Process Improvement (PI) Tools:
Typology and Descriptions

About the Project

This project is a quick reference and simple typology of commonly used process improvement (PI) tools. The typology can be useful in two ways. It can:

- Guide current managers to find helpful tools given their needs
- Start discussions on future PI work or research that may benefit from a categorization of tools.

Background

The following tools should be used as part of a larger whole-system transformation toward continuous performance improvement. Such widespread systems change and the use of specific PI tools are most effective when implemented together in a linked way. In particular, lean-based improvement is much more than a toolbox, often entailing fundamental shifts in thinking and leading as well as culture change. For more information on the cultural aspects of lean process improvement, including respect for people, humble leadership, and systems thinking, the Shingo Principles can be referred to as a guide.

There are two parts to this resource:

- **Part 1: Type Categories for Each PI Tool**
  This helps identify what a tool can be used for.

- **Part 2: Descriptive Tables of Tools Listed**
  This is helpful for a cursory understanding of each tool.

Part 1: Typology for PI Tools

PI Tool Name	Type of Tool
5 Why	Root cause analysis Exploration
5s	Error proofing Exploration Workplace organization (physical & digital)
A3	Problem solving Group communication Management of people Project management
Balanced Scorecard	Alignment Monitoring
Control Chart	Monitoring Quantitative analysis
DMAIC (Define, Measure, Analyze, Improve, Control)	Iterative improvement cycle
Driver Diagram	Process planning
Fishbone Diagram	Root cause analysis Exploration
Gantt Chart	Project management Group communication
Histograms / Scattergrams	Quantitative analysis Exploration
Huddles	Group communication Management of people Problem solving Performance monitoring
Kanban	Visual control Inventory or resource control
Kaizen Events	Exploration Iterative improvement cycle
Mission, Vision, Values	Goal setting Alignment
Pareto Charts	Quantitative analysis Root cause analysis
PDSA (plan-do-study-act) aka PDCA (plan do check act)	Exploration Iterative improvement cycle

PICK Chart	Prioritization Alignment
Problem Statement	Goal setting Alignment
Radar Charts	Quantitative analysis Exploration
SMART Objectives	Goal and objective setting Alignment
Statistical Hypothesis Testing	Quantitative analysis
True North	Goal setting Alignment
Value Stream Process Map	Group communication Process analysis
Voice of the Customer (or Patient)	Monitoring Exploration
X Matrix	Strategy alignment Monitoring Process planning

Part 2: PI Tools Descriptive Tables

These descriptions were created to get an initial understanding of the PI tools. Some tools below have longer descriptions, while others list references for more information.

5 Whys	
Name	Why-Why diagram
Definition	A methodology of asking a series of questions beginning with "why" to reveal the root cause of a problem.
Type of Tool	● Root cause analysis ● Exploration
Common Uses	● To find the origin of a problem by in-depth inspection ● To prevent recurring problems ● Used during the "Plan" phase of a PDSA cycle
Input	● Access to a deep understanding of the situation and critical thinking ability. ● "Continue to turn each cause into a problem and ask "Why?" Do not stop until you reach an answer that is fundamental (company policy or procedure, systems, training needs, and so forth.)" (Tague, N. R., 2005, p. 513)
Output	● A root cause and identification of system vulnerabilities
Limitations	● Not suitable for large, complex problems with multiple causes
Examples	Note. The below example asks "why" questions to find the root cause of waiting times. From *On the mend: Revolutionizing healthcare to save lives and transform the industry (*p. 38), by Toussaint, J., & Gerard, R. A*,* 2010, Lean Enterprise Institute.

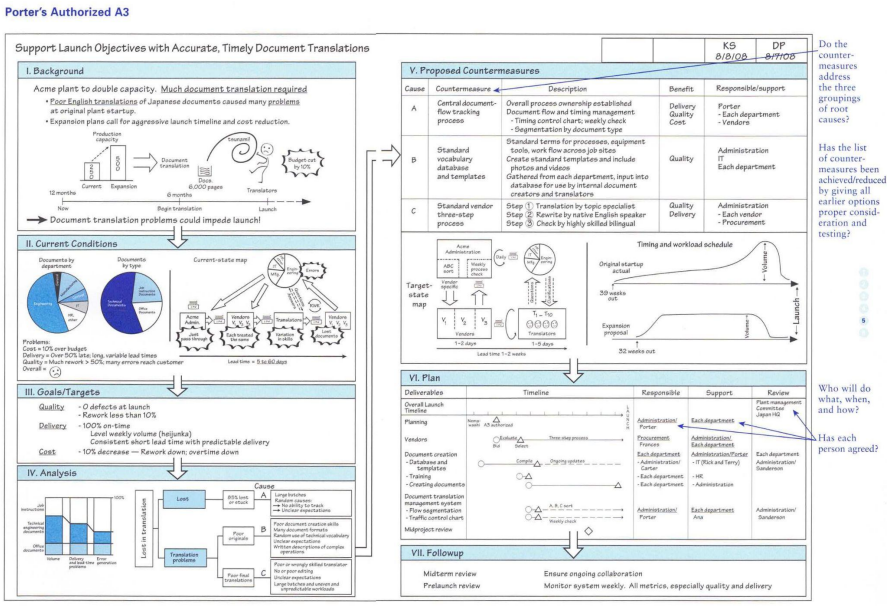
	Let's start with the problem of a STEMI patient's waiting time in the emergency room. 1. Why is the patient waiting? Because a cardiology consultation is needed? 2. Why the consult? Because the cardiologists say they must be the ones to diagnose a STEMI event. 3. Why are cardiologists needed? Because the cardiologists do not trust the emergency doctors to accurately diagnose a STEMI. 4. Why the distrust? Because emergency doctors have not been specifically trained to recognize a STEMI event. 5. Why? There is no standard process to diagnose a STEMI event.

5S: Sort, Set, Shine, Standardize, Sustain	
Name	● "Named after five Japanese words that roughly translate to ○ **sort** (*seiri*) ○ **set** (*seiton*) ○ **shine** (*seiso*) ○ **standardize** (*seiketsu*) ○ **sustain** (*shitsuke*)" (Tague, N. R., 2005, p. 32) ● "Sometimes the 5S are translated into CANDO: clearing up, arranging, neatness, discipline, and ongoing improvement" (Tague, N. R., 2005, p. 32) ● " [...] The approach is called 6S for sort, set in order, sweep and shine, standardize, self-discipline, and safety) (Juran, J. M., & De Feo, J. A. (Eds.), 2017, p. 704)
Definition	Method for error-proofing a workspace by sorting, straightening, standardizing, and sustaining
Type of tool	● Exploration ● Error proofing
Common Uses	● Awareness and prevention of problems ● Identifying and addressing inefficiency in a workflow
Input	● Knowledge of a workspace, including workflow, resources used, and ideal outcomes
Output	● A more efficient, productive, and safer work environment

