2 The DMAIC Process

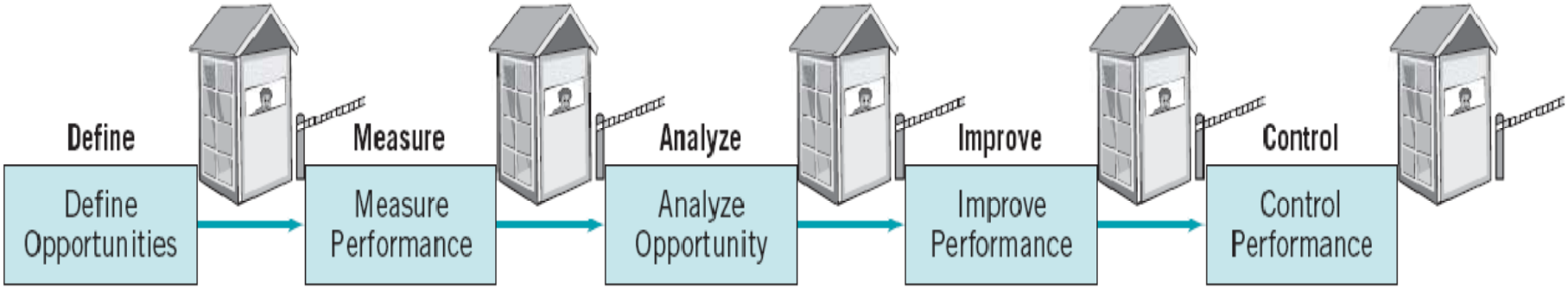
CHAPTER OUTLINE

Learning Objectives

1. Understand the importance of selecting good projects for improvement activities.
2. Explain the five steps of DMAIC: Define, Measure, Analyze, Improve, and Control.
3. Explain the purpose of tollgate reviews.
4. Understand the decision-making requirements of the tollgate review for each DMAIC step.
5. Know when and when not to use DMAIC.
6. Understand how DMAIC fits into the framework of the six-sigma philosophy.

DMAIC

- DMAIC is a structure problem-solving technique consisting of the following steps:
  - Define
  - Measure
  - Analyze
  - Improve
  - Control
- DMAIC is usually associated with six sigma, but it can be used with any business or process improvement effort



Objectives

- Identify and/or validate the business improvement opportunity
- Define critical customer requirements
- Document (map) processes
- Establish project charter, build team

Objectives

- Determine what to measure
- Manage measurement data collection
- Develop and validate measurement systems
- Determine sigma performance level

Objectives

- Analyze data to understand reasons for variation and identify potential root causes
- Determine process capability, throughput, cycle time
- Formulate, investigate, and verify root cause hypotheses.

Objectives

- Generate and Quantify potential solutions
- Evaluate and select final solution
- Verify and gain approval for final solution

Objectives

- Develop ongoing process management plans
- Mistake-proof process
- Monitor and control critical process characteristics
- Develop out of control action plans

FIGURE 2.1 The DMAIC process.

TABLE 2.1

Tools Used in DMAIC

Tool	Define	Measure	Analyze	Improve	Control
Project charter	Chapter 2				
Process maps & flow charts	Chapter 2	Chapter 5			
Cause-and-effect analysis		Chapter 5			
Process capability analysis		Chapters 6, 8			
Hypothesis tests, confidence intervals			Chapter 4		
Regression analysis, other multivariate methods			Chapter 4		
Gauge R&R		Chapter 8			
Failure mode & effects analysis			Chapter 2		
Designed experiments			Chapters 13, 14	Chapters 13, 14	
SPC and process control plans		Chapters 5, 6, 7, 9, 10, 11, 12	Chapters 5, 6, 7, 9, 10, 11, 12		Chapters 5, 6, 7, 9, 10, 11, 12

Projects

- Essential part of DMAIC
- Breakthrough opportunity
- Financial systems integration
- Value opportunity of a project must be clear
- Project selection
- Project management

