

# Problem 02

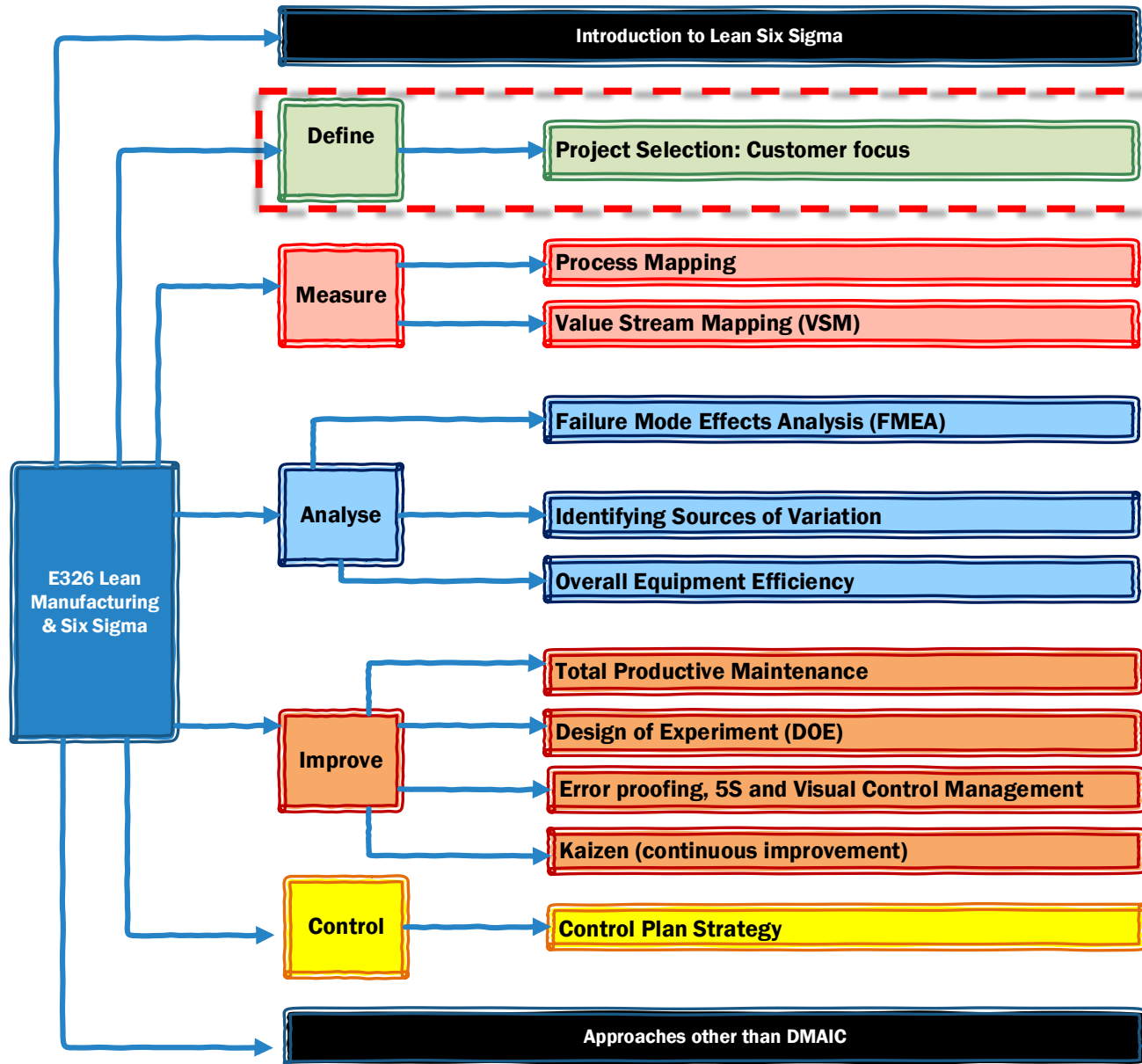
## How to listen to VOC?

