Vol. 04, No. 4 (2022) 407-416, doi: 10.24874/PES04.04.003

Proceedings on Engineering Sciences

www.pesjournal.net

AN EMPIRICAL ASSESSMENT OF PROBLEM STATEMENT CREATION WITH IS/IS-NOT

Matthew Barsalou[1]
Robert Perkin

Received 18.04.2022.
Accepted 29.07.2022.
UDC – 005.6

Keywords:

RCA; Is/Is-Not Analysis; Problem Solving; Problem Statement; Root Cause Analysis

A B S T R A C T

This paper explores the creation of problem statements using 5W2H questions using an is/is-not matrix and seeks to determine if use of 5W2H type questions leads to a quicker resolution of problems. An 8D report database with fields for problem descriptions and days to root cause identification was used to determine if better defined problems were solved quicker than problems that were less well defined. The level of detail in the problem statements was assessed, problems were classified as having a low or high level of detail, and then a statistical hypothesis test was performed. Problems with a better defined problem statement were solved quicker than those without. Those with a more detailed problem statement required a mean of 34.1 day and those with a less detailed problem statement required a mean of 48.0 days.

.

1. INTRODUCTION

These are instructions for authors and this document has been prepared using the required format. The paper must be written in correct English. If the quality of the language is too poor, this can prevent your paper from being included in the Proceedings. For the good appearance of the Proceedings it is of intrinsic importance that all full texts are of the same shape. The paper is to be written in two-column format on the paper size A4 and be right and left justified, using single spacing (Times New Roman 10 pt). The width of top, and bottom margins is 25 mm, and left and right is 20 mm. The width of each column is to be 80 mm, and the gap between columns should be 10 mm (Format>Columns).

Problems such as major production disturbances happen in organizations resulting in increased costs (Ylippaa et al. 2017) and the problems must be solved. However, the problem must be defined prior to attempting to find the root cause and this is done with a problem statement (Mohaghegh and Furlan (2020). Having a clearly define problem statements helps to ensure the problem solving team is addressing the correct problem and helps to avoid looking in the wrong place for the cause of the problem.

A problem is a “negative deviation from a norm” (Latino and Latino 2002 p. 23) and this deviation needs to be solved. There are many types of problems that may need solving, often related to quality problems. According to Smith, problems may be due to either the design of a product or process or due to performance in terms of effectiveness or efficiency (1994), where effectiveness pertains to conformance to requirements and efficiency refers to aspects such as number of parts per hour.

Quality problems are often detected when they occur, with the need to address them being obvious such as

[1] Matthew Barsalou
Email: matthew.a.barsalou@gmail.com

when a customer sends a formal complaint. Problems also need solving when an undesired event or a failure occurs (Robitaill 2004). Alternatively, problems may also be encountered in Kaizen and Continuous Improvement (CI) projects, which are performed to achieve improvements (Carnerud et. al. 2018). Here, improvement opportunities are sought out and then the problems are addressed.

To solve the problem, a root cause analysis (RCA) is often performed to identify the cause of the problem (Mahto and Kumar 2008) because the cause of problems must be understood before actions can be taken to eliminate the problem (Anderson and Fagerhaug 2000).

An RCA (root cause analysis) is performed to identify the source of a problem (Dell, et al. 1993), but an approach to problem solving should be used when performing an RCA to solve a problem and there are many approaches to problem solving can be used for RCA. For example, an 8D report, Six Sigma, or PDCA (Plan-Do-Check-Act) can be used (Okes 2009). Other options include an A3 report (Chakravorty 2009), Kepner Tregoe's problem analysis method, and the Shainin System (deMast 2013). Six Sigma is also an approach that can be used for problem solving.

Regardless of the exact problem solving method used, there is a commonality across methods with most having some form of problem definition, analysis, solution selection and evaluation, and a way of ensuring the problem does not return (Mohaghegh et. al. 2020).

Many quality tools can be used for problem solving. An is/is-not analysis is often used for problem solving; however, a failure may be influenced by many factors, therefore, the use of additional quality tools may be required (Finlow-Bates et. al. 2000). A common tool used for finding the cause of a failure is an Ishikawa diagram (Suárez-Barraza and Rodríguez-Gonzále 2019). Other commonly used problem solving tools include Pareto analysis and histograms (Jiju et. al. 2021).

Additional tools for RCA include the seven basic quality tools consisting of the Ishikawa diagram (also known as fishbone diagram or cause-and-effect diagram), check sheets statistical process control charts, graphs, histograms, Pareto diagrams, and scatter plots. The seven management tools may also be useful; these are affinity diagrams, arrow diagrams, matrix diagrams, matrix data analysis method process decision program charts (PDPCs), relation diagrams, and systematic diagrams. Additional useful tools include brainstorming, flow charts, fault tree analysis (FTS), and failure modes, effects analysis (FMEA), and department purpose analysis (Donauer et. al. 2015). Other quality tools and methods are the five whys, brainstorming, barrier analysis, affinity diagram, and more complicated advanced methods such as simulation analysis and Bayesian networks (Abellana 2021).