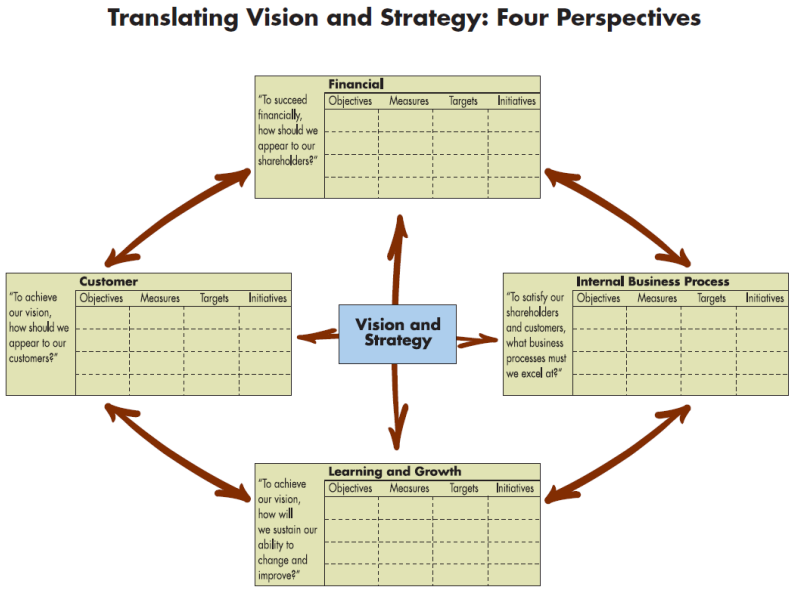
5S: Sort, Set, Shine, Standardize, Sustain	
Limitations	● Relatively superficial analysis that does not identify root causes ● A culture to sustain improvements is a limiting factor
Examples	Note. Using the 5s can organize supplies. From *Lean hospitals: Improving quality, patient safety, and employee engagement (Third edition)* (fig 6.3 and 6.4, p. 129) by Graban, M., 2016, CRC Press, Taylor & Francis Group.  Figure 6.3 Disorganized operating room supplies before 5S.  Figure 6.4 An operating cabinet that has been better organized through 5S.

A3	
Name	A3 refers to an ISO paper size.
Definition	A3 is a documentation process used to rigorously solve problems, coach personnel, and tell a story. The A3 process grew out of Toyota's Total Quality Management (TQM) efforts during the late 1970s (Yoshino, 2016). Concisely presenting TQM efforts on a single sheet of paper was an efficient communication method. It is currently used in many countries and industries.

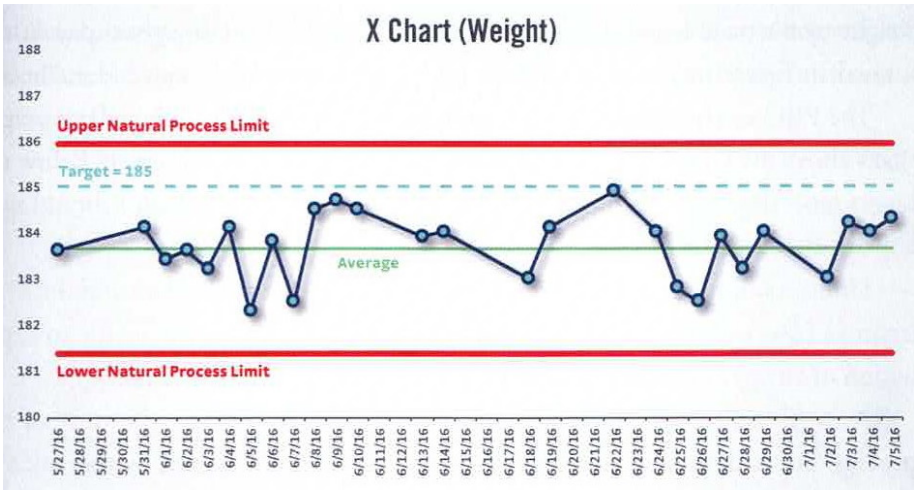
Type of tool	● Group communication ● Management of people
Common Uses	● **Problem-solving** - Identifying and managing a problem through PDSA cycles (Sobek, p 29) ● **Status** - Capstone for completed projects (Sobek, p 87) ● **Proposal** - Communicating a new organizational need (Sobek, p 59) ● **Personal** - "... help leaders identify and focus on behavior changed the need to make" (Toussaint et al., 2020, p143) ● Can be helpful to assign ownership and build consensus
Input	Authors of A3s create 4 to 10+ sections, depending on style and complexity. Below is an example of A3 sections from John Shook (2008, p.7) ***Title*** *– Names the Problem, theme, or issue.* ***Owner / Date*** *– Identifies who "owns" the problem or issue and the date or the latest revision* ***Background*** *– Establishes the business context and importance of the issue.* ***Current Conditions*** *– Describes what is currently known about the problem or issue.* ***Goals/Targets*** *– Identifies the desired outcome.* ***Analysis*** *– Analyzes the situation and the underlying causes that have created the gap between the current situation and the desired outcome.* ***Proposed Countermeasures*** *– Proposes some corrective actions or countermeasures to address the problem, close the gap, or reach the goal.* ***Plan*** *– Prescribes an action plan of who will do what when in order to reach the goal.* ***Follow-up*** *– Creates a follow-up review/learning process and anticipates remaining issues.* The labeling and scope of each section can vary by author. Here are some other section labels included by different authors: ● Problem Statement ● Scope ● Root Causes ● PDSA Cycle (Plan-Do-Study-Act cycle) ● Action Items The input for an A3 can look similar to an SBAR (Situation, Background, Analysis Recommendations) used in healthcare. (Stewart, 2017)
Output	● A concise one-page report telling the story of an issue ● Diagrams, graphs, bolded words, and bullet points are common (Sobek, 2008)

Limitations	• For an A3 to be most effective, more than one person (ideally, key stakeholders and managers) needs to understand the A3 process, which requires prior training.
Examples	Note. The example A3 below has charts, tables, drawings, and written data. From *Managing to learn: Using the A3 management process to solve problems, gain agreement, mentor and lead (*p. 98-99) by Shook, J, 2008, Lean Enterprise Institute. 

Balanced Scorecard (BSC)	
Name	Balanced Scorecard (BSC)
Definition	• A numeric representation of top-level day-to-day institution-wide outcomes to help align strategy. • "Managers using the balanced scorecard do not have to rely on short-term financial measures as the sole indicators of the company's performance. The scorecard lets them introduce four new management processes that, separately and in combination, contribute to linking long-term strategic objectives with short-term actions." (Kaplan, R.S. and Norton, D.P., 1996, p. 152)
Type of Tool	• Alignment • Monitoring
Common Uses	• Measuring and monitoring progress toward strategic goals • Supports alignment to vision at all levels of the organization

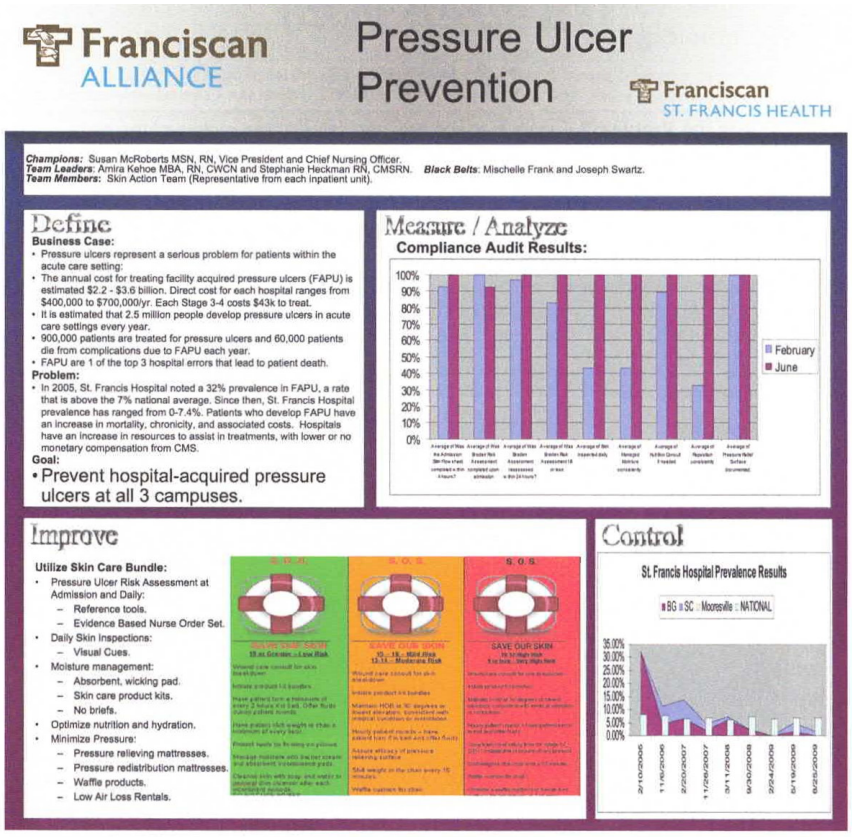
	• Communicating, reviewing, and developing strategy (Tague, N. R., 2005, p. 111)
Input	Typical input categories (Kaplan, R.S. and Norton, D.P., 1996, p. 153): • *Financial* • *Customer* • *Internal Business Process* • *Learning and Growth*
Output	• Concise overview of Key Performance Indicators (KPIs) defined by strategy
Limitations	• To be adopted across the entire organization, it needs buy-in from top leadership • Requires reporting of a lot of data, which may need to be measured, collected, and analyzed from various sources
Examples	Note. The diagram below shows how the scorecard categories are related to vision and strategy. From *Using the Balanced Scorecard as a Strategic Management System*, by Kaplan, R.S. and Norton, D.P., 2007, Harvard Business Review, p 153. 