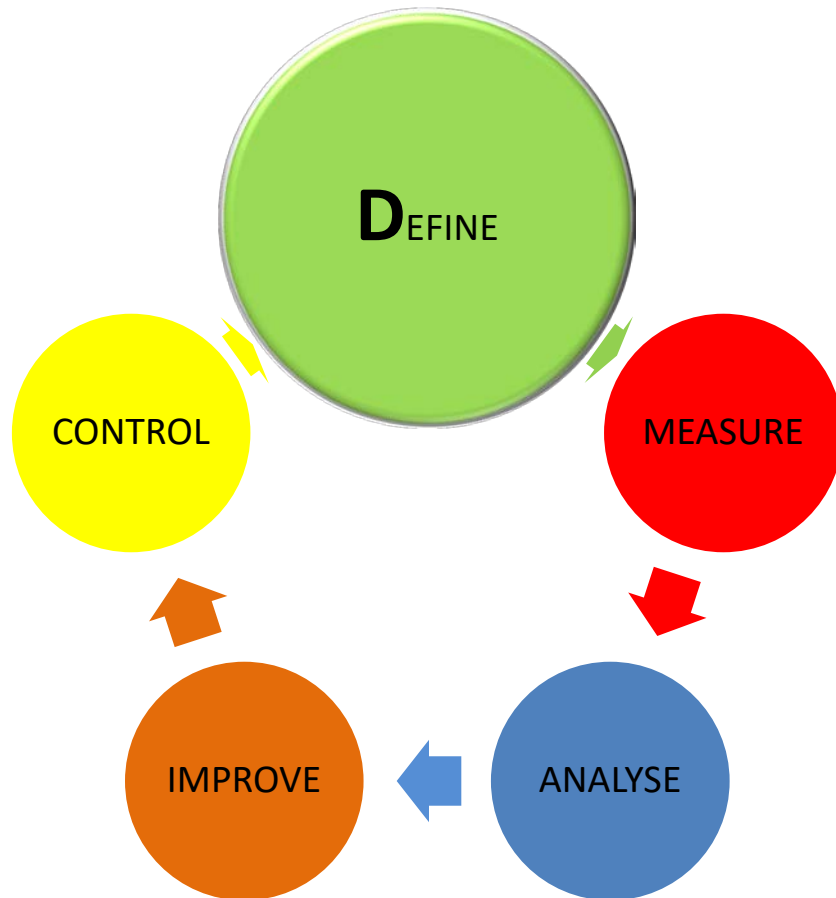
E326 – Lean Manufacturing & Six Sigma



SCHOOL OF  
ENGINEERING

# E326 Lean Manufacturing and Six Sigma Topic Tree





Define the project and goals of the improvement activity

### Objectives of Define phase:

- To identify and/or validate the improvement opportunity, develop the business processes, define critical customer requirements.
- To define the team structure for the project and establish roles and responsibilities.

# Review the Potential of a Six Sigma Project

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- Who are our customers?
- What are the problems you are trying to address?
- How do our customers understand the term “Quality”?
- What are the potential benefits of solving this problem?
- Will you be able to quantify these benefits in terms of cost savings, cost avoidance, or improved customer satisfaction if you solve this problem?
- What key output variables are needed to measure project success? How will we measure it?
- ... ..

*The answers to these questions provide the basis of any Six Sigma project. The first step toward improving processes, products, or services is determining what your customers consider critical to quality.*

# Why Customer Satisfaction Matters



- The 80/20 rule has been a very popular credo of business professionals in this era of customer-oriented business strategy. It states that for most companies, 80% of their profitable revenue comes from just 20% of their clients.

80/  
20

## Customer Satisfaction Survey Best Practices and Tips

Here are a few customer satisfaction facts that businesses should consider:

- ▶ Increasing loyalty and customer retention by just 5% can increase profits by 75%
- ▶ Most dissatisfied customers will eventually tell 9 other people about their problem.
- ▶ Only 4% of dissatisfied customers actually complain to the company.
- ▶ Satisfied customers, on the other hand, tell 5 to 6 other people about their positive experience.

- Customer satisfaction is in the eye of the customer. Once an organization is able to gauge customer satisfaction, the opportunities for making profitable decisions are endless.

# Voice-of-Customer (VOC)



- An early step in any project is to seek the voice of the customer (VOC).
- “Voice of the customer” is the term used to describe the stated and unstated needs or requirements of the customer.
  - ✓ *A sample question to customers: “What influences your level of satisfaction with our products/services?”*
- The voice-of-customer can be captured in a variety of data collection methods (ensure no bias or ambiguity from customer responses):
  - ✓ *direct discussion or interviews; surveys; focus groups; customer specifications; observation; field reports; complaint logs, etc.*
- *There is no excuse not to consider the VOC! No project is too small to do VOC.*



# Critical-To-Quality (CTQ)



- Critical customer requirements are usually expressed as expectations or needs, but not necessarily in quantifiable terms. Process **CTx** (usually CTQ but can be CTC\* or CTD\*\*) represents measurable product or process performance characteristics and act to quantify the critical customer requirements.
- CTQs are the internal critical quality parameters that relate to the wants and needs of the customer. Any characteristic of a product, a service, or a process that a customer considers critical to quality is labeled a CTQ.
- A CTQ usually must be *translated from a qualitative opinion into a quantitative specification (measurable term)* that a project team can use to take action.

# Defining CTQ Outputs



- VOC Becomes CTQs



- **Characteristics of product or service:** A word or phrase that describes some aspect of the product or service.
  - Example: dry cleaning process time.
- **Measures and operational definitions:** A definition of how the product or service's characteristic is to be quantified. There may be several ways of quantifying a given characteristic.
  - Example: the unit used to measure time between when the cleaner receives clothes and when the clothes are ready for pickup (hours).



# Defining CTQ Outputs



## Target value(s)

- The aim for a product or service. If there were no variation in the product or service, this is the value that would always be achieved; it is the desired level of performance.
- Example: clothes ready for pickup in 24 hours.