Problems statements can be defined starting with using 5W2H questions (Reid and Smyth-Renshaw 2012). The 5W2H with questions such as what, where, and when can be used with an is/is-not matrix for writing a problem statement (Westcott 2007). The is/is-not matrix can then be used to create the problem statement (Breyfogle 2003).

2. LITERATURE REVIEW

2.1 5W2H and its Variants

Data is needed for problem solving (MacDuffie and Paul 1997) and creating a sufficiently detailed problem statement and using 5W2H can both help to clearly define the problem (Stamatis 2002) and make clear what additional data must be collected.

The abbreviation 5W2H stands for who, what, when, where, why, how, and how (Tague 2005). Bauer, Duffy, and Westcott recommend asking questions such as where the problem was observed, why the problem happened before, what are the symptoms of the problem, how serious the problem is, when the problem occurred, what might have happened, but did not happen, how big is the problem, and is the cause of the problem known (2006).

The use of abbreviation 5W2H is common; however, there is variation in which words various authors' uses. There is also variation in the concept, with Mahto and Kumar using 3W2H, which stands for what, when, where, how and how much (2008).

An example of a problem statement crated with what, who, where, when, and why questions is "Our work order processing department has been averaging 10% more complaints each month during the past three months after introducing the new Excel 2013 tool to manage work orders for all organizational departments" (Max 2015 p. 71).

The use of 5W2H is not new to problem solving and is already a part of some approaches. For example, the use of 5W2H is a step in the use of A3 reports (Tortorella et. al. 2015) and continuous improvement projects frequently use 5W2H to identify changes (Wagner 1993) that may contribute to the problem under investigation.

2.2 Is/Is-Not Analysis

A matrix can be used for the 5W2H questions when creating a problem statement (Max 2015) and many of the questions, necessary for investigating a problem, can be align well with an is/is-not matrix. An is/is-not analysis is sometimes referred to as a Kepner-Tregoe analysis or K-T analysis (Finlow-Bates et. al. 2000).

The concept of an is/is-not analysis was introduced by Kepner and Tregoe in their book *Executive Problem Analysis and Decision Making*. They used an example of a number two cracker having complaints regarding safety measures on routine things, but not cracker one or cracker two or any dramatic incidents. The problem only pertained two number two cracker and not number one or three and the problem started at 7am with the morning shift and was continues, but is not before 7am, afternoon shift, late shift, or intermittent. The extent was all six employees and not less than all six employees (1973).

An is/is-not analysis is not technically classified as a tool for finding root causes, but it has been successfully applied to the analysis of failures (Jing 2008) where it can be useful for eliminating incorrect potential failure causes, thereby resources are not expended on investigating potential causes that don't further the investigation (Levinson 2006).

As an RCA tool, an is/is-not is an effective tool for quickly finding the cause of failures (Rucker 2016); it merely shows defenses between what is affected and what is not affected and not the reason for the difference. An investigation into the reason or the difference is needed. However, the differences between what is affected and what is not affected can help to identify the root cause of a problem (Barsalou and Perkin 2015) because the difference may be what is causing the problem.

In addition to being one of many quality tools used during an RCA, an is/is-not helps with displaying relevant facts pertaining to a problem and also makes clear what information is missing (Schnoll 2011); therefore, making clear what additional information is needed.

Like a simple 5W2H, there is variation in the exact wording used in an is/is-not matrix. For example, Kepner and Tregoe use the categories what, where, when, and extent. What refers to both the object and the specific problem. Where refers to the location where the item problem is found to have a problem and the location on the item that has the problem. When asks when the problem was first found, when the problem has occurred again, and when in the history of the item the problem occurred, such as the usage cycle. The extent category includes the questions how many were found, how many problems are on an individual item, and what is the trend, such as the size of the problem (Kepner and Tregoe 2006).

Finlow-Bates et.al. use the questions what, where, when and magnitude and give an example of excess vibration in only one of three turbines, at one of three couplings, begging the previous Friday, only during some startups, and 40% above the permissible limit (2000).

Another variation on is/is-not uses what, where, when, and scope; however, the specific information requested is much like that of other versions of is/is-not. For example, what pertains to the affected product or process and the type of failure and where pertains to both where the failure happened and where on the part the failure happened. When is referring to when the failure first happened and when in the usage the failure is being detected. The scope of the failure refers to both the number of failures and persons affected as well as costs (VDA 2018).

Palady and Snabb tell us the what, where, when, and how much type questions used in an is/is-not analysis are used to identify what the problem is, where it