CHAPTER 2

THEORETICAL ASPECTS AND LITERATURE REVIEW

This chapter relates to theoretical aspects to develop KPIs and also determine the appropriate KPIs for controlling the production performance in squid snacks process. This starts from using SWOT Analysis to evaluate internal and external factors affecting the case study factory. Then, perform critical success factor to conduct the relevant success factors and develop KPIs according to CSFs. Additional, to verify the influence KPIs, statistical methods have been performed. The details are as follows.

2.1 SWOT Analysis

SWOT analysis is a tool for auditing an organization and its environment. It is the first stage of planning and helps to focus on key issues. Once key issues have been identified, they feed into objectives. It can be used in conjunction with other tools for audit and analysis, such as PEST analysis and Porter's Five-Forces analysis. It is a very popular tool because it is quick and easy to analyze.

SWOT stands for strengths, weaknesses, opportunities and threats. Strengths and weaknesses are internal factors. On the other hand, opportunities and threats are external factors.

This analysis is a very effective way of identifying the strengths, minimizing weaknesses and examining the opportunities and threats the company face. Carrying out an analysis using the SWOT framework helps business to focus their activities into areas where they are strong and where the greatest opportunities lie. The sample of SWOT Analysis diagram is shown in Figure 2.1. (http://www.marketingteacher.com)

Figure 2.1 SWOT analysis diagram

2.2.1 Strengths

Every organization has some strength. In some cases this is obvious, for example, dominant market shares. In other cases, it is a matter of perspective, for instance, a company is very small and hence has the ability to move fast. It is important to note that companies that are in a bad position also have strengths. Whether these strengths are adequate is an issue for analysis. The example questions that the answers will indicate the source of strengths are as following.

- What are the major sources of a company's revenue and profit?
- What is the market share of the company in its various product lines?
- Does the company have strong brands?
- Is the marketing/advertising effective?
- What is the major focus are of the company?
- Does the company have a pool of skilled employees?
- Is the morale of the employees high?
- Are there rewards in place to create an atmosphere conducive to excellence?

- What is the cost of capital?
- What is the stock price track record?
- Does the company harness information technology effectively?
- Does the company manage its inventories efficiently?
- Has the company demonstrated the ability to adapt and change?
- Is the company able to innovate?
- How has the company withstood international competition?

2.1.2 Weaknesses

Every organization also has some weakness. In some cases, this is obvious, for example, a stricter regulatory environment. In other cases, it is a matter of perspective, for example, a company has 99% market share and is open to attack from every new player. It is important to note that companies that are extremely competent in what they do, also have weaknesses. How badly these weaknesses will affect the company is a matter of analysis. The example questions that the answers will indicate the source of weaknesses are as following.

- What are the least profitable product lines for the company?
- In what areas is the company not able to recover costs?
- Which are the weak brands?
- Is the marketing/advertising effective?
- Is the company not focused?
- Is the company able to attract talent?
- What are the biggest expenditures of the company?
- Is the company able to raise money when it needs to?
- Does the stock price history inspire confidence?
- Will the company be able to stand price pressure from competitors?
- Has the company been able to bring new ideas and products to the market place?

- Do employees feel facilitated to perform their best?
- Do employees have faith in management?
- Are the corporate governance standards high enough?
- Is the company losing out to competitors on the technology front?

2.1.3 Opportunities

All organizations have some opportunities that they can gain from. These could range from diversification to sale of operations. Identifying hidden opportunities is the mark of an astute analyst. The example questions that the answers will indicate the source of opportunities are as following.

- What is the competitive position of the company?
- Are there new technologies that the company can use to innovate or lower costs?
- Are there opportunities to extend brands into related areas?
- Are there inexpensive acquisition opportunities?
- Can the company use the internet as a channel of marketing?
- Is there room for implementation of incentive plans to boost employee performance?
- Can the company spread its wings internationally?
- Can quality of operations, products and inventory management be improved without incurring serious cost?
- Can the company move up the value chain?
- Is there an opportunity to demand better prices from suppliers?
- Can the employees be multi-skilled to reduce the level of redundancy?
- Is the time right for upstream or downstream diversification?
- Are there opportunities to cooperate with non-competitive businesses for mutual benefit?

