)** Establish a time horizon
- **3)** Select a forecasting technique
- **4)** Obtain, clean and analyze data
- **5)** Make the forecast
- **6)** Monitor the forecast

Approaches to Forecasting
- **1) Judgemental** – "Non-quant. analysis of subjective inputs" (considers soft info. such as human factors, gut instinct)
- **2) Quantitative** – "Quantitative analysis"

1) Judgmental Forecasting
- **Executive Options** (pool opinions of high-level executives) [long-term fore.]
- **Expert Opinions** (Delphi Method – "Experts complete a series of questions to achieve a consensus format") [tech. fore.]
- **Sales Force Opinions** (salesmen opinions based on direct customer contact)
- **Consumer Surveys** (focus groups or questionnaires to customers)
- **Historical Analogies** (use demand for a similar product as the forecast)

2) Quantitative Forecasting
- **Time-Series Models** – "Extends historical patterns of numerical data in future"
- **Associative Models** – "Uses explanatory variables to predict future demand for the variable of interest"

★ Time-Series Models

Time Series – "A time-ordered sequence of observations taken at regular intervals of time"

Six Patterns Identified in a Time Series
- **1) Level (avg.)** – horizontal pattern of demand (i.e. average observed demand)
- **2) Trend** – steady upward or downward movement of demand
- **3) Seasonality** – regular variations related to time of year or day
- **4) Cycles** – wavelike variations lasting more than one year
- **5) Irregular Variations** – caused by unusual circumstances (not reflective of typical behaviour
- **6) Random Variations** – residual variations after all other behaviours are explained (AKA – **"Noise"**)

Time Series Models
- **1) Naïve Methods**
- **2) Averaging Methods**
  - **2A)** Moving Average
  - **2B)** Weighted Moving Average
  - **2C)** Exponential Smoothing
- **3) Trend Models**
  - **3A)** Non-Linear Trend
  - **3B)** Linear Trend
  - **3C)** Trend-Adjusted Exp. Smoothing
- **4) Techniques for Seasonality**
  - **4A)** Techniques for Cycles
- * Cannot use any Time Series Model to forecast trends (because the forecasts lag behind actual sales) *

1) Naïve Methods
- "The forecast for the next period **should equal** the results of the last period"
- Simple, low cost Low accuracy
- Three key formulas:
  Stable Time Series Data: $F_t = A_{t-1}$
  Seasonal Variations: $F_t = A_{t-n}$
  Data w. Trend: $F_t = A_{t-1} + (A_{t-1} - A_{t-2})$

2A) Moving Average
- $F_t = \frac{\sum Demand\ in\ Previous\ n\ Periods}{n}$
- "Average of last few actual data values, updated each period"
- Smooths bumps, but lags behind changes

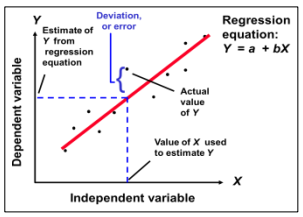
2B) Weighted Moving Average (WMA)
- $F_t = \frac{\sum(Weight)\ x\ (Demand)}{\sum Weights}$
- Assigns different weights to different periods (must sum to 100%)

2C) Exponential Smoothing
- "Sophisticated WMA"
- $F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$
  F_t = Previous Forecast + % (Forecast Error)
- $F_t = (1 - \alpha)F_{t-1} + (\alpha)(A_{t-1})$
  If $\alpha = 1$ then $F_t = A_t$ (f. reflects recent data)
  If $\alpha = 0$ then $F_t = F_t$ (f. does not " " ")
- α = smoothing constant (chosen subjectively from 0 to 1)
  * **Lower α** = more stable demand
  * **Higher α** = less stable demand

3) Techniques for Trend
- "Develop equation that describes trend"

3A) Non-Linear Trend
- i.e. Using an exponential, logarithmic, polynomial, etc. types of trend lines

3B) Linear Trend
- Equation: $\hat{y}_t = a + bt$
- Slope: $b = \frac{n\sum ty - \sum t \sum y}{n\sum t^2 - (\sum t)^2}$
- Y-Intercept: $a = \frac{\sum y - b\sum t}{n}$