Control Chart	
Name	• Statistical Process Control (SPC) Chart • Process Control Chart • Process Behavior Chart (Graban, 2019, p. 25) • Shewhart Control Chart (Juran & De Feo, 2017, p. 231)

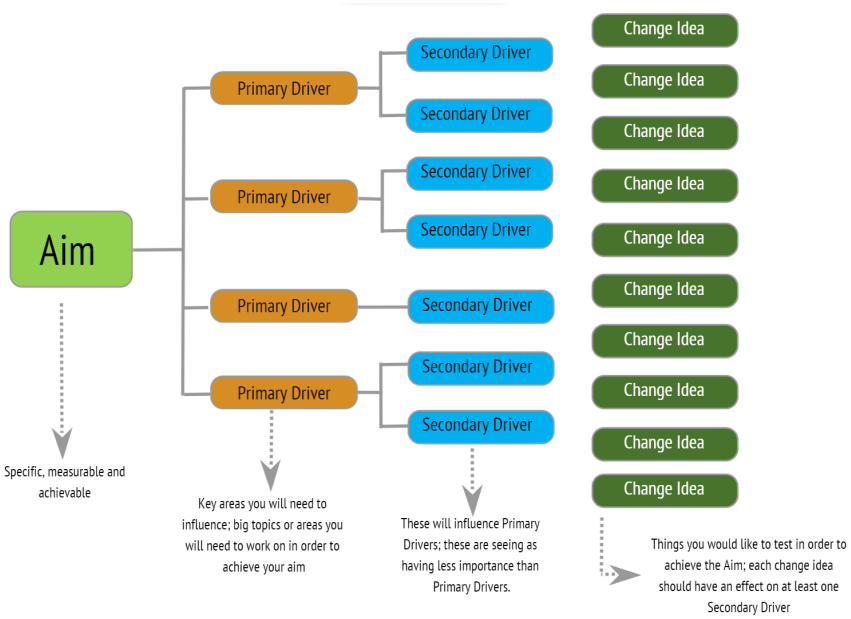
Definition	• Developed by Walter Shewart in 1924 (Smalley, 2018, p. 13) • A line chart of outcomes over time with lines for an upper limit, lower limit, and average
Type of Tool	• Monitoring • Quantitative analysis
Common Uses	• Analyzing different types of variation and identifying variation that requires further action. • Monitoring to differentiate "special cause variation" from "common cause variation" or "signal" from "noise" (Graban, 2019) • Evaluation of a change and monitoring during the "control" phase of a DMAIC effort
Input	• Measures of a defined process outcomes overtime including means and upper control limit (UFC) and lower control limit (LFC)
Output	• Line graph for visually differentiating "special cause variation" from "common cause variation."
Limitations	• Data collection and monitoring can be time-consuming.
Examples	Note. The example below is a control chart for weight measured on different days. From *Measures of Success: React Less, Lead Better, Improve More* (p. 27) by Graban, M. R., 2019, Constancy, Inc. 

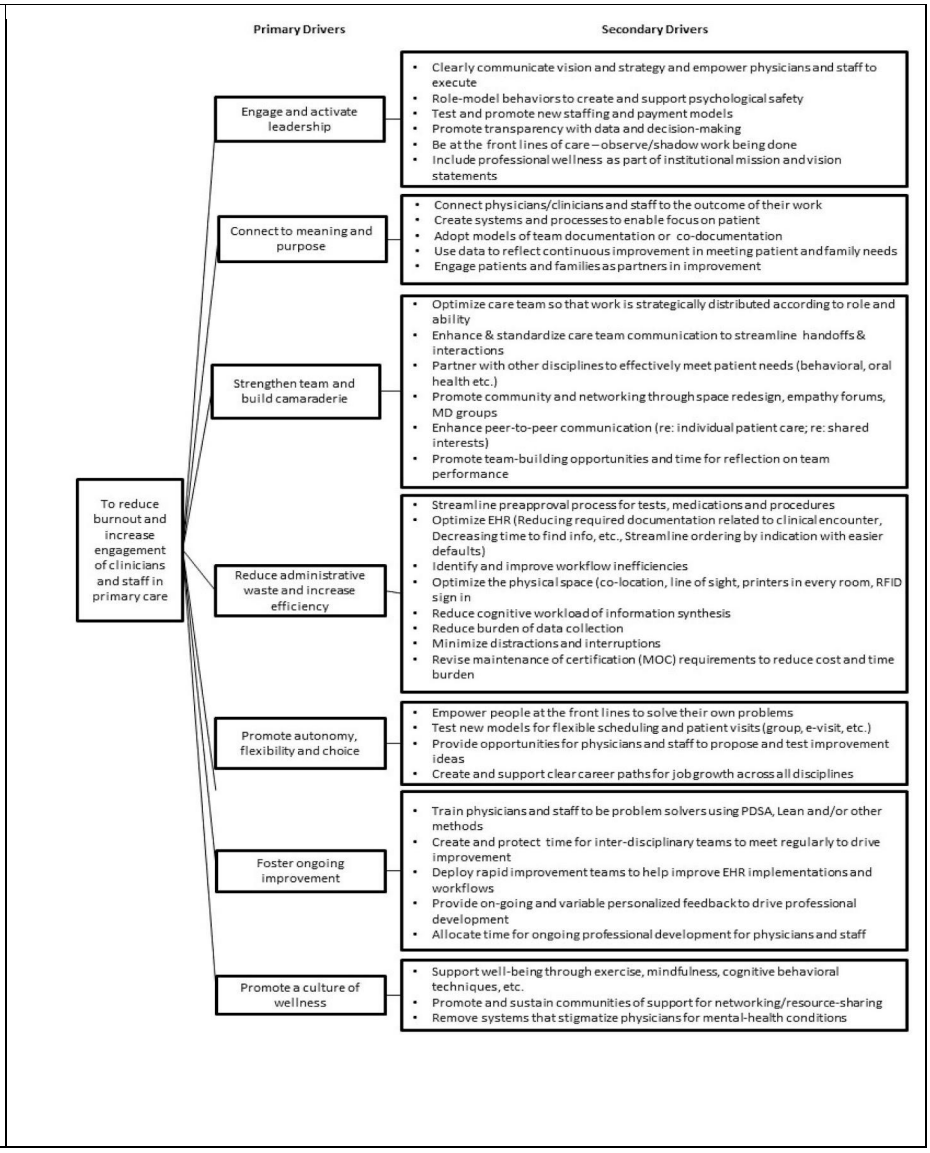
DMAIC: Define, Measure, Analyze, Improve, Control	
Name	• Six Sigma Improvement • Six Sigma problem solving
Definition	• "DMAIC is a quality improvement and problem-solving method used to improve business performance." (De Feo, 2020) • Associated with Six Sigma and Lean methodology