- Can dead-wood work-force or product lines be reduced to boost profitability?
- Can the company get more predictable cash flows by establishing better relations with customers?

2.1.4 Threats

No organization is immune to threats. These could be internal, such as falling productivity. Or they could be external, such as lower priced international competition. The example questions that the answers will indicate the source of threats are as following.

- Does the company have adequate reserves to withstand sudden changes in the environment?
- What is the level of regulation in the industry?
- Is there trade union activity that could have an adverse effect?
- Do the products of the company have enough brand equity to withstand price competition?
- Are international competitors eating away market share?
- Are employees adequately trained and motivated?
- Is the company considered a good employer?
- Is the company spread too thin?
- Are accounting practices non-conservative?
- Are the financials on the verge of illiquidity?
- If the investment environment becomes non-conducive, can the company work with internal accruals?
- Is the company keeping up with technological changes?
- Have margins been under pressure?
- Is the size of transactions decreasing?
- Has the company been able to keep up with competitors in cyberspace?

Carrying out this analysis will often be illuminating both in terms of pointing out what needs to be done and in putting problems into perspective.

2.2 Critical Success Factors

Critical success factors or CSFs are those areas of one's business in which the decision is expected to be crucial to the success or failure of a particular business. The one that are believed to be critical, however, should get priorities in times, effort and money. They are the ones that really have to be right.

The CSFs method is not new. It is based on the concept of "success factors" introduced by Ronald Daniel in 1961. The idea of identifying critical success factors is very simple. In any organization certain factors will be critical to the success of that organization, in the sense that, if objectives associated with the factors are not achieved, the organization will fail.

CSFs are the few key areas of activity in which favorable results are absolutely necessary for a particular manager to meet their goals. This method has also been used successfully to aid executive teams in establishing and prioritizing their shared strategic agenda. Because these areas of activity are critical, the manager should have the appropriate information to allow them to determine whether events are proceeding sufficiently well in each area. CSFs concept has become a widely used approach to determining the information needs of managers and to conduct strategic planning for the company. The list of CSFs for any business will vary, depending on the specific business, what is the owner's personal objective of going into business. Early consideration of what should really be important in the planning and developing a business will help managers focusing attention to critical area of the business.

Daniel (1961) suggested that in most industries, three to six factors determined success and that key jobs relating to these factors must be done very well for a company to be successful. Rockart (1979) suggested that CSFs analysis would be beneficial in identifying these factors. Thus, CSFs are those few things that must go well

to ensure success for a manager or an organization, and, therefore they represent areas that must be given special attention to bring about higher performance.

2.2.1 Critical Success Factors Analysis

According to Morrisey (1996), there are four steps in critical success factors analysis:

1. **Identifying issues**

The first and most obvious step is to identify the perceived issues, which could represent either problems or opportunities. It is important to recognize that these issues are considered only as perceived until they have been validated through the analysis process. There are several effective techniques for identifying issues:

1. Ask the members of the planning term. Individual responses to these questions may be shared and consolidated into a list of issues.
2. Brainstorming to identify potential issues.
3. Existing strategic and tactical plan should be reviewed to identify any additional factors that need to be added to the issues list.
4. Assumptions made about markets, product acceptance, competition and other external factors should be examined to determine their current validity.
5. Current performance reports may identify some issues.
6. Publications related to the company or markets may reveal other factors that need to be considered.

Next step is to review all of the potential issues on the list and eliminate or combine those that are duplications.