- ● = "Observations from the past"
- **Deviation of Error** = "Distance from the data point to the line"
- **Regression Linke** – "The line with the 'minimum mean squared error'"

Using Excel for Linear Trends
- **= SLOPE** (Range of y's, Range of x's)
- **= INTERCEPT** (Range of y's, Range of x's)

3C) Trend-Adjusted Exponential Smoothing
- "Variation of exponential smoothing used when a time series exhibits a trend"
- $TAF_{t+1} = S_t + T_t$
- $S_t = TAF_t + \alpha(A_t - TAF_t)$
  (Is the smoothed avg. at end of period **t**)
- $T_t = T_{t-1} + \beta(S_t - S_{t-1} - T_{t-1})$
  (Is the smoothed trend at end of period **t**)

4) Techniques for Seasonality
- **Additive Model** (Demand = Trend + Seasonality)
- **Multiplicative Model** (Demand = Trend x Seasonality)
- **Seasonal Relative** (see below)

Seasonal Relative (SR)
- "Proportion of average (or trend) for a season in the multiplicative model"
- i.e. SR of 1.2 = 20% above average
- **Deseasonalize** (DD) – "Remove SR to more clearly see other components"
  DD = $\frac{Actual\ Demand}{Seasonal\ Relative}$
- **Reseasonalize** (RD) – "Adjust the forecast for seasonal component"
  RD = $(Forecast\ Based\ on\ DD)\ x\ SR$

Steps for Time Series Decomposition
- **1)** Compute the seasonal relatives
- **2)** Deseasonalize the demand data
- **3)** Fit a model to the DD demand data
- **4)** Forecast using this model
- **5)** Reaseasonalize the DD forecasts

4A) Techniques for Trends
- Best method is using **associative models**

★ Associative Models

Associative Models
- **Predictor Variables** – "Variables that can be used to predict values of the variable of interest" (essence of associative mod.)

1) Simple Linear Regression
- "Process of finding a straight line that best fits a set of points on a graph"
- AKA – **"Least Squares Line"**
- Same equation as **(3B) Linear Trend** (equation: $\hat{y} = a + bx$)

2) Multiple Regression
- "Associative models with more than one predictor variable"
- **Complex** calculations (need a computer)

3) Correlation Coefficient (r)
- **r** = "Measures the strength of the relationship between two variables"
- (Ranges from **-1 to 1**)
  = CORREL (Range of y, Range of x)
- **r^2** = "Measures the proportion of variation in the values of y that is 'explained' by the predictor var. in the regression model"
- (Ranges from **0 to 1**)
  = RSQ (Range of y , Range of x)
- $r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2} \times \sqrt{n(\sum y^2) - (\sum y)^2}}$

Accuracy and Control of Forecasting Process
- **1) Error**
- **2) Three Measures of Forecasts**
- **3) Control Charts**
- **4) Tracking Signal**

1) Error
- **Error** = (Actual Value – Forecast Value)
- **Bias** = The sum of the forecast errors
- **(+) Bias** = forecast too high
- **(-) Bias** = forecast too low

2) Three Measures of Forecasts
- **2A)** Mean Absolute Deviation
  MAD = $\frac{\sum|Actual - Forecast|}{n}$
  MAD = 2.5 (10/4)
- **2B)** Mean Squared Error
  MSE = $\frac{\sum(Actual - Forecast)^2}{n}$
  MSE = 7.5 (30/4)
- **2C)** Mean Absolute Percent Error
  MAPE = $100\frac{\sum(\frac{|Actual - Forecast|}{Actual})}{n}$ **%**
  MAPE = 1.17% (4.69%/4)

Period	Actual	Forecast	e	|e|	e^2	$\frac{\|e\|}{A} \times 100$
1	217	215	2	2	4	0.92%
2	213	216	−3	3	9	1.41%
3	216	215	1	1	1	0.46%
4	210	214	−4	4	16	1.90%
				$\sum$=10	$\sum$= 30	$\sum$= 4.69%

