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Evidence That Sticks

Root Cause Analysis Paves the way for Process Improvement

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All improvement initiatives emphasize the importance of management support as a condition for success, and the lack thereof is often listed as a source of failure.

The exact definition of management support is not specified, but I maintain that there is an even more important element for success – process knowledge.

Without process knowledge, management support becomes irrelevant because sustainable process improvement will not occur. My personal observation in dozens of companies reveals that there is a consistent lack of process knowledge within and across processes by all employees, including managers. The need for more thorough process knowledge is the most powerful factor that limits or destroys improvement initiatives.

A harmful by-product of poor process knowledge is misaligned or incorrect performance metrics between and within departments. Here are a few examples that I have encountered during my career.

> The purchasing department within a plastic compounding operation aimed to reduce the cost of raw materials. Purchasing accomplished this by buying a critical raw material in a different form – moving from granular to flake. When the material was used, thousands of pounds of off-grade material were produced. The evidenced-based root cause analysis revealed that the screw feeders were designed for granular material, not flake.
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> In another plastic compounding facility, the maintenance department set equipment reliability and operating efficiency as key performance metrics. Extruders were equipped with a clutch that tripped when high torque occurred to protect the extruder screw. A new and very thick product was tripping the clutch regularly on one of the machines.
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> The maintenance department removed the clutch, assuming that the torque created by the new product was not excessive. Other products operated within an acceptable torque range and had never tripped the clutch. The solution seemed simple and the extruder was back in operation quickly. The metrics were recovered, which seemed like success.
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> A few weeks later, the extruder screw was destroyed while in operation. The evidence-based RCA revealed that a feed tank level indicator had failed, interrupting a critical feed. The torque spiked as a result. With no clutch in place, the screw was destroyed.

In both cases, the departments met their performance metrics. And in both cases, the companies lost a lot of money. Metrics designed in the absence of process knowledge undoubtedly cost companies millions of dollars every year. This loss is not the result of poor technology, insufficient training, or unreasonable customer demands. It is a self- imposed management strategy driven by poor process knowledge.

Many contend that when employees gain experience, their process knowledge increases. But there is a distinct difference between learning how to better operate what may be an inefficient or flawed process and developing an effective knowledge base regarding process behavior.

For example, Six-Sigma emphasizes the need to understand the relationships between the process inputs (the Xs) and the process outputs (the Ys) with the intention of creating predictive control. Most readers will agree that there are few such processes within their organization.

Most processes are poorly designed, or never formally designed, and the user has learned by trial, error, grief, and frustration how to control the process to get the desired output. This is a compelling reason for avoiding process change. The user has no desire to go through the painful ordeal of relearning how to control the revised process.

This problem is driven by the absence of logical problem-solving skills within organizations. This skill deficiency is probably another legitimate complaint against our educational system, but it is not a legitimate reason for continued naiveté among the professional ranks, especially for those with a scientific background. The critical processes must be understood in detail to support and sustain continuous improvement. Lean and Six-Sigma cannot do it for you.

Defining "logical problem-solving" often generates controversy. It is ambiguous depending on your experience and understanding. But as a basis for this article, I have used the scientific method that we all learned at some point.

1. Ask a question
2. Do background research
3. Construct a hypothesis
4. Test your hypothesis by doing an experiment
5. Analyze your data and draw a conclusion
6. Communicate your results

But imagine telling your manager at the oil refinery that produces 100,000 barrels per day at $71 per barrel that you are going to solve the latest process problem using the generic scientific approach. Your manager will certainly ask for much more detail before allowing you to proceed with experiments in such an important and expensive process. You will need to prove that you have a methodology that has been thoroughly demonstrated before proceeding.

Evidence-Based Root Cause Analysis

The answer is found through the use of an evidence-based root cause analysis methodology. In my case, I have used the Apollo Root Cause Analysis methodology, a simple four-step approach, for nearly twenty years with excellent results. Here are the steps in the Apollo RCA process:

1. Define the problem
2. Develop a cause and effect chart
3. Identify solutions
4. Implement and monitor the effectiveness of the best solutions

An effective solution must possess the following attributes:

- It must prevent a recurrence of the problem.
- It must be within your control to implement.