2. **Prioritizing issues**

Determine the most important perceived issues. Those are likely to have the greatest impact. Choosing a limited number that truly represent the vital few issues ensures that they are likely to receive the attention they deserve. A simple, but effective, technique for prioritizing is as follows:

1. Have each individual term members evaluate each of the remaining issues using a 3-2-1 weighting factor, with 3 being both important and urgent, 2 being important but not urgent and 1 representing issues that could be deferred or that the company not have the ability or resource to address.
2. On a chart, record the weighting factors identified by each individual term member alongside each issue.
3. Compile priorities based on both the number of responses and the weighted average.
4. Discuss the issues to ensure term agreement on priorities.

Other identified issues need to be disposed of in some way such as combining them with related issues on the list, retaining them for later consideration or eliminating them.

3. **Analyzing issues**

This is the most crucial step in the analysis process. It involves both validating a particular issue and developing effective ways for addressing it.

4. **Summarizing issues**

The specific conclusions and alternative courses of action need to be summarized in a way that will make it easy to prepare the objectives and action plans.

2.3 Key Performance Indicators

Generally, KPIs are used to describe a particular value or characteristic designated to measure input, output, outcome, efficiency or effectiveness. They are composed of a number and a unit of measure. The number provides the magnitude (how much) and the unit is what gives the number its meaning (what).

KPIs are linked to a business goal. They typically consist of anything else that is deemed critical to a company's success and used to measure the progress that the company is making. In general, every KPIs will have a target value that may change over time. The actual value of the KPIs is compared to the target value to determine how much progress has been made towards achieving the business goal.

According to Morrisey (1996), KPIs should meet the following criteria:

1. They should be measurable factors. There are many factors, such as cash flow, quality standard and delivery schedules, that may prove very useful for tracking performance at the total organization.
2. They may be selected from any or all of the following types:
    - Hard numbers, such as sales, units of production, products shipped and clients served
    - Percentages, such as profit margins, market share, sales to new customers, repeat business and productivity increases
    - Significant achievements, such as major project completions, certifications, new service capability and performance awards
    - Service factors, such as response time, frequency of contact and customer acceptance
    - Problems to be overcome, such as excess inventory, schedule slippages, quality deficiencies and cost overruns
    - Indirect indicators, which may suggest effectiveness in subjective areas such as turnover or absenteeism (related to employee morale) and survey results (related to customer service)

3. They should identify what will be measured, not how much or in what direction. Focusing specifically on the factor to be measured usually provides for greater objectivity in making sure selected the most appropriate KPIs. Identifying the specific numbers or results desired before considered other alternatives might lead to premature selection of KPIs because of its emotional appeal.
4. They should represent factors that can be tracked on an ongoing basis to the extent possible. KPIs that can only be measured after they have been completes, such as acquisition, are acceptable in certain areas. However, when KPIs can be identified in such a way that they can be tracked as ongoing trends, such as sales growth or percentage of repeat business, they are much more useful as a part of the total planning process.
5. The cost of identifying and monitoring KPIs should not exceed the value of the information obtained. A representative sampling would probably be nearly as useful at a much lower cost.

2.3.1 Developing Key Performance Indicators

Developing KPIs has 4 steps. It starts with identify critical success factors, establishing KPIs, launch of KPIs and monitoring performance. However, to be successful in developing KPIs, the company must define target performance levels and then decides the best way to represent variance from that target.

Step 1: Identify critical success factors

The first step is to identify the special set of critical success factors. The company must think deeper and broader this through in the past. It is critical that the KPIs selected must support the CSFs that the company wants to achieve. If get these wrong, everything that follows will be out of alignment.