What should be considered when evaluating proposed projects? Suppose that a company is operating at the 4σ level (that is, about 6,210 ppm defective, assuming the 1.5σ shift in the mean that is customary with six-sigma applications). This is actually reasonably good performance, and many of today's organizations have achieved the $4–4.5\sigma$ level of performance for many of their key business processes. The objective is to achieve the 6σ performance level (3.4 ppm). What implications does this have for project selection criteria? Suppose that the criterion is a 25% annual improvement in quality level. Then to reach the six-sigma performance level, it will take x years, where x is the solution to

$$3.4 = 6210(1 - 0.25)^x$$

It turns out that x is about 34 years. Clearly, a goal of improving performance by 25% annually isn't going to work—no organization will wait for 34 years to achieve its goal. Quality improvement is a never-ending process, but no management team that understands how to do the above arithmetic will support such a program.

If the improvement goal is 50%, then x = 11 years, and if it's 75% then x = 5 years.

Must focus on projects that have high impact

2.2 The Define Step

Business Case • This project supports the business quality goals, namely a) reduce customer resolution cycle time by x% and b) improve customer satisfaction by y%.	Opportunity Statement • An opportunity exists to close the gap between our customer expectations and our actual performance by reducing the cycle time of the customer return process.
Goal Statement • Reduce the overall response cycle time for returned product from our customers by x% year to year.	Project Scope • Overall response cycle time is measured from the receipt of a product return to the time that either the customer has the product replaced or the customer is reimbursed.
Project Plan • Activity Start End Define 6/04 6/30 Measure 6/18 7/30 Analyze 7/15 8/30 Improve 8/15 9/30 Control 9/15 10/30 Track Benefits 11/01	Team • Team Sponsor • Team Leader • Team Members

FIGURE 2.2 A project charter for a customer returns process.

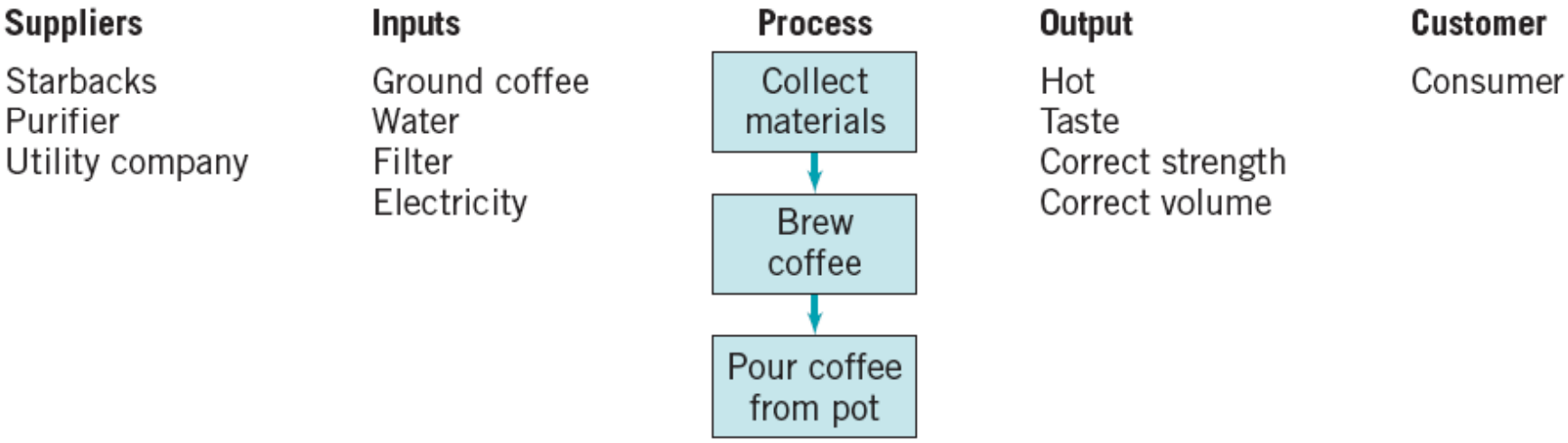


FIGURE 2.3 A SIPOC diagram.