- It cannot create another problem in the process.
- It must be in alignment with the goals of the business.

The concept of cause and effect must be well-understood in order to develop strong, logical problem-solving skills. Most importantly, there are two types of causes – action-based and condition-based.

There must be at least one condition-based cause and one action-based cause, and they must occur at the same time in the same place for an undesirable event to occur. This implies that a single root cause does not exist, which is true. A combination of causes must always come together to create a problem.

For example, a fire requires three condition-based causes and one action-based cause before it can occur. You must have oxygen, flammable material, and an ignition source – all condition-based causes. And, the ignition source must be activated. Whether it is someone striking a match, a spark from static electricity, lightning, or something else, the action-based cause must occur. Remove any of these four causes and it is physically impossible for a fire to occur. Therefore, undesirable events are the result of multiple-cause interactions.

Each cause must be supported by evidence and this is where insufficient process knowledge surfaces. It is a common practice in most companies to carefully delineate job responsibilities within a process. The practice appears logical at first glance. People think if they clearly communicate job responsibilities, they will improve focus and efficiency. But, the practice also creates barriers, often referred to as “silos,” within an organization. Those who dare venture outside of their “box” do so at great risk.

But a process typically overlaps many job functions and these self-imposed barriers severely limit the development of process knowledge. No one knows the entire process. Applying Lean Six-Sigma to portions of a process without understanding the whole process -- while well intended -- will not improve overall process performance and will not add the value that the organization expects and needs from the program.

I have encountered many Lean Six-Sigma programs that lacked direction and supported improvements wherever they could be found. Many resource dollars were expended working on projects that did not contribute to the “bottom line” of the organization. Just from a simplistic throughput perspective, any improvement effort up- or down-stream of the process bottleneck cannot improve the throughput of the process. This misdirected application of Lean Six-Sigma is driven by a lack of process knowledge and business needs.

The Six-Sigma DMAIC (Design, Measure, Analyze, Improve and Control) process instructs the Black Belt to rank all process inputs (Xs) against the most important outputs (Ys). It is a simple statement, but it is a process that could take years to complete in the absence of well-developed process knowledge. In my experience, two years of consistent effort was necessary just to identify the critical X-Y relationships of one process. But it is even more important to understand that most relationships are not one-to-one. In many cases, there are multiple Xs controlling the Y or a single X may influence many Ys.

Design of Experiments is recommended to validate the relationships. DOE is a very powerful and worthwhile tool, but it consumes a lot of time, adds cost, and poses some risk to the operation. I have seen many well-designed DOEs that were “on-hold” until operations allowed access, thus delaying the potential process improvement.

The Lean community has attempted to address this issue by assigning value stream managers – people responsible for the entire process. This is an excellent idea, but most companies retain their department managers, so inter-departmental barriers remain.

Evidence-based RCA programs can address many of these issues in less time and with less cost and risk. A well-developed program can reduce or delay the need for DOE and effectively identify the issues within the entire process or across processes.

As an added benefit, each evidence-based RCA increases the team's process knowledge. The ability to conduct complete systems analyses becomes possible as the RCA database grows. Once the team develops this system-wide process knowledge, it is able to apply the knowledge to other initiatives, increasing the value that the team and the RCA program provide for the organization. Lean and Six-Sigma's limited ability to do this is a frequent complaint.

Evidence-Based RCA Compared with Other Methods

There are several methods in use to prevent these process problems. Six-Sigma uses the failure Mode and Effects Analysis (FMEA), Fishbone diagrams, and Fault Tree Analysis (FTA). The 5-Why methodology is popular with Lean practitioners, while ISO requires a Management of Change (MOC) policy to ensure that changes are controlled.

All of these methods require extensive process knowledge to be successful, but they are missing the crucial elements of effective problem solving.