## Specification limits

- How much variation is the customer willing to tolerate in the delivery of the product or service? Specification limits are performance limits that are acceptable to the customer.
- Example: Upper specification limit for online delivery time is 7 days.

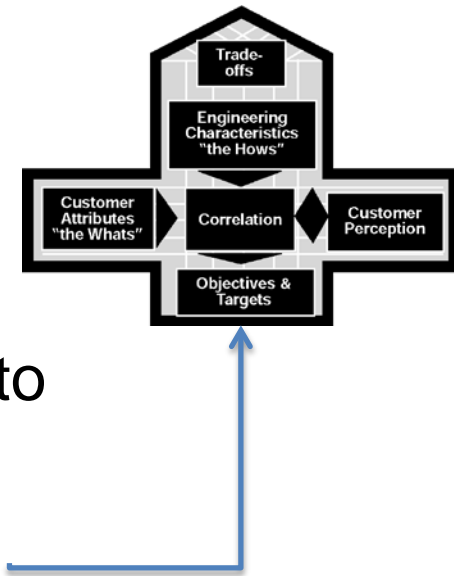
## Defect rate(s)

- This is how often the producer is willing to produce a product or service outside the specification limits.
- Example: 1 late delivery for every 10 food delivery ordered.

# Quality Function Deployment (QFD)



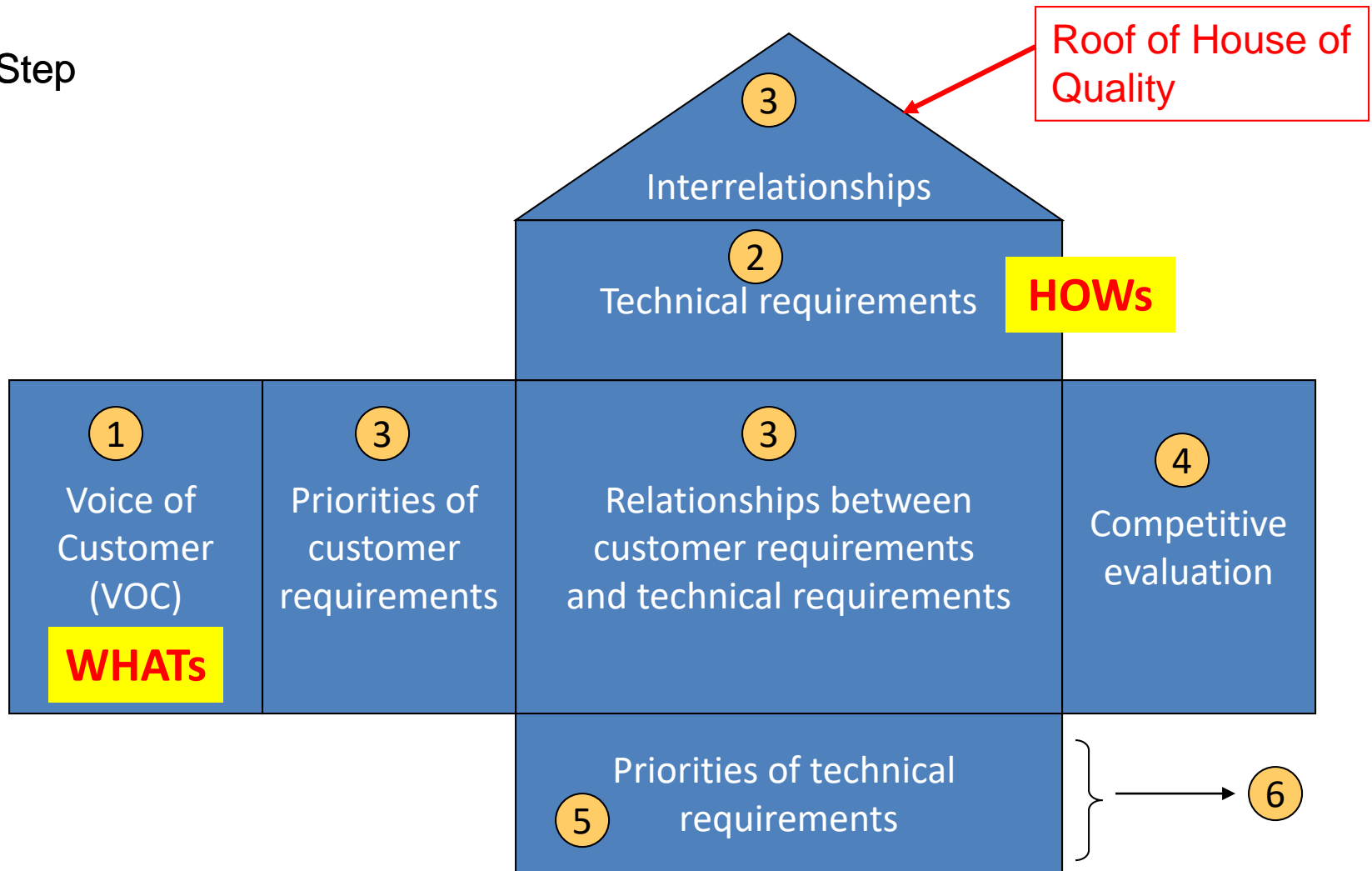
- Quality Function Deployment (QFD) is a methodology for building the "Voice of the Customer" into product and service design.
- It is a team tool which captures customer requirements and translates those needs into characteristics about a product or service.
- QFD matrix (also known as the "*House of Quality*") helps illustrate the linkage between the VOC (*the Whats*) and the resulting technical requirements (*the Hows*).
- QFD matrix consists of several parts.
  - A typical QFD matrix and a map of various parts in QFD matrix together with explanations have been attached in worksheet. You can refer to the file.