To analyze CSFs, the company must examine through the organization such as;

- Customer focus
- Financial
- People
- Innovation

Table 2.1 Example of critical success factors

Critical Success Factors	Aspect of organizational performance
▪ Improved customer satisfaction ▪ Improved product and service delivery ▪ Increased product and service range	Customer focus
▪ Increased sales ▪ New business ▪ Higher earnings per employee ▪ Cash flow ▪ Improved cost performance	Financial
▪ Achievement of a real partnership ▪ Maximization of the potential of the organization's employees ▪ Creation of a world-class team ▪ Safe and interesting work environment	People
▪ Development and maintenance of strategic competitive advantage ▪ Focus on continuous improvement of all key processes ▪ Improved product and service performance ▪ New products in new markets ▪ Improved performance in key internal processes ▪ Community leadership and responsibility	Innovation

Step 2: Establishing KPIs

The next step is to establish KPIs for each critical factor as a yardstick for measuring performance with regard to the goal and objectives of the company. Some of these measures will be quantitative and some qualitative. Choose the measure which best reflects understanding of how the issue affects the business.

Step 3: Launch of KPIs

This step has 4 major phases:

1. Goals down and plans up

This requires the high level KPIs to be cascaded down to each operaticnal team. As its name implies, the process presents the high level KPIs as goal and allows teams to develop their relevant KPIs through the plans they create to achieve this goal.

2. Develop individual performance plans

On the basis of the new suite of plans, the CEO, Divisional, section and team leaders create their personal performance plans by selecting the most critical KPIs from the relevant organizational plan. Once developed, they are signed off at the appropriate level.

3. Documentation development

All KPIs, Divisional, team and personal plans are logged with the appropriate organizational unit and a process for updating through the next planning cycle decided.

4. Training

To support all staff in their effort to achieve the KPIs for which they are accountable, it is essential that comprehensive training options be made available. These should be broken into group training (where corporate-wide development is needed) and individual training (from which individuals can select as required). Training should cover technical and functional performance as well as behavioral performance.

Step 4: Monitoring performance

The company should monitor performance, measure and review performance at least once a year in regard to development priorities and objectives and take steps to improve performance where performance targets are not met the target. The important thing is establish a process of regular reporting to management level. Moreover, it is necessary to have a substantial continuous improvement plan to simplify the KPIs system.

2.4 Statistical Techniques

In this section, there are many statistical techniques determined to perform the significance and hypothesis testing with two samples. One technique is used with proportion, one is used with variances and the others are used with means. The techniques for analyzing means are separated into those used with large samples and those used with small samples. In four of the five techniques presented in this section, the two samples are assumed to be independent samples. The samples are independent because the item or people sampled in each group are in no way related to those in the other group. Any similarity between items or people in the two samples is coincidental and due to chance. The other technique is for analyzing data from two dependent or related samples, which are samples selected in such a way as to be dependent or related. In this case, items or persons in one sample are matched in some way with items or persons in the other sample (Kiemele, Schmidt, and Berdine, 2000). The significance tests are summarized in Table 2.2.

Table 2.2 Summary of significance tests

Test No.	To Test	Normal Distribution	Sample Size	Samples Independent	Others	Variance Known	Significance Test
1.	Mean = Specified Value	✓	small or large	-	-	✓	Normal
2.	Mean = Specified Value	✓	small	-	-	X	Student's t-Test
3.	Difference between two Means	✓	small or large	✓	$\sigma_1^2 = \sigma_2^2$	✓	Normal
4.	Difference between two Means	✓	small	✓	$\sigma_1^2 \neq \sigma_2^2$	X	Aspin- Welch Test
5.	Difference between two Means	✓	small	✓	$\sigma_1^2 = \sigma_2^2$	X	Student's t-Test
6.	Difference between two Means	✓ or X	small or large	X	-	✓ or X	Paired Comparison Test
7.	Variance = Specified Value	✓	small	-	-	✓ or X	x^2 Test
8.	Difference between two Variances	✓	small or large	✓	-	✓ or X	F-Ratio Test

Before explain about significance tests, principle of significance testing and concept of standard error will be explained to introduce the background of significance testing.