- They do not require the identification of both condition-based and action-based causes. It is physically impossible for an event to occur without both.

- These methods do not require evidence; therefore, many of the causes are based on consensus, conjecture, and previous experience.

As a result, these methods are not likely to thoroughly and accurately identify the root causes.

Failure Mode and Effects Analysis

FMEA is deeply embedded throughout industry and is used to improve quality in both design and process areas. It was originally developed by the military and used extensively by NASA as a more systematic approach to analyze failure. They are also used to conduct Process Hazard Analyses (PHA) in OSHA's Process Safety Management (PSM) program.

I have been involved in dozens of FMEAs and it involves a group of "experts" who meet, identify and rate the failure modes, severity, and detection values for the process. It is entirely based on consensus and conjecture. It requires no evidence and no multiple-cause conditions. It is a very tedious, drawn-out process that is highly susceptible to groupthink – a phenomenon where independent thinking is lost in order to maintain the cohesiveness of the group.

FMEA serves a valuable purpose in industry. NASA, the original champion, may have been the right environment since process knowledge was likely high. But, it is an ineffective means of developing process knowledge. The limitations of the FMEA methodology, coupled with a lack of process knowledge, make it a less-effective tool for quality improvement and process hazard analysis as well.

I have personally conducted a process hazard analysis using evidence-based root cause analysis with powerful results. The multiple cause and evidence requirements provided credibility to the analysis. The team expressed confidence in its solutions and implemented them very quickly as a result.

Ironically, NASA is currently one of the biggest users of evidence-based root cause analysis.

5-Whys

Many companies emphasize their commitment to accountability and responsibility within the workforce. Unfortunately, this is often misapplied and used to place blame on the person closest to the problem. The 5-Why methodology is especially

susceptible to this since it is a qualitative, linear methodology applied to a non-linear event. It cannot identify all of the applicable causes

I have reviewed several 5-Why programs and they consistently show that nearly all causes are the result of incorrect actions taken by people. Whoever is closest to the problem must have been responsible in some fashion.

This is not surprising. It has been shown that people are much less likely to connect the effect with the correct causes as the time between the two increases. Companies like the 5-Why methodology because it is fast, but the tradeoff for speed is inaccuracy. Five-Why is missing the critical elements of logical problem solving and fails to identify the actual root causes in most cases.

International Standards Organization (ISO)

ISO requires an organization to document its procedures and follow them. The organization just has to do what it says it does. This provides consistency within an organization, but it does not address the missing elements required to improve quality.

During my career in organizations without RCA programs, or ineffective ones, the biggest struggle during an ISO audit was demonstrating that they were effectively identifying and addressing corrective and preventive actions. Most audit findings were associated with this issue.

The new ISO 9001:2008 standard requires that organizations demonstrate the effectiveness of their corrective action programs. Providing effectiveness data for corrective and preventive actions was an easy task in organizations that had an evidence-based RCA program in place.

The program determined when an investigation was required, tracked the solutions that were implemented, and validated the effectiveness of the solutions over an extended period.

Statistical validation of the solutions is critical to the development of process knowledge, and the lack of problem recurrences is an excellent performance metric.

Lean and Six Sigma tools all have their purpose and strengths, but they are more effectively applied – and are more likely to achieve the expected results related to efficiency, cost savings and ROI -- when process knowledge is significantly improved. The best way to enhance process knowledge is through faithful use of a root cause analysis methodology that is evidence-based, pinpoints both actions AND conditions, and is proven to prevent problem recurrence.

Tracy Willis has nearly 20 years of experience in business process improvement and incident investigations within Rohm & Haas and Solvay. While serving as Plant Manager for Solvay's Greenville, SC plant, Willis integrated a Root Cause Analysis program within the Lean Six Sigma program, which before his departure achieved a return on investment of more than 400 percent. Willis is a certified Lean Six Sigma Master Black Belt and a Shingo examiner. As owner of Precision Processes, Willis provides specialized consulting in process analysis and improvement. He also is a certified Apollo Root Cause Analysis instructor and investigator.