Type of Tool	● Iterative Improvement Cycle
Common Uses	● Provides a thorough approach to address the quality issue of a product or process ● Identify problems, troubleshoot solutions, and maimaintainprovements
Input	Note. The list below is from *Juran's Quality Handbook: The Complete Guide to Performance Excellence* (fig. 14.5, p. 409) by Juran, & De Feo, 2017, McGraw Hill Education. **Define value** 1. Define stakeholder value and critical to quality (CTQ) 2. Map high-level process 3. Assess for 6S **Measure value** 1. Measure customer demand 2. Plan for data collection 3. Create a value stream attribute map 4. Determine pace, Takt Time and manpower 5. Identify replenishment and capacity constraints 6. Implement 6S (S1-S3) **Analyze process - flow** 1. Analyze the value stream attribute map 2. Analyze the process load and capacity 3. Perform value added/non-value added analysis 4. Apply Lean problem-solving **Improve process - pull** 1. Conduct rapid improvement events (RIE) 2. Design the process changes and flow 3. Feed, balance, and load the process 4. Standardize work tasks 5. Implement new process **Maintain control** 1. Stabilize and refine value stream 2. Complete process and visual controls 3. Identify mistake-proofing opportunities 4. Implement 6S (S4-S6) 5. Monitor results and close out project
Output	● Improvement in the quality of a product or process
Limitations	● Process can be too cumbersome for simple quality problems
Examples	Note: In the example below, the DMAIC process was used for pressure ulcer prevention. From a book by Graban & Swartz, titled *Healthcare kaizen: Engaging front-line staff in sustainable continuous improvements*.

	(2012, Figure 7.9, p. 185)  Figure 7.9 A "DMAIC" format A3 summary of patient safety improvements.

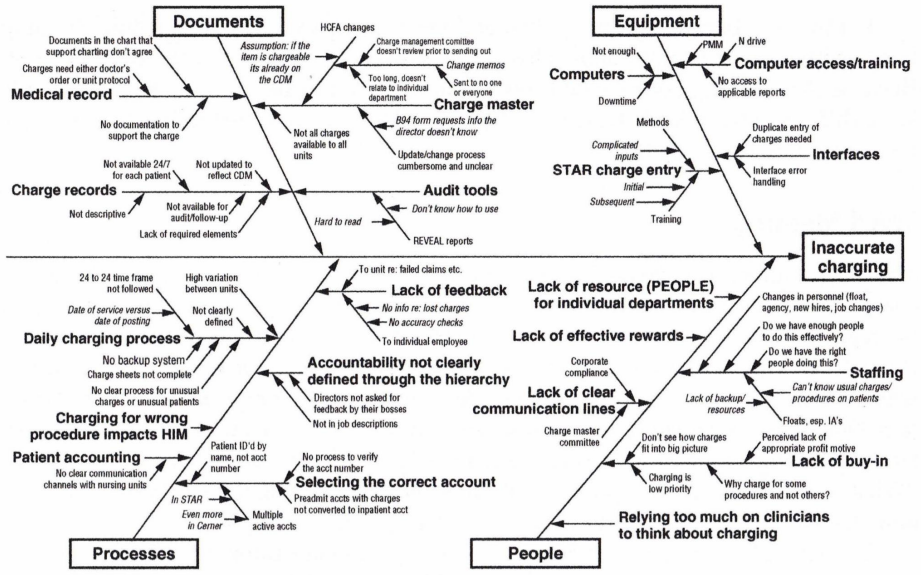
Driver Diagram	
Name	• Key driver diagram
Definition	• "A driver diagram is a visual display of a team's theory of what "drives," or contributes to, the achievement of a project aim. This clear picture of a team's shared view is a useful tool for communicating to a range of stakeholders where a team is testing and working." (Institute for Healthcare Improvement, nd) • Complex projects may have multiple primary and secondary drivers. (Langley, 2009, p. 119) • Visually, it has similarities to a cause-effect diagram, but instead of presenting the causes of a problem, it presents drivers to the desired outcome
Type of Tool	• Process planning

Common Uses	• Communicates a project planner's theory of what factors contribute to the desired outcome • Helps in the planning phase of a PDSA cycle and can be modified as ideas change (Langley, 2009, p. 119) • Can help build project consensus (Sullivan et al., 2021)
Input	• Systemic understanding of processes that may lead to the desired outcome Note. The template of inputs below is from the UK's National Health Service website. From Driver Diagrams. Quality Improvement, East London NHS Foundation Trust. 2022 (https://qi.elft.nhs.uk/resource/driver-diagrams/) 
Output	• Visual representation of a project's theory of change. It can include primary drivers, secondary drivers, and change ideas.
Limitations	• An initial diagram may need to be adapted as facts challenge the presented theory of change
Examples	Note. The example below focuses on the causes of burnout. From "Moving the needle on primary care burnout: Using a driver diagram to accelerate impact" Sullivan et al., 2021, Healthcare, 9(4) (figure 1) 1https://doi.org/10.1016/j.hjdsi.2021.100595. ,

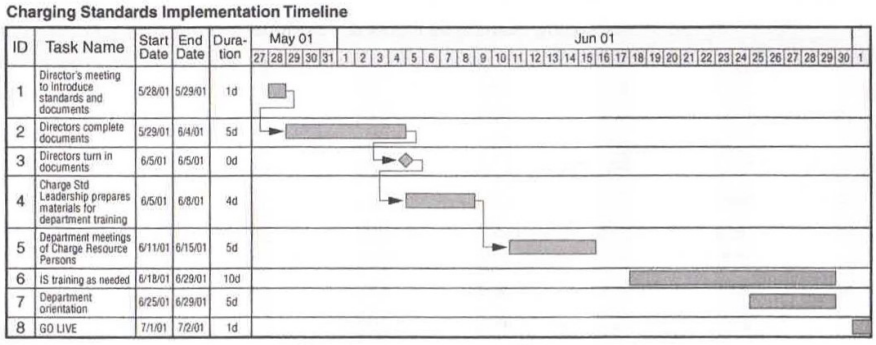


Fishbone Diagram

Name	● Ishikawa Diagram ● Cause and Effect Diagram
Definition	● "A tool that visually identifies which factors might influence performance" (Olden, P. C., 2015, p. 237) ● Originally emphasized by Kaoru Ishikawa, professor of engineering at Tokyo University and father of quality circles (Tague, N. R., 2005, p. 15)
Type of Tool	● Root cause analysis ● Exploration

Common Uses	● "This tool can be used to drill down to factors that contribute to good performance or bad performance. The performance is stated in the "fish head" on the right side of the diagram." (Olden, P. C., 2015, p. 237) ● Valuable to "use especially when the team's thinking tends to fall into ruts" (Tague, N. R., 2005, p. 247) ● "Can be helpful in breaking down a large, complex problem" (Graban, M., 2016, p. 161)
Input	● Ability to think critically and categorize potential causes ● Categories are broad in scope and vary ● "The four main fishbones (or categories of factors) are the ○ *environment in which the work is performed* ○ *equipment used to perform the work* ○ *procedures done to perform the work, and* ○ *people who perform the work"* (Olden, P. C., 2015, p. 237)
Output	● Possible causes of a problem sorted into categories and subcategories
Limitations	● It may not identify the actual root cause
Examples	Note. The example below focuses on inaccurate charging. From *The quality toolbox (2nd ed)*, Tague, N. R, 2005, fig 4.19, p 73. ASQ Quality Press  **Figure 4.19** St. Luke's: fishbone diagram.