3) Control Charts

- "Plot the errors to see if errors are within pre-set control limits"
- Process is **"in control"** if (all errors are within control limits, no patterns exist)
- **Standard Deviation of Error** = s

$$s = \sqrt{MSE} = \sqrt{\frac{\sum e^2}{n}}$$

- Control Limits = 0 ± 2s (or 3s)
- **Example**: Control limits are 0 + 2s
  If s = 25... (UCL = +50 and LCL = –50)
  * Quest. will always advise **± 2s** or **± 3s** *

4) Tracking Signal

- "Ratio of cumulative error to MAD"
- Investigate if **TS > 4** or **TS < – 4**
- $TS = \frac{\sum (Actual - Forecast)}{MAD}$

CHAPTER 9 (Management of Quality)

- **Quality** – "The ability of a product or service to consistently meet or exceed customer expectations"
- **Quality Control** – "Monitoring, testing and correcting quality control problems after they occur"
- **Quality Assurance** – "Providing confidence in a product's quality by preventing defects before they occur"

Evolution of Quality Management

- **Pre-Industrial Revolution** (craftsmanship)
- **Industrial Revolution** (division of labour)
- **1950s** (quality assurance)
- **1970s** (quality management systems)
- **1980s** (TQM & continuous improvement)
- **Today** (Six Sigma & statistical tools)

Dimensions of Quality of Goods (for a car)

- **Performance** (everything works)
- **Aesthetics** (interior design, materials)
- **Special Features** (technology)
- **Safety** (antilock brakes, airbags)
- **Reliability** (does not break down easily)
- **Durability** (long life, rust resistance)
- **Perceived Quality** (brand reputation)
- **Service After Sale** (warranties, maint.)
- **Latent Quality** (roadworthiness)

Dimensions of Service Quality (for car repair)

- **Tangibles** (clean facilities, neat personnel)
- **Convenience** (good location and hours)
- **Reliability** (always fix car issues)
- **Responsiveness** (ask questions promptly)
- **Time** (reasonable wait time)
- **Assurance** (knowledgeable staff)
- **Courtesy** (friendly staff)

Determinants of Quality

- **Product Design** – "Intention of designers to include or exclude features that customers require"
- **Process Design** – "Translating product characteristics into process specifications"
- **Production** – "The degree to which goods conform to design specifications"

Costs of Quality

- **Internal Failure Costs** – "Fixing problems during production"
- **External Failure Costs** – "Fixing problems after delivery to the customer"
- **Appraisal Costs** – "Costs associated with inspection and testing"
- **Prevention Costs** – "Costs of preventing defects from occurring"

Quality Gurus (1/2)

- **W. Edwards Deming**
  (14 Points necessary for quality.)
  (Management must fix system.)
  (Must reduce variation in output.)
  (Statistical Process Control – SPC)
  (Plan-Do-Study-Act – PDSA)
- **Joseph M. Juran**
  (Viewed quality as fitness-for-use.)
  (Believed 80% of defects are controllable.)
  (First to measure cost of quality.)
  (Quality is a trilogy: quality planning, quality control, quality improvement.)

Quality Gurus (2/2)

- **Armand Feignbaum**
  (Q. affects whole org. Is a "total field".)
  (Intro. quality at the source. Meaning every emp. should inspect own work)
- **Philip B. Crosby**
  (Developed the zero defects concept.)
  ("Do it right the first time".)
  (Said quality was free. Pays for itself.)

Quality Certification

- **ISO 9001** – "Set of international standards on quality management and quality assurance, critical to international bus."
- Adopted by over 100 countries
- Documentation takes 12-18 months. Must re-register every 3 years.

ISO 9001 Elements

- **1)** Quality Management System (QMS)
- **2)** Management Responsibility
- **3)** Resource Management
- **4)** Product Realization
- **5)** Measurement, Analysis & Improve.