A process map or value stream map may also be prepared. These should be completed by at least the end of the Measure step.

The Define Tollgate

1. Does the problem statement focus on symptoms, and not on possible causes or solutions?
2. Are all the key stakeholders identified?
3. What evidence is there to confirm the value opportunity represented by this project?
4. Has the scope of the project been verified to ensure that it is neither too small nor too large?
5. Has a SIPOC diagram or other high-level process map been completed?
6. Have any obvious barriers or obstacles to successful completion of the project been ignored?
7. Is the team's action plan for the measure step of DMAIC reasonable?

2.3 The Measure Step

- Purpose is to evaluate and determine the present process state
- Identify key process input variables (KPIV) and key process output variables (KPOV)
- Data – from historical records, from sampling, from observational studies
- Histograms, box plots, Pareto charts, scatter diagrams, stem-and-leaf diagrams may all be useful
- In some businesses, the measurement system must be developed
- Measurement systems capability may be important

The Measure Tollgate

1. There must be a comprehensive process flow chart or value stream map. All major process steps and activities must be identified, along with suppliers and customers. If appropriate, areas where queues and work-in-process accumulate should be identified and queue lengths, waiting times, and work-in-process levels reported.
2. A list of KPIVs and KPOVs must be provided, along with identification of how the KPOVs related to customer satisfaction or the customers CTQs.
3. Measurement systems capability must be documented.
4. Any assumptions that were made during data collection must be noted.
5. The team should be able to respond to requests such as, "Explain where that data came from," and questions such as, "How did you decide what data to collect?" "How valid is your measurement system?" and "Did you collect enough data to provide a reasonable picture of process performance?"

2.4 The Analyze Step

- Determine cause-and-effect relationships
- Sources of variability – common cause versus assignable cause
- Tools – control charts, hypothesis testing, confidence intervals, regression models, failure modes and effects analysis
- Discrete event simulation

The Analyze Tollgate

1. What opportunities are going to be targeted for investigation in the improve step?
2. What data and analysis supports that investigating the targeted opportunities and improving/eliminating them will have the desired outcome on the KPOVs and customer CTQs that were the original focus of the project?
3. Are there other opportunities that are not going to be further evaluated? If so, why?
4. Is the project still on track with respect to time and anticipated outcomes? Are any additional resources required at this time?

2.5 The Improve Step

- Process redesign to reduce bottlenecks
- Mistake-proofing
- Statistical tools – particularly designed experiments
- DOX can be applied to either the physical process or a computer model of the process
- Pilot test the solution to confirm that it will solve the problem

The Improve Tollgate

1. Adequate documentation of how the problem solution was obtained.
2. Documentation on alternative solutions that were considered.
3. Complete results of the pilot test, including data displays, analysis, experiments, and simulation analyses.
4. Plans to implement the pilot test results on a full-scale basis. This should include dealing with any regulatory requirements (FDA, OSHA, legal, for example), personnel concerns (such as additional training requirements), or impact on other business standard practices.
5. Analysis of any risks of implementing the solution, and appropriate risk-management plans.

2.6 The Control Step

- Complete all remaining work on project
- Provide the process owner with a process control plan
- Training documents (if appropriate) should be provided
- Methods and metrics for future audits
- Transition plan to the new process might include a validation step

The Control Tollgate

1. Data illustrating that the before and after results are in line with the project charter should be available. (Were the original objectives accomplished?)
2. Is the process control plan complete? Are procedures to monitor the process, such as control charts, in place?
3. Is all essential documentation for the process owner complete?
4. A summary of lessons learned from the project should be available.
5. A list of opportunities that were not pursued in the project should be prepared. This can be used to develop future projects; it is very important to maintain an inventory of good potential projects to keep the improvement process going.
6. A list of opportunities to use the results of the project in other parts of the business should be prepared.

Chapter Case Studies

- Litigation documents
- Improving on-time delivery
- Improving service quality in a bank

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