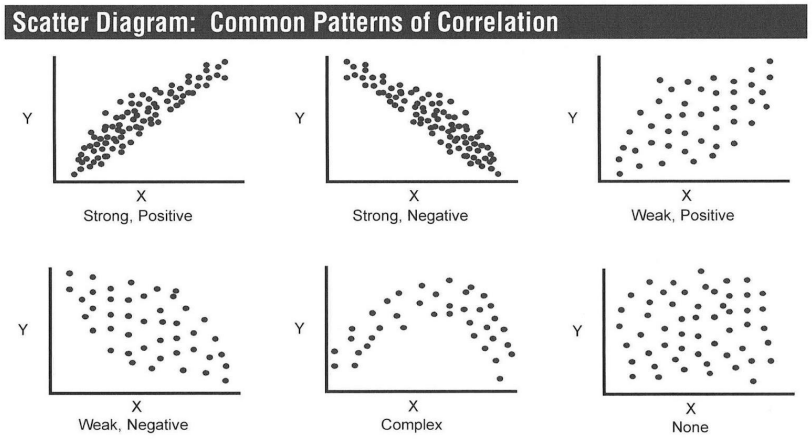
Gantt Chart	
Name	● Milestones Chart ● Project Bar Chart

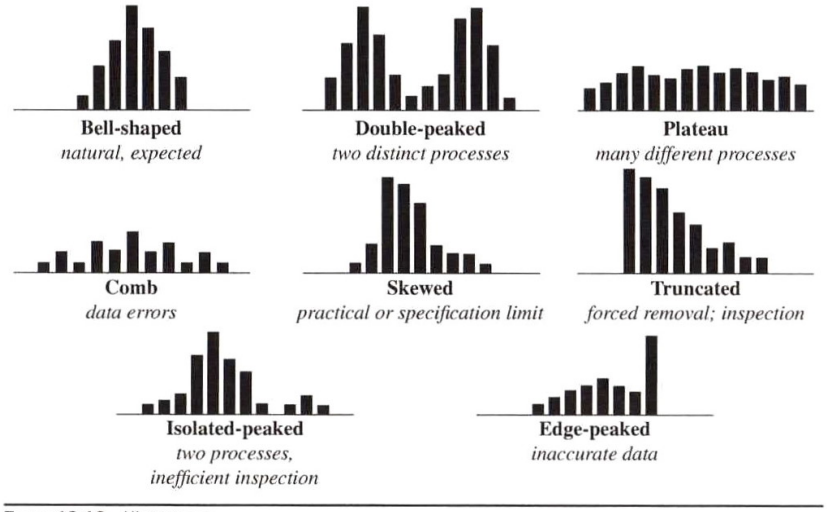
	• Activity Chart
Definition	• Visual representation of a project schedule • It shows the tasks of a project, when each must take place, and how long each will take (Tague, N. R., 2005, p. 271) • "The chart was originally developed by Henry L. Gantt, an engineer and social scientist, as a horizontal bar chart for production control in 1917. Gantt charts can be created on graph paper, or more complex automated versions can be created using spreadsheet or project management software." (Langley, 2009, p. 443)
Type of Tool	• Group communication
Common Uses	• A visual reference of a project's overall time frame and progress • "Used as a project planning tool to show who will do what, and when, to accomplish a project on time and achieve the project purpose" (Olden, P. C., 2015, p. 49)
Input	• Sequence of tasks • Key milestones • Time required for each task
Output	• Knowledge of a process and a timeline • Knowledge of when a task is completed
Limitations	• Maintenance and setup can be time consuming
Examples	Note. The example below shows different lengths for tasks. From *The quality toolbox (2nd ed)*, (fig 4.21, p. 75) by Tague, N. R, 2005, ASQ Quality Press. 

Histograms / Scatter Plot	

Name	• Scatter Plot Alternative Names
	  ○ Scatter Diagram
	  ○ X-Y Graph

Definition	• **Histogram:** a graphical representation of the frequency of one quantitative variable.

	● **Scatter Plot:** a graphical representation of a bivariate relationship with discrete points ● The inventions of the histogram and scatter plot have been attributed to many people in the scientific and statistical communities. However, the true origins remain unclear.
Type of Tool	● Quantitative analysis ● Exploration
Common Uses	● Can provide a quick visual overall representation of a relationship ● Can help identify outliers in the data ● "Depicting the distribution, variation, or spread of the data; showing the deviation from standard" (Sobek, D. K., & Smalley, A., 2008, p. 109)
Input	● Quantitative data of two variables
Output	● **Histogram:** a graph representing the frequency of one quantitative variable ● **Scatter Plot:** a graph representing the relationship between two quantitative variables
Limitations	● May lead to misclassification of relationship when the pattern is not obvious
Examples	Note. The graph below compares different scatter diagrams. From *Juran's Quality Improvement Reference Guide and Tool Kit*. by Juran, J. I., (p. 54) 2013, CreateSpace Independent Publishing Platform  Note. The graph below compares different histograms. From *Quality Handbook: The Complete Guide to Performance Excellence,* (fig. 19.16, p.559) *by* Juran & De Feo, 2017, McGraw Hill Education

	 FIGURE 19.16 Histograms.

Huddles	
Name	● Daily standup meeting ● Tiered daily huddles
Definition	Short structured meeting with "quick communication, prioritized around immediate needs" (Graban "Lean Hosp." p 256) Huddles can occur daily and be tiered to incorporate multiple levels of frontline staff into upper management.
Type of Tool	● Group communication ● Management of people
Common Uses	● Management of anticipated issues for the day ● Tiered daily huddles can be used to escalate issues rapidly through the management chain ● Basic team communication
Input	● Team members ● Agenda
Output	● Communication of the day's activities, needs, and issues ● Plan for problems that do not need a root cause analysis ● Escalation of issues that need attention from supervisors
Limitations	● Not suitable for agendas requiring a significant amount of time
Examples	Note. Below is a huddle agenda example. From *Lean Hospitals: Improving quality, patient safety, and employee engagement Third edition, (*p. 256), Graban M., 2016, CRC Press, Taylor & Francis Group.

	Sample Huddle Agenda 1. Safety reminder of the day; review safety issues or risks 2. Immediate problems to be aware of (instruments down or people called in sick) 3. Review of yesterday's metrics and trends 4. New employee suggestions or ideas; updates on previous ideas 5. Share any positive feedback

Kanban	
Type of Tool	● Visual control ● Inventory or resource control
Resources for More Information	● Graban, M. (2016). Lean hospitals: Improving quality, patient safety, and employee engagement (Third edition). CRC Press, Taylor & Francis Group. ● Lean Enterprise Institute, Marchwinski, C., Shook, J., & Lean Enterprise Institute (Eds.). (2003). Lean lexicon: A graphical glossary for lean thinkers. Lean Enterprise Institute.