Hazard Analysis Critical Control Point (HACCP)

- "A quality control system designed for food processors" (similar to ISO 9001)
- Three main steps are:
  1) Perform hazard analysis
  2) Determination of critical control points
  3) Creation of the HACCP plan

Canada Awards for Excellence (CAE)

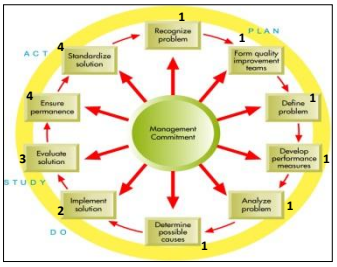
- Administered by National Quality Institute
- Six principles for business excellence:
  1) Leadership and governance
  2) Planning and env. Sustainability
  3) Customer / client / citizen focus
  4) People focus and healthy workplace
  5) Process management
  6) Supplier / partner focus
- Stages of quality mgmt. implementation:
  1) Foundation
  2) Transformation
  3) Role Model (silver of bronze cert.)
  4) World Class (gold certificate)

Total Quality Management (TQM)

- (Underlined are the three key features)
- "A philosophy that involves everyone in an org. in a continual effort to improve quality and achieve customer satisfaction"
- Five steps in the TQM approach:
  1) Find out what customer wants
  2) Design product that exceeds the wants
  3) Design processes that prevent defects
  4) Keep track of results
  5) Extend these concepts to suppliers
- **Poka-yoke** – "Incorporating process design elements that prevent mistakes" (AKA – **Fail-Safing**)

Plan-Do-Study-Act (PDSA)

- "Problem-solving & quality improvement methodology used in continuous improvement" (AKA – **Deming Cycle**)



Sig Sigma (6σ)

- "A business process for improving quality, reducing costs and increasing customer satisfaction"
- **Statistically** – Having **< 3.4** defects / mil.
- Five steps of Six Sigma:
  1) Define **(2)** Measure
  3) Analyze **(4)** Improve **(5)** Control

Seven Basic Quality Tools (1/2)

- **Check Sheet** – "A tally of problems or other events by category"
- **Flowchart** – "Diagram of steps in process"

Seven Basic Quality Tools (2/2)

- **Scatter Diagram** – "A graph that shows the degree and direction of a relationship between two variables"
- **Histogram** – "A chart that shows an empirical frequency distribution"
- **Pareto Chart** – "A diagram that arranges categories from highest to lowest frequency of occurrence" (Says 80% of problems can be attrib. to 20% of causes)
- **Control Chart** - "A statistical chart of time-ordered values of a sample statistic"
- **Cause-and-Effect Diagram** – "A diagram used to organize a search for the cause(s) of a problem" (AKA – **Fishbone Diagram**)

Methods for Generating Ideas

- **Brainstorming** – "Technique for generating a free flow of ideas in a group"
- **Quality Circles** – "Groups of workers who meet to discuss ways of improving products or processes"
- **Interviewing** – "Technique for identifying problems and collecting information"
- **Benchmarking** – "Process of measuring performance against the best in the same or another industry"
- **The 5W2H Approach** – "Asking questions that include what, why, where, who, when and how / how much"

CHAPTER 10 (Statistical Quality Control)

Two Types of Variation

- **1) Common Cause Variation**
- **2) Special Cause Variation**

1) Common Cause Variation

- "Natural variation in output of a process, caused by countless minor factors"
- AKA – **Random Variation** or **Chance**
- This type of process is in statistical control, stable and predictable

2) Variable Cause Variation

- "Non-random variability in a process output, whose cause can be identified"
- AKA – **Assignable Variation**
- This type of process is out of control, unstable and unpredictable

Forms of Stat. Sampling of Quality Control

- **1) Statistical Process Control** – "Sampling to determine if the process is in statistical control or not"
- **2) Acceptance Sampling** – "Sampling to accept or reject the immediate batch of product at hand"

Phases of Quality Control

- * Ordered least to most progressive *
- **1)** Inspection before and after production **(Acceptance Sampling)**
- **2)** Corrective action during production **(Statistical Process Control)**
- **3)** Quality built into the process **(Continuous Improvement & Six Sigma)**

Statistical Process Control Planning Process

- **1)** Define important quality characteristics and how to measure each
- **2)** FOR EACH CHARACTERISTIC:
  2A) Determine a quality control point
  2B) Plan...
  (i) How to inspect
  (ii) How much to inspect
  (iii) Where centralized or on-site
  2C) Plan corrective action process