# The House of Quality



# : Step



# Building the House of Quality



## Six Basic Steps:

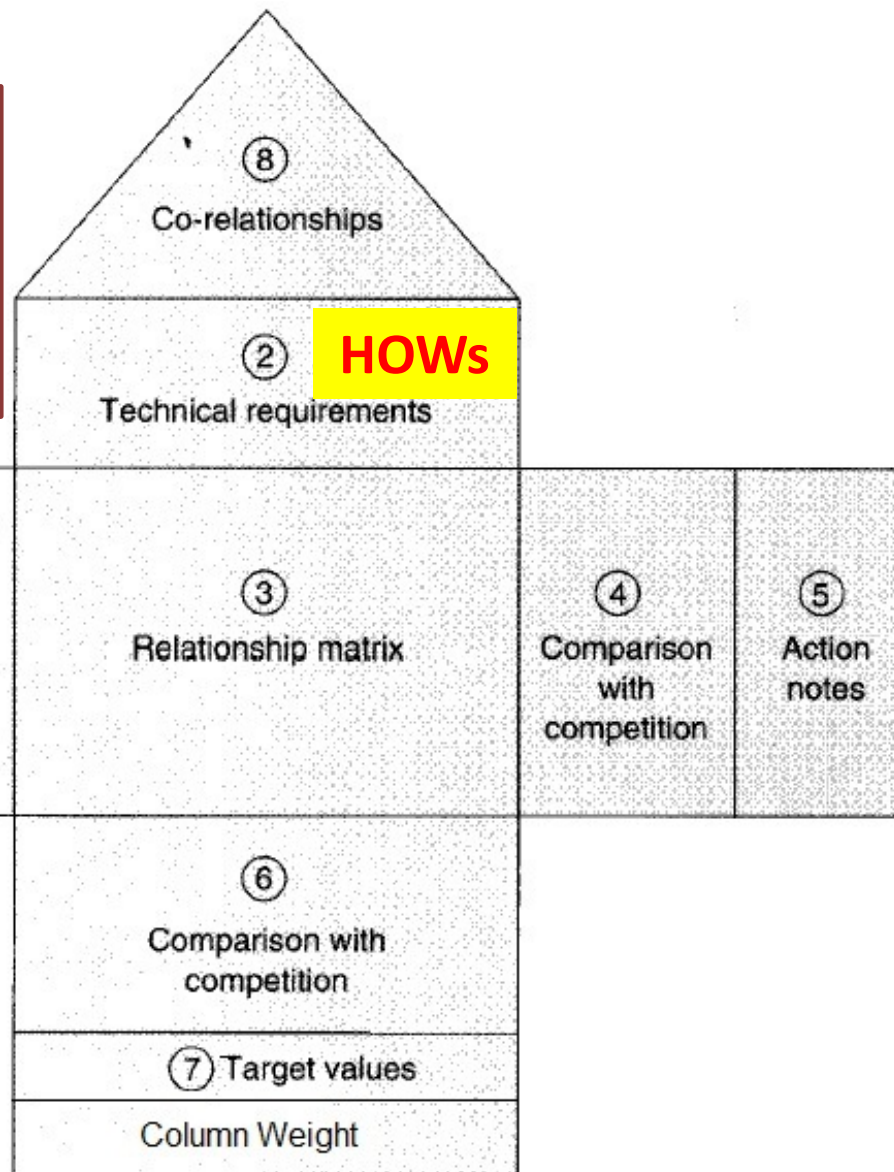
- Step 1: Identify customer requirements
- Step 2: Identify technical requirements
- Step 3: Relate customer requirements to the technical requirements
- Step 4: Conduct an evaluation of competing products or services
- Step 5: Evaluate technical requirements and develop targets
- Step 6: Determine which technical requirements to deploy in the remainder of the production/delivery process



# Entries for QFD matrix



No standard format or standard symbols. Make sure you know what they are.