Kaizen Events	
Name	● Rapid Improvement Event (REI) (De Feo, J. A., & Barnard, W., 2004, p. 408) ● Rapid Process Improvement Workshop (Graban, M., 2016, p. 278)
Definition	● Kaizen is often translated from Japanese as "good change." ● "It is often used as a name for all encompassing continuous improvement methods." (De Feo, J. A., & Barnard, W., 2004, p. 408) ● "A formally defined event, typically one week long, with a team that is formed to analyze the current process and to make improvements in a process or value stream, with the team being disbanded after the event." (Graban, M., 2016, p. 316) ● Kaizens can vary in size and scope, including daily kaizens for smaller issues. ● "Masaaki Imai popularized the term and concept of *kaizen*, which means small, continuous improvements, often using the PDSA cycle." (Tague, N. R., 2005, p. 15) ● "It has become associated with the use of small teams carrying out improvements on a regular basis." (De Feo, J. A., & Barnard, W., 2004, p. 408)
Type of Tool	● Exploration

<table>
<tr><td></td><td>

- Iterative Improvement Cycle

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<tr><td>Common Uses</td><td>

- To solve problems during a week-long event “conducted by a team formed specifically for this purpose and disbanded afterward. The team is often cross-functional, led by a kaizen leader experienced with Lean principles.” (Graban, M., 2016, p. 278)
- Kaizens can focus on different levels of an organization
  “Flow kaizen focuses on material and information flow (which require a high vantage point to see) and process kaizen focuses on people and process flow.” (Rother, M., & Shook, J., 2018, p. 6)

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<tr><td>Input</td><td>

- Team participation
- Focused problem
- Mindset open to continuous improvement

</td></tr>
<tr><td>Output</td><td>

- Solution to the defined problem
- Multiple improvement attempts

</td></tr>
<tr><td>Limitations</td><td>

- Improvements not sustained after the kaizen
- Underscoping (Graban, M., 2016, p. 279)

</td></tr>
<tr><td>Examples</td><td>
Note. Below is an example Kaizen Event agenda. From Improving quality, patient safety, and employee engagement Third edition, (Table 12.3, p. 279), Graban M., 2016, CRC Press, Taylor & Francis Group.
<table>
<tr><th><u>Day</u></th><th><u>Purpose/goals</u></th></tr>
<tr><td>Monday</td><td>- Conduct Lean and Kaizen event training
- Observe the current process firsthand, collect data, talk with employees</td></tr>
<tr><td>Tuesday</td><td>- Brainstorm, identify, and discuss opportunities for improvement
- Establish performance improvement goals</td></tr>
<tr><td>Wednesday</td><td>- Start implementing changes to layout or process
- Experiment with changes, follow PDCA</td></tr>
<tr><td>Thursday</td><td>- Finalize what works and standardize the new process
- Design management methods for sustaining change</td></tr>
<tr><td>Friday</td><td>- Document results and improvements, compare to plan
- Present event to management, celebrate success, plan for future changes</td></tr>
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<table>
<tr><th colspan="2"><h1>Mission, Vision, Values</h1></th></tr>
<tr><td>Type of Tool</td><td>

- Goal setting
- Alignment

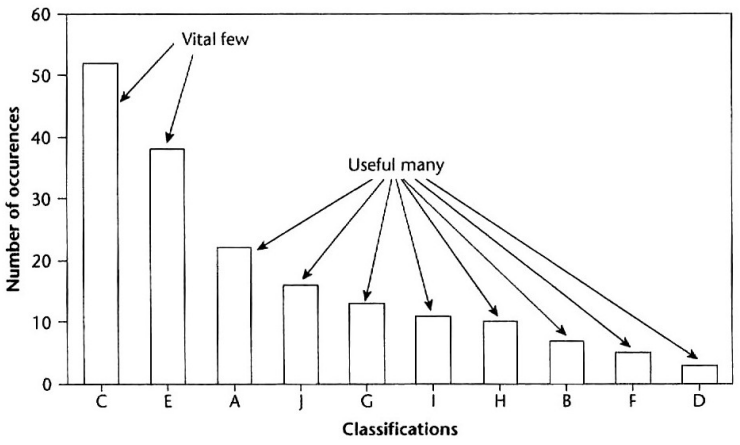
</td></tr>
<tr><td>Resources for More Information</td><td>

- Collins, J. C., & Porras, J. I. (1996). Building your company’s vision. Harvard Business Review, 74(5), 65.

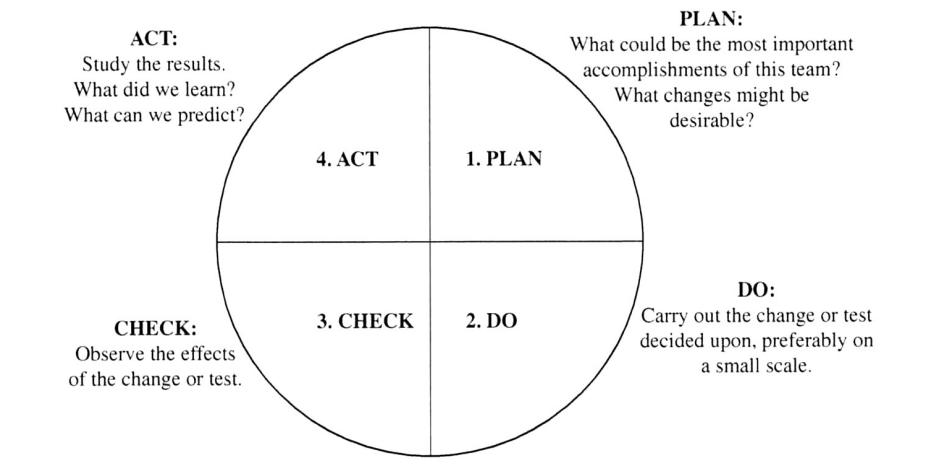
</td></tr>
</table>

	● Juran, J. M., & De Feo, J. A. (Eds.). (2017). Juran's quality handbook: The complete guide to performance excellence (Seventh edition). McGraw Hill Education.

Pareto Charts	
Name	● Pareto Analysis ● Pareto Diagram ● 80/20 Rule
Definition	● "A Pareto chart is a bar graph. The length of the bars represent frequency or cost (money or time), and they are arranged in order from longest on the left to shortest on the right. Therefore, the chart visually shows which situations are more significant." (Tague, N. R., 2005, p. 376) ● "The Pareto Chart was developed by Dr. Joseph Juran. He named it after a 19th-century Italian economist Vilfredo Pareto, whose work provided the first example of the unequal distribution Juran called the Pareto Principle: 80 percent of an effect comes from 20 percent of the causes." (Tague, N. R., 2005, p. 381) ● "The Pareto Principle states that for any given effect (an output of a process or a symptom in this case), there are a number of contributors. These contributors make unequal contributions. By far, a relatively few contributors make the greatest contribution. These are called the vital few. Some contributors occur less often and are called the useful many." (Juran, J. M., & De Feo, J. A. (Eds.), 2017, p. 165)
Type of Tool	● Quantitative analysis ● Root cause analysis
Common Uses	● Focuses problem-solving efforts by highlighting the most prominent problem areas ● Helps to prioritize the most significant problems/causes to achieve the most meaningful improvements
Input	● List of problem causes (categories) and the frequency of their occurrences
Output	● List of problem causes ordered by frequency
Limitations	● Not a root cause analysis ● Does not offer solutions
Examples	Note. The example Pareto chart below identifies the "vital few" and "useful many." From *The improvement guide: A practical approach to enhancing organizational performance (2nd ed) (*fig B.21, p. 437), by Langley, G. J. (Ed.), 2009, Jossey-Bass.

	FIGURE B.21. PARETO CHART. 

PDSA (Plan-Do-Study-Act)	
Name	● Deming Cycle ● Shewhart Cycle (De Feo & Barnard, 2004, pg 96)) ● PDCA (Plan-Do-Check-Adjust) ● SDSA (Standardize-Do-Study-Adjust) (Tague, 2005)
Definition	● "A control model in which managers plan goals, do things to implement plans, check implementation, and act to improve implementation to achieve goals." (Olden, P. C., 2015, p. 240) ● Origins go back to Edward Deming's teaching on continuous improvement (Graban, 2016 pg34)
Type of Tool	● Iterative Improvement Cycle
Common Uses	● Used as a structure for improvement projects that can be iterative ● Can be part of an A3 problem solving report
Input	● Managers can keep going through all four steps repeatedly until the goals are met Note: The diagram below uses "check," whereas others use the word "study." From *Juran's quality handbook: The complete guide to performance excellence (Seventh edition)* (fig 6.6, p. 222) by Juran & De Feo titled (2017)

	 **FIGURE 6.6** The PDCA Cycle. (Shewhart and Deming, 1986.)
Output	• An improved process
Limitations	• Process can be too cumbersome for simple quality problems • A mindset for continuous improvement is needed for sustainability • Potentially a long-time frame
Examples	Note: The diagram below is a flow diagram for a PDSA cycle. From *Understanding A3 thinking: A critical component of Toyota's PDCA management system* (Figure 2.1, pg 20) by Sobek, D. K., & Smalley, A., 2008, CRC Press.