2.4.1 The Principle of Significance Testing

Variation will occur because the outcome of any item, process or situation will be the result of the combined effects of many factors, all of which will vary over time or between similar items. Some of these effects may be fully predictable, others will not. Where these effects are not predictable, not know, or not quantifiable the variation will either be truly random, or if not truly random then at least having the practical effect of being random. This is known as *random variation* and will, for given situations, tend to produce certain patterns in the outcome. The properties of these patterns have been thoroughly investigated and are understood, so they can be used to model the situations they represent. These models are known as *sampling distributions* because they represent the distribution of values that would be obtained if a sample is selected randomly from a population where just random variability is present. Three common sampling distributions are the Normal, the Poisson and the Binomial distributions. Having decided on the appropriate statistical model for a particular situation, it is then possible to measure the absolute value of a particular characteristic and the extent of the random variability present so that future changes or results from different items can be compared to it. It is then possible to see how likely it is that a particular result came from the appropriate model. In other words, the observed sample is compared to a reference set in the form of a statistical model whose parameters are known.

The principle can be explained by reference to a sample of measurements of size taken from a production process where random variability is present. If the individual components are selected from a production process where random variability is present. If the individual components are selected at random from a batch, a dimension measured and a frequency distribution of the results is plotted, they will be distributed Normally;

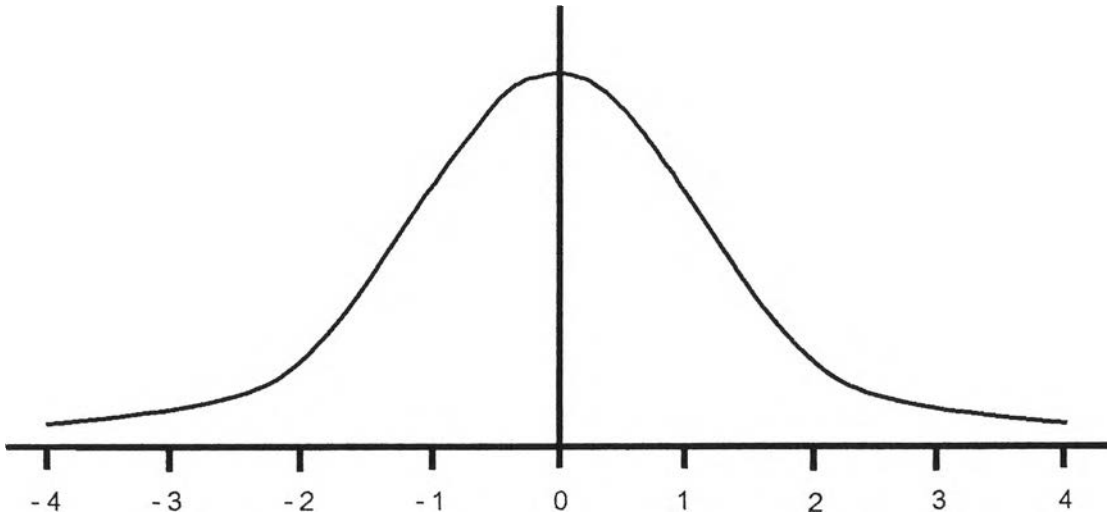

Figure 2.2 Normal distribution curve

From the properties of the Normal Distribution;

99.8% of components will fall within ± 3.09σ

95% of components will fall within ± 1.96σ

This distribution, once established for a particular situation can act as a reference set or yardstick against which the size of future components can be judged to determine if a significant change has occurred in the process. If a component is outside the ± 1.96σ or ± 3.09σ 'limits', it can be concluded that a change has probably occurred. The probability or certainty of our conclusion will depend on how far outside the 'limits' the component is.