① from VOC analysis, usually has “importance rating”; “WHATs”

② established in response to ①; “HOWs”

③ displays connection between ① and ②; relationship can be “strong (9), moderate (3), weak (1)”;

④ and ⑥ are not always shown;  
⑤ about improvement activities (optional);

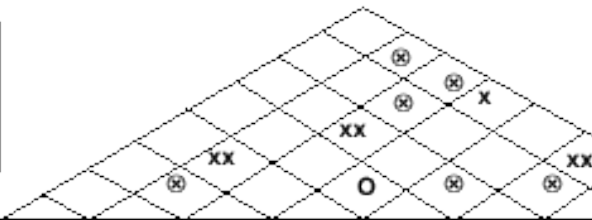
⑦ are targets for ②;

⑧ tells about correlation among ②, “+” means improve together, “-” means one improve, the other worsens;

Column weight is optional, tells about importance of ② in meeting ①; equals to sum of the multiplication of “importance rating” and “value in relationship matrix”

# Example of a QFD matrix



<b>INTERACTIONS:</b> xx Strong negative relationship x Mild negative relationship ⊗ Mild positive relationship O Strong positive relationship										<b>RELATIONSHIPS:</b> ⊗ 5 Strong relationship o 3 Moderate relationship Δ 1 Weak relationship	
Customer Reqmts \ Product Design Reqmts	Priority	Bleed air ducting to interface P1.A	Low APU weight	Low turbine wheel weight	High equivalent shaft horsepower	Controlled turbine inlet temperature	Turbine assy. tri-hub containment	Strong internal containment ring	Lightweight containment ring	Competitive Evaluations	
										1	5
Cust. envelope/interface	3	⊗						⊗		x	o
Max.Weight 160lbs.	4	O	⊗	O			O		⊗	o	x
Bleed air 75 lbs/min	4	O			⊗	⊗				o	x
Turbine containment	5			O		O	⊗	⊗		o	x
Elect pwr. 40KVA	3				⊗					x	o
Reliable	5			O		⊗				x	o
Support oil-cooled gen.	5		O							o	x
***											
Technical Evaluations	5 1	x o	x o	x o	x o	o x	o x	x o	x o		
Target Value	Target Loc.	158lb	<6 lb	350hp	1850°	2.5 lb @Pwr	3 lb @Pwr	<6 lb	<b>Evaluations:</b> x We o XYZ Co.		
Technical Difficulty	1	4	3	5	3	4	2	4			
Importance Rating	39	35	42	35	60	52	40	20			

# Factors in Project Selection

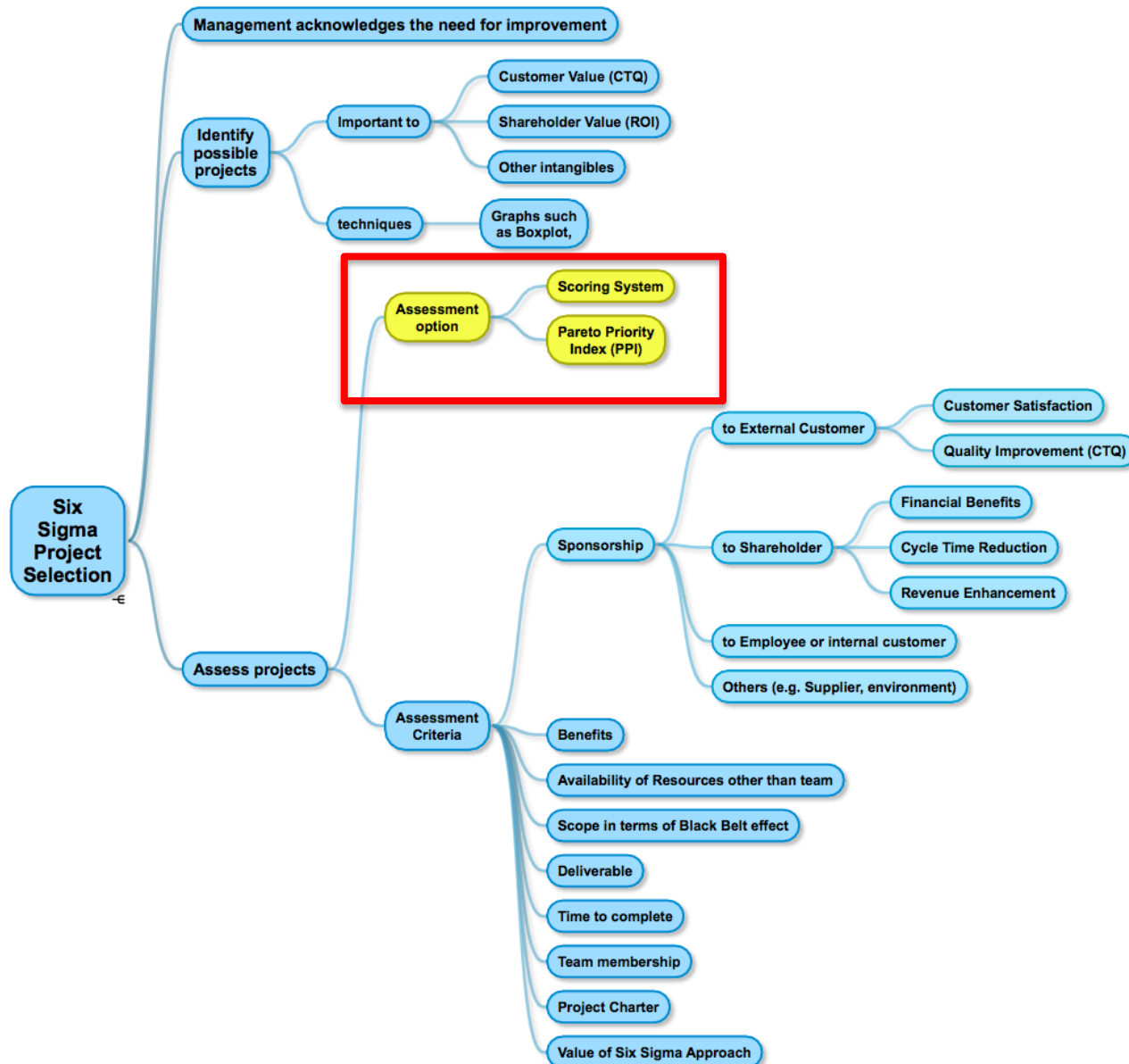
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Factors that should be considered when selecting Six Sigma projects include the following