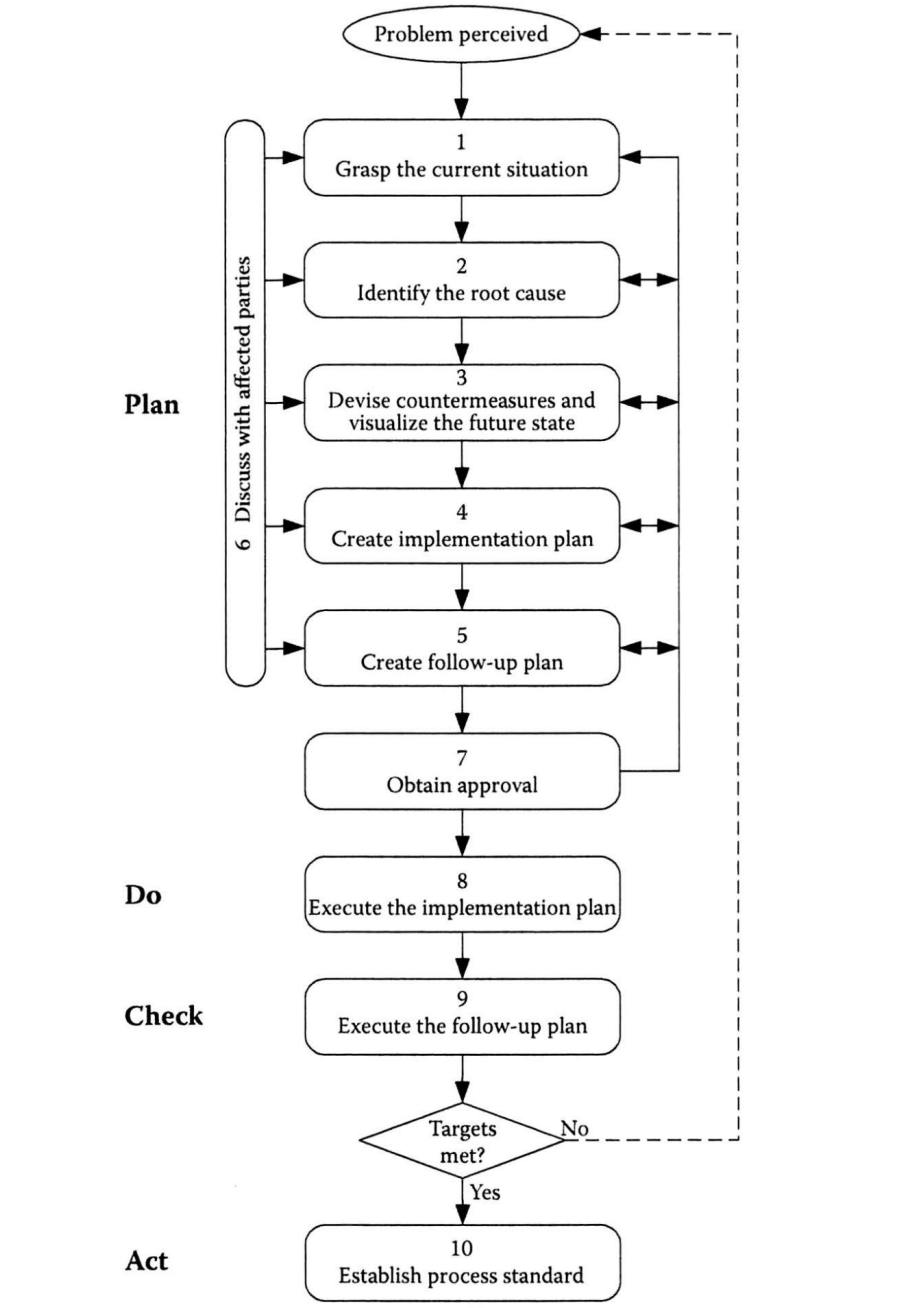


Figure 2.1 Practical problem-solving process

Problem Statement	
Type of Tool	• Goal setting • Alignment

Resources for More Information	● Juran, J. M., & De Feo, J. A. (Eds.). (2017). Juran's quality handbook: The complete guide to performance excellence (Seventh edition). McGraw Hill Education.

Radar Charts	
Type of Tool	● Quantitative analysis ● Exploration
Resources for More Information	● Tague, N. R. (2005). The quality toolbox (2nd ed). ASQ Quality Press.

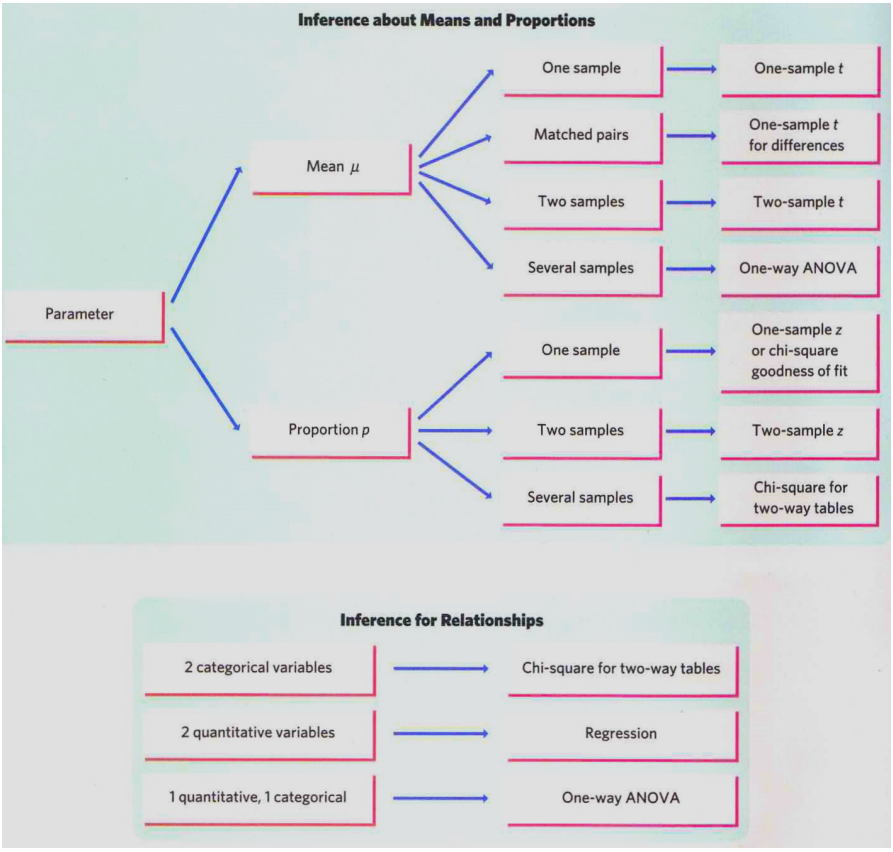
SMART Objectives	
Name	● SMART Goals ● S.M.A.R.T. Objectives
Definition	George Doran introduced the acronym and criteria below "**Specific** – target a specific area for improvement. **Measurable** – quantify or at least suggest an indicator of progress. **Assignable** – specify who will do it. **Realistic** – state what results can realistically be achieved, given available resources. **Time-related** – specify when the result(s) can be achieved" (Doran, 1981) SMART criteria have broad usage in various industries. There have been efforts to amend and expand the criteria. For example, changing the acronym to SMARTER by adding "Engaging" and "Rewarding" as criteria (MacLeod, 2012)
Type of Tool	● Goal and Objective setting ● Alignment
Common Uses	● Support the achievement of long-term goals by providing structure and trackability of progress ● Connects the objective with an action plan and appropriate follow up ● Aids managers in the objective-making process

Input	● Details of the target ● The means to measure the outcome ● A person or entity that can be responsible for the objective ● An understanding of resources and scope to make the objective realistic ● A timeline for completion or specific milestones

Output	● An object goal that follows Doran's structure
	  o Specific
	  o Measurable
	  o Assignable
	  o Realistic
	  o Time-related
	● Not all criteria may be helpful for every objective. For example, some objectives may meet only four criteria.