2.4.2 The Concept of Standard Error

Figures 2.3 represent the degree of uncertainty when estimating the mean from individual observations. If small samples of components are selected from a batch and their means are plotted, they will again form Normal distribution but they will be less spread out than for individual values;

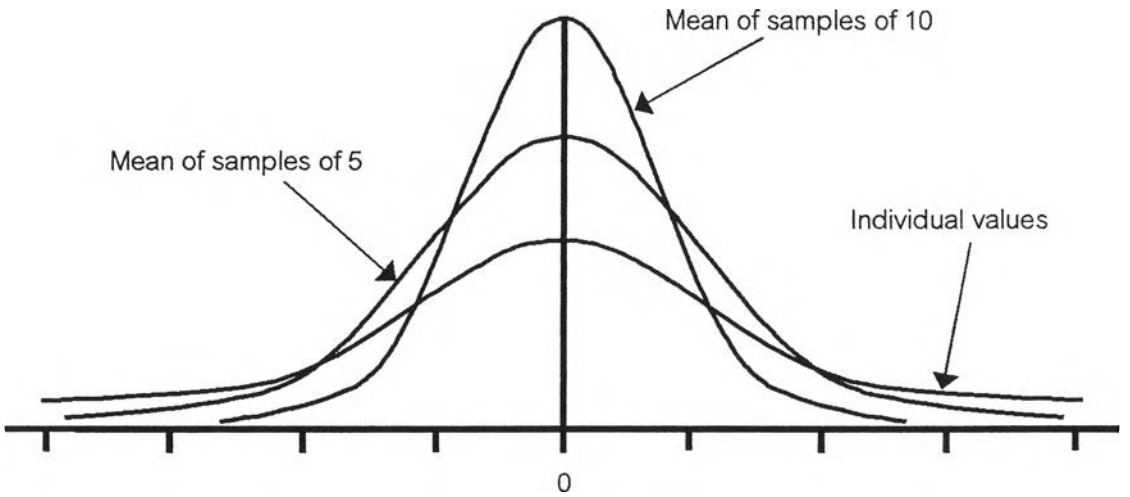

Figure 2.3 Variation in component size around the mean

Common sense says that the larger the sample size, the more reliable will be the estimate of mean size that the process is producing. The spread of sample means is measured by $\frac{\sigma}{\sqrt{n}}$ is known as the 'Standard Error of the Mean', where n = sample size.

In the same way, a certain amount of error will occur when any summarizing statistic is calculated from samples. Thus;

Standard Error of the Mean = $\frac{\sigma}{\sqrt{n}}$

Standard Error of the Median = $\frac{1.25\sigma}{\sqrt{n}}$

Standard Error of the Standard Deviation = $\frac{\sigma}{\sqrt{2n}}$

Standard Error of the Variance = $\sigma^2\sqrt{\frac{2}{n}}$

Therefore, just as the standard deviation represented the expected limits on the spread of individual items, so the Standard Errors can be taken to represent the 'limits' of expected variability in summarizing statistics. They can be taken as yardsticks against which sample statistics can be compared. So significance testing involves comparing the difference of interest with the Standard Error. This is done by calculating a Test Statistic;

$$\text{Test Statistic} = \frac{\text{Difference}}{\text{Standard Error}}$$

Then, either the Test Statistic is compared with a limiting value based on risks of a wrong decision or the probability that the value came from the distribution is looked up in the Table 2.2.

2.4.3 Significance Tests

1. **To test whether the mean of a population is equal to specified value ($\mu = \mu_0$)**

   For large samples (or if variance is known)

   Assumption: Normal Distribution

   Test statistic: $\dfrac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$

   Where: $\bar{x}$ = mean of the sample

   μ_0 = specified value of the population mean

   σ = population standard deviation

   n = sample size

   Distribution: Normal

   Confidence Interval: $\bar{x} \pm \mu_{\alpha/2} \dfrac{\sigma}{\sqrt{n}}$

2. **To test whether the mean of a population is equal to a specified value ($\mu = \mu_0$) or Student's t-Test**

   For small samples

   Assumption: Normal Distribution

   Test statistic: $\dfrac{\bar{x} - \mu_0}{\hat{\sigma} / \sqrt{n}}$

   Distribution: t - distribution

   Degree of freedom, ν = n-1

Confidence Limits (Two – tailed): $\bar{x} \pm t_{\alpha/2,\nu} \frac{\hat{\sigma}}{\sqrt{n}}$

If sample size is large, Normal test can be used.