- Impact on customers and organizational effectiveness
- Probability of success
- Impact on employees
- Fit to strategy and competitive advantage
- Financial return, as measured by costs associated with quality and process performance and impacts on revenues and market shares
- The project selected must be able to convince top management that the effort to be deployed to implement the Six Sigma project is worthwhile.

# Overview of Project Selection





# Project Assessment Options



## 1. Scoring System



Scoring System

Identify criteria for assessment	
Sponsorship	Time to Complete
Benefits	Team Membership
Availability of resources other than team	Project Charter
Scope in terms of Black Belt effort	Value of Six Sigma Approach
Deliverables	

## 2. Pareto Priority Index (PPI)\*

$$PPI = \frac{\text{Savings} \times \text{Probability of success}}{\text{Cost} \times \text{Time to completion (years)}}$$

# Project Charter

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Project charter states the purpose of the project and serves as an informal contract that helps the project team stay on track with the goals of the enterprise. It contains:

- Purpose: Establishes goals and objectives
- Benefits: States how the enterprise will fare better when the project reaches its goals
- Scope: Provides project limitations in terms of budget, time and other resources
- Results: Defines the criteria and metrics for project success

*Note : A project charter template has been provided in worksheet. You can refer to it.*

# Problem 02

## Suggested Solution

# Problem Analysis Techniques

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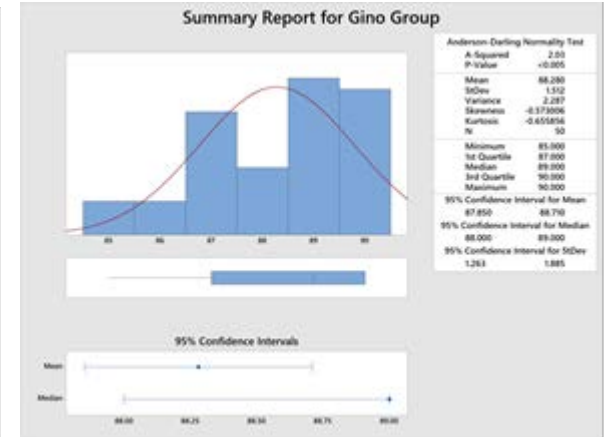
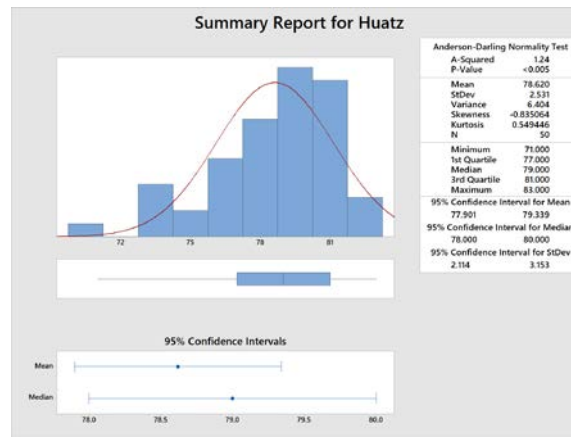
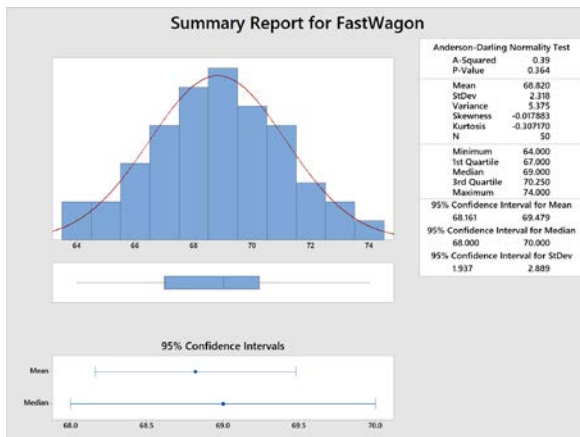