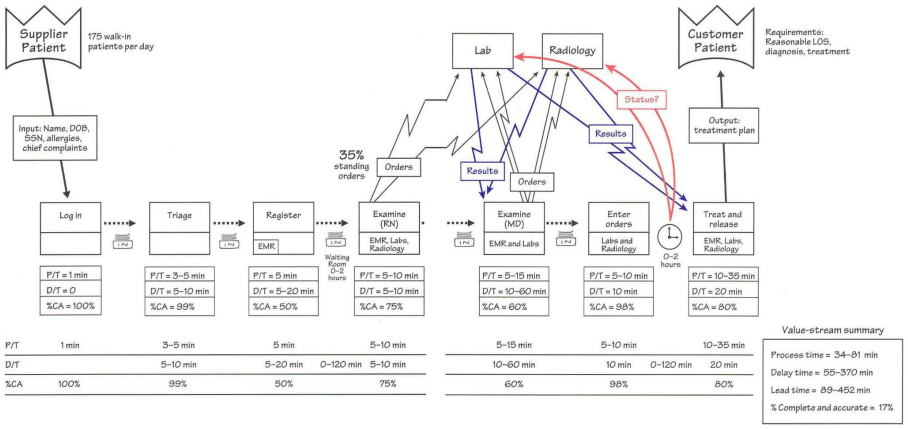
Limitations	● Not appropriate for complex goals, large in scope, with undefinable metrics and timelines.
Examples	"To develop and implement by December 31, 198_ an inventory system that will reduce inventory costs by $1 million, with a cost not to exceed 200 work hours and $15,000 out-of-pocket initial expenditures" (Doran, p. 35)

Statistical Hypothesis Testing	
Name	● Hypothesis tests ● Significance tests
Definition	Statistical tool for hypothesis testing
Type of Tool	● Quantitative analysis
Common Uses	● Assess statistical significance (or correlation) between two or more sets of variables ● One of the steps on the pathway to proving causation
Input	● Two sets of sampled data
Output	● Provides P-value for a given relationship
Limitations	● Requires some understanding of statistics for usage and interpretation
Examples	Note. The flowcharts below aid in choosing the appropriate statistical test given a type of data. From *Practice of Statistics in the Life Sciences Fourth Edition* (inside back cover) by Baldi and Moore, 2018, W.H. Freeman, Macmillan Learning.

True North	
Type of Tool	• Goal and Objective setting • Alignment
Resources for More Information	Smalley, A. (2011, November 2). Toyota's True North Concept. Art of Lean. http://artoflean.com/index.php/2011/11/02/toyotas-true-north-concept/

Value Stream Process Map	
Name	• Spaghetti diagram • Material and information flow mapping (Rother, Shook, p. xi)
Definition	• Diagram used in continuous improvement cycle detailing the flow of information and materials as they change from suppliers to delivery • Developed in manufacturing by Toyota, but it has recently been adopted by other industries too, e.g., health care and IT, to increase efficiency and reduce waste.

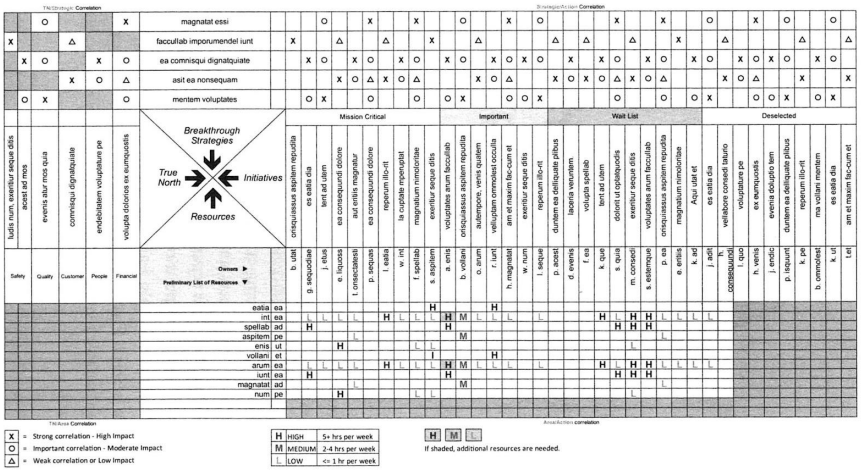
Type of Tool	• Group communication • Exploration • Waste reduction
Common Uses	• Visualizing steps of an existing process and then designing an optimized future state • Identifies value-adding and non-value-adding components • Identifies wasteful activities • Sometimes placed in an A3 diagram or part of a PDCA
Input	• Accurate description of current conditions of a product/process path • Detailed knowledge of the current process, including the time needed to execute each step
Output	• Visual representation of value-adding and non-value-adding steps
Limitations	• The meaning of material flow icons and information flow icons needs to be widely understood
Examples	Note. The value stream map below focuses on a patient's path from walking in to getting a treatment plan. From *Perfecting patient journeys: Improving patient safety, quality, and satisfaction while building problem-solving skills*, (p 34-35) by Worth, et al., 2012, Lean Enterprise Institute. 

Voice of the Customer (or Patient)	
Type of Tool	• Monitoring • Exploration
Resources for More Information	Voice of the Customer • Tague, N. R. (2005). *The quality toolbox* (2nd ed). ASQ Quality Press. Patient Satisfaction

	● Barnas, K., & Adams, E. (2014). Beyond heroes: A lean management system for healthcare (1st ed). ThedaCare Center for Healthcare Value.

X Matrix	
Name	● X Matrix ● Hoshin Kanri X-Matrix
Definition	● "A living document, an iterative method for focusing on top strategic priorities, deselecting less-than-critical projects, and keeping the work aligned with the resources at hand" (Toussaint et al., 2020, p. 171) ● Associated with the Hoshin Kanri strategic planning process
Type of Tool	● Strategy alignment ● Monitoring ● Process planning
Common Uses	● Facilitates dialogue on important elements of strategy, including, resource allocation, priorities, alignment, and progress
Input	● A strategy ● There is no standardized format for the labels of four input categories. Toussaint & Barnas (2020) use these four labels o Metrics (The True North) o Priorities (Strategic Breakthroughs) o Initiatives o Resources
Output	● A one-page diagram with four quadrants that communicates the relationship between metrics, priorities, initiatives, and resources
Limitations	● Can be "time-intensive" and "intimidating to look at" (Toussaint et al., 2020, p. 173).
Examples	Note. The diagram below illustrates how the categories can relate to each other. From *Becoming the change: Leadership behavior strategies for continuous improvement in healthcare*, (fig 10.1 p. 172) by Toussaint et al.

2020, McGraw-Hill.



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