3. **To test for a significant difference between two means ($\mu_1 = \mu_2$)**

For large samples (or if variance is known)

Assumption: Normal Distribution

Test statistic: $$\frac{(\bar{x}_1 - \bar{x}_2) - k}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Distribution: Normal

Confidence Limits (Two – tailed): $(\bar{x}_1 - \bar{x}_2) \pm \mu_{\alpha/2} \cdot \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$

4. **To test for a significant difference between two means ($\mu_1 = \mu_2$)**

(Aspin – Welch Test)

For small samples

Assumption: Normal Distribution

Test statistic: $$\frac{(\bar{x}_1 - \bar{x}_2) - k}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Distribution: t – distribution

Degree of freedom, $$\nu = \frac{\left(\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{\hat{\sigma}_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{\hat{\sigma}_2^2}{n_2}\right)^2}$$

Confidence Limits (Two – tailed): $(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,\nu} \cdot \sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}$

5. **To test for a significant difference between two means ($\mu_1 = \mu_2$)**

(Student's t-Test)

For small samples and if variances are not significantly different

Assumption: Normal Distribution

Test statistic: $$\frac{(\bar{x}_1 - \bar{x}_2) - k}{\hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where; $\hat{\sigma}$ = pooled estimate of the unknown standard deviation

$$= \sqrt{\frac{(n_1 - 1)\hat{\sigma}_1^2 + (n_2 - 1)\hat{\sigma}_2^2}{n_1 + n_2 - 2}}$$

Distribution: t – distribution

Degree of freedom, $\nu = n_1 + n_2 - 2$

Confidence Limits (Two – tailed): $$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2;\nu} \cdot \hat{\sigma}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

6. **To test for a significant difference between two means – Paired Comparison**

Assumption: Normal Distribution

Apply t-Test to difference;

n pairs of measurements x_{1j}, x_{2j}, (j = 1, 2,..., n)

H_o (Two-Tailed) : $\mu_{1j} = \mu_{2j}$ (for all j)

H_1 : $\mu_{1j} \neq \mu_{2j}$

$d_j = x_{1j} - x_{2j}$ (j = 1, 2,..., n)

H_o: $\mu_d \neq 0$, H_1: $\mu_d \neq 0$

Test statistic: $$\frac{\bar{d} - k}{\hat{\sigma}_d / \sqrt{n}}$$

Distribution: t – distribution

Degree of freedom, ν = n - 1

If sample sizes are large Normal test (test 1) can be used

7. To test whether the variance of a population is equal to a specified value ($\sigma^2 = \sigma_0^2$)

   Assumption: Normal Distribution

   Test statistic: $\frac{(n-1)\hat{\sigma}^2}{\sigma_0^2}$

   Distribution: x^2 , Degree of freedom, ν = n - 1

   Confidence Limits (Two – tailed): $\left[\frac{(n-1)\hat{\sigma}^2}{x^2_{1-\alpha/2;\nu}}, \frac{(n-1)\hat{\sigma}^2}{x^2_{\alpha/2;\nu}}\right]$

8. **To test for a significant difference between two variances ($\sigma_1^2 = \sigma_2^2$)**

   (F – Ratio Test)

Sometimes we are interested in the variability of a population of data rather than a measure of central tendency such as the mean or proportion. A variance is a measure of dispersion or variability. There are occasions when business analysts are interested in testing hypotheses about two population variances.