- Graphical means to present collected data by
  - Simple graphical methods such as *histogram*, boxplot, pie chart and scatter plots and etc.
  - Use of mean, standard deviation (for normal distribution)
  - Use of median, percentile and other techniques for non-normal distribution
- Minitab > Stat > Basic Statistics > Graphical Summary
  - Summarizes your data to give basic statistical information like Mean & Median
  - Performs Normality Test
  - Calculates Confidence Intervals and skewness

# Graphical Summary



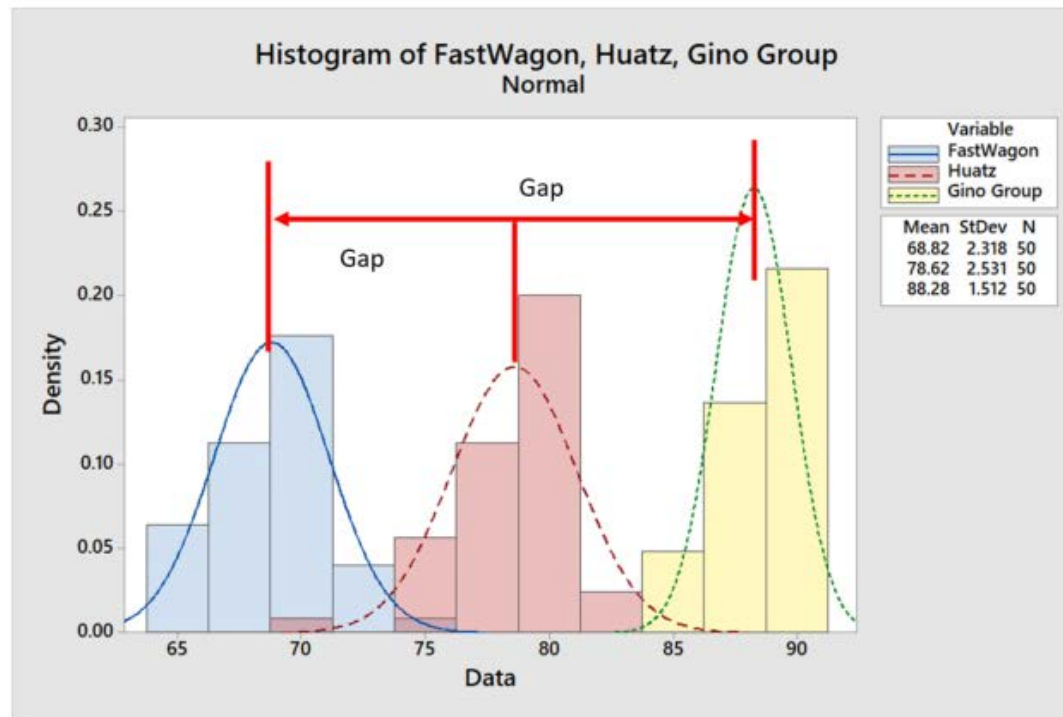
- Only data for FastWagon is normally distributed.  
(To determine if data follow a normal distribution, check the p-Value. If the p-value is lower than the pre-determined level of significance, the data do not follow a normal distribution)
- *Mean and Standard Deviation* are applicable for normally distributed data.
- *Median and Percentile* are good alternative for Non-normal data.
  - ✓ Other technique available to tackle Non-Normal data is Box-Cox transformation. *The topics will be covered more in Quality Control.*



# Needs for Possible Project(s)



- Minitab -> Graph -> Histogram
  - Average customer satisfaction graph shows a gap between FastWagon and the other two competitors.
  - This indicates FastWagon maybe behind industry standard in term of customer satisfaction and attention is needed.



# Measurable CTQ, CTD, CTC



- How is Customer Satisfaction **measured**?

<b>Customer Requirement (Whats)</b>	<b>CTx</b>	<b>Measurable variable (Hows)</b>
No excessive / hidden fees	CTC	Service fees charged
Friendly and helpful service staff	CTQ	Clients' feedback on service staff on rating on friendliness and helpfulness
Knowledgeable service staff	CTQ	Clients' feedback on service staff's product knowledge rating
Shorter waiting time for clients when they carry out their transactions	CTD	Number of customers in queue OR Waiting time for customer

**Note:** in “Measurable variable column”, you only need to put a measurable variable, e.g. “Waiting time”, which is going to measure the performance. You do NOT need to solve the problem at this moment, therefore, do NOT put “Shorter Waiting time”, which means to solve the issue.

# Understand and develop the QFD



Legend		
⊙	Strong Relationship	9
○	Moderate Relationship	3
△	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
-	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Correlation between  
Technical  
requirements

List out Technical requirements such as waiting time in minutes, number of wrong order served/delivered. (**HOWs**)

**Measurable variable  
(Hows)**

Service fees charged

Clients' feedback on service staff on rating on friendliness and helpfulness

Clients' feedback on service staff's product knowledge rating

Number of customers in queue OR Waiting time for customer

List out Customer Requirements like, low wrong dish served/delivered, shorter waiting time etc. (**WHATs**)

Rate the important  
of the customer  
requirement

Establish the relationship between the Customer requirements vs. Technical requirements. For example: “++” Shorter waiting time, etc.