Statistical Process Control (SPC)

- "A system to monitor process mean and process variation"
- **Benefits** – detects special cause variation and detects problems early

Designing Control Charts Steps (SPC)

- **1)** Determine a sample size
- **2)** Obtain 20 to 25 samples
- **3)** Establish and graph preliminary CL's
- **4)** Plot sampled values on control chart
- **5)** Are there any points outside CL's?
  YES (assume no assignable cause)
  NO (investigate and correct)

Types of Errors

- **Type I Error** (α) – "Concluding a process is out of control when it truly is in control"
- **(Type I** Error is the **Producer's** Risk)
- **Type II Error** (β) – "Concluding a process is in control when it truly is out of control"
- **(Type II** Error is the **Consumer's** Risk)

Types of Control Charts (SPC)

- **1) Variable Control Charts**
- **1A)** $\bar{x}$ Chart (Sample Mean Chart)
- **1B)** R Chart (Range Chart)
- **2) Attribute Control Charts**
- **2A)** p-Chart
- **2B)** c-Chart

1) Variable Control Charts

- **1A) $\bar{x}$ Chart** – "To test whether process mean has shifted" (due to special cause)
- **1B) R Chart** – "To test whether process variation shifted" (due to special cause)

1A) $\bar{x}$ Chart

- Any point that falls outside the **UCL and LCL** shows special cause variation
- $UCL_{\bar{x}} = \bar{\bar{X}} + z\sigma_{\bar{x}}$
- $LCL_{\bar{x}} = \bar{\bar{X}} - z\sigma_{\bar{x}}$
- $\sigma_{\bar{x}}$ = Standard deviation of sampling distribution of sample means $(\frac{\sigma}{\sqrt{n}})$
- σ = Process standard deviation
- **n** = Sample size
- **z** = Standard normal deviation
- $\bar{\bar{X}}$ = Grand mean (avg. of sample means)

1A) $\bar{x}$ Chart

- Alternate method for calculation
- $UCL_{\bar{x}} = \bar{\bar{X}} + A_2\bar{R}$
- $LCL_{\bar{x}} = \bar{\bar{X}} - A_2\bar{R}$
- A_2 = Can be obtained from Table 10-2
- $\bar{R}$ = Average of sample ranges

2) Attribute Control Charts

- **2A) p-Chart** – "Used to monitor the proportion of defectives **in a process**"
- Observations can be placed into two categories (i.e. pass or fail)
- *** (Binomial** distribution) *
- **2B) r-Chart** – "Used to monitor the number of defects **per unit**)
- Defects per unit can be observed (i.e. scratches, chips, etc.)
- *** (Normal** distribution) *

2) Attribute Control Charts

- $\sigma_p = \sqrt{\frac{p(1-p)}{n}}$
- **Opt.1:** $UCL_p = p + z\sigma_p$ $LCL_p = p - z\sigma_p$
- **Opt. 2:** $UCL_c = c + z\sqrt{c}$ $LCL_c = c - z\sqrt{c}$
- * If LCL is negative... set it to **zero** *

Process Capability

- "Refers to inherent variability of a process output relative to variation allowed by design specifications"

Key Terms

- **Target Value** – "Specific value for a design variable set by designers"
- **Tolerances** – "Indicates the range of acceptable output values"
- **Process Variability** – "Reflects natural variability in the process" (measured in terms of process standard deviation)

Capability Ratio (C_p)

- **Capability Ratio** – "Measures if the specification range is as wide as process range" (if **≥ 1** then process is **capable**)
- $C_p = \frac{Upper\ Spec - Lower\ Spec}{6\sigma_{\bar{x}}}$
- * Only use $\mathbf{C_p}$ when the mean of the process **does** fall on the middle point of the design specification *

Capability Index (C_{pk})

- **Capability Index** – (if **≥ 1** proc. is **capable**)
- $C_{pk} = min(\frac{\bar{X} - LTL}{3\sigma}\ or\ \frac{UTL - \bar{X}}{3\sigma})$
- * Only use $\mathbf{C_{pk}}$ when the mean of the process **does not** fall on the middle point of the design specification *