In quality control, statisticians often examine both a measure of central tendency (mean or proportion) and a measure of variability. Suppose a manufacturing plant has made two batches of an item, produced items on two different machines, or produced items on two different shifts. It might be of interest to compare the variances from the two batches or groups in an effort to determine whether there is more variability in one than another. For example, if one machine or shift has more variability than another, managers might want to investigate why that machine or shift is not as consistent as the other.

Variance is sometimes used as a measure of the risk of a stock in the stock market. The greater the variance, the greater the risk. By using techniques discussed here, a financial business analyst could determine whether the variance (or risk) of two stocks are the same.

In testing hypotheses about two population variances, the sample variances are used. It makes sense that if two samples come from the same population (or populations with equal variances), the ratio of the sample variance $\frac{\hat{\sigma}_1^2}{\hat{\sigma}_2^2}$, should be about 1.

However, because of sampling error, sample variances even from the same population (or from two populations with equal variances) will vary. This *ratio of two sample variances* formulates what is called an *F*-value.

$$F = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_2^2}$$

These ratios, if computed repeatedly for pairs of sample variances taken from a population, are distributed as an *F* distribution. The *F* distribution will vary by the sizes of the samples, which are converted to degrees of freedom.

With the *F* distribution, there are degrees of freedom associated with the numerator (of the ratio) and the denominator. An assumption underlying the *F* distribution is that the populations from which the samples are drawn are normally distributed for *X*. The *F* test of two population variances is extremely sensitive to violations of the assumption that the populations are normally distributed. The business analyst should carefully investigate the shape of the distributions of the populations from which the samples are drawn to be certain the populations are normally distributed. The formula used to test hypotheses comparing two population variances follows.

$$F = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_2^2}$$

F – distribution with degree of freedom ν_1, ν_2

$\nu_1 = n_1 - 1$

$\nu_2 = n_2 - 1$

2.5 Literature Surveys

All literature surveys related to development of performance measurement and indicator are presented as below.

Ahmad, I. (1990) proposed the thesis about the development of performance measurement in organization in order to indicate the low performance and suggest how to improve it. The performance measurement system that used in this thesis is Performance Objectives Model, which weight each factor in order to show the most important factor for the organization.

Gallagher and Knight (1986) explained the methodology and benefits of Group Technology as well as to indicate the current scale of development in production by reference to actual industrial applications. Some parts mentioned the applications of the basic approach to design, estimating and planning for production.

Jackson and Karen (1996) suggested the step of Lean management system and the implementation of this system. Some parts mentioned about strategic control & planning and implementation.

Kaplan and Norton (1992) have devised a framework "Balanced Scorecard" for an integrated performance measurement system for strategic, operational and financial measures. The balanced scorecard provides answers to four basic questions: How do customers see us? (Customer perspective); What must we excel at? (Internal perspective); Can we continue and create value? (Innovation and learning perspective); and How do we look to shareholders? (Financial perspective). The balanced scorecard includes financial measures that tell the results of actions already taken. And it complements the financial measures with operational measures on customer satisfaction, internal processes, and organization's innovation and improvement activities- operational measures that are the drivers of future financial performance.

Khemthongvongsa, S. (1999) proposed the thesis about Lean management system. The result of the system can develop performance indexes in order to make customer satisfaction and improve production process quality.

Kongsupapsiri, P. (2001) proposed the thesis that intended to present the development of key performance indicators for production. He aimed to improve the production planning and key performance indicators in the real factory.

Pant, A. (1997) studied the performance of the organization by comparing two systems: Total Productivity Model and Data Envelopment Analysis. First, Total Productivity Model examines these factors: man, material and component, fund, energy and expend. Next, Data Envelopment Analysis analyzes the performance over different time period. The outcome of this system can be used as a tool for control and evaluation of past accomplishments as well as a tool to aid in planning future activities.

Rolstadas, A. (1995) described about performance management by using Benchmarking technique. He explained since creating the system, selecting the performance indicators until controlling and assessing the result.