Compare the requirements with competitors

**Customer Requirement  
(Whats)**

**CTx**

No excessive / hidden fees

CTC

Friendly and helpful service staff

CTQ

Knowledgeable service staff

CTQ

Shorter waiting time for clients when they carry out their transactions

CTD

Compare how the each of the Technical requirements match the competitors

Set the Target value for each Technical requirements

Calculate the weightage and importance for the above technical requirement



# Sample QFD (QC3)



## House of Quality Matrix

Project:

Project

Project Leader:

Alan Wu

Product:

Car



How to fill in the matrix

Customer Requirements					Planning Matrix							
					Our Product	Huatz's Product	Gino Group's Product	Planned Rating	Improvement Factor	Sales Point	Overall Weighting	Percentage of Total
Safety	5	Strong	Weak	None	3	4	3	4	1.2	1.5	9.0	44%
Reliability	5	Weak	Strong	Weak	3	2	4	4	1.2	1.3	7.8	38%
All terrain driving	3	None	Weak	Strong	3	2	1	3	1.0	1.2	3.6	18%
Technical Priorities		88.8	82.8	40.2	211.8				Total		20.4	
Percentage of Total		42%	39%	19%								
Benchmarking	Our Product	1.5 m	120g	90mm								
	Competitor A's Product	2m	140g	100mm								
	Competitor B's Product	1.5 m	100g	110mm								
Design Targets		>=2 m	<100g	>80mm								

# Pareto Priority Index (PPI)



- Project A: To reduce the number of wrong service provided.
- Project B: To reduce the number of complaints or negative feedback received on staff service.
- Project C: To improve the service charge.
- Project D: To reduce customers' waiting time for transaction.
- Project E: To reduce the number of complaints or negative feedback received on service charge.

Project	Savings (k) per year	Probability	Cost (k)	Time to implement (year)	PPI
A	12	0.65	5	1.0	1.56
B	12	0.70	12	0.5	1.40
C	18	0.75	20	1.0	0.68
D	22	0.80	11	0.8	2.00
E	16	0.85	5	1.2	2.27

Note: Assumptions were made on the data above (not provided in problem statement)



- Project sequence recommended:  
Start with Project E → D → A → B → C

# Sample Project Charter (QC3)



## Project Charter

### Project Authorization

Organization:	Champion:	Process Owner:
FastWagon	Alan	Wu
Project:		Project #:
To reduce the number of wrong service provided		
Problem Statement:		
Sales revenue for FastWagon had reduced by \$2 million as some customers have switched to competitors due to wrong service provided.		
Project Objective:		
The number of wrong service provided currently estimated is 3 per 10 services requested ordered. If the wrong service can be reduced to 1 per 10 services requested, it is projected to generate a potential cost savings of \$2 million for customers not switching to competitors.		
Estimated Defect Level:	Initial Goal:	Estimated Benefits:
30%	1 per 10 services requested	\$2,000,000
Approval Date:	Champion Signature:	Process Owner Signature:
30/10/2018 	Alan	Wu
Estimated Completion Date:	Project Leader:	Financial Analyst:
30/3/2019 	Vincent Ong	

### Project Team

Name	Role	Comments	Phone
Vincent Ong	Project Leader		
James Lee	Team Member		
SS Kim	Team Member		
Wan			

# Sample Project Charter (QC3)



## Project Definition and Scoping

Metrics (unit of measure):

order unit

Critical to Satisfaction (linkage to customer):

wrong order (unit) is the quantity of car services requested but provided wrongly

Defect Definition (include opportunity):

A recent customer survey confirms dissatisfaction with wrong service provided.

Scope of Project:


The target is no more than 1 wrong service per 10 services requested.

## Goals and Benefits

### Defect Levels/Goals:

	Date	DPMO(LT)	Zbench(ST)	Cpk
Baseline		0	10,000.00	0.00
Goal		0	20,000.00	0.00
Stretch Goal		0	22,000.00	0.00


### Estimated Financial Benefits:

 Important information

Hard Savings	\$0
Soft Savings	\$0
Implementation Costs	\$0

Based on how many months: 12

**Note:** Improvement goals, estimated financial benefits, actual baseline DPMO, and Zbench should be reviewed and revised as needed after the end of the Measure phase when you have established a solid baseline for the project.

Measure phase completed on: 

☐ Were goals revised after completion of Measure phase?

☐ Were financial benefits revised after completion of Measure phase?

# Learning Objectives

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- Identify potential Lean Six Sigma projects based on customer requirements
- Demonstrate understanding of Six Sigma tools: “Critical to Quality”, “Voice of Customers” and “Quality Function Deployment”
- Evaluate potential Lean Six Sigma projects using Pareto Priority Index (PPI)
- Apply Project Charter to the selected Lean Six Sigma project

# Overview of E326 Lean Manufacturing and Six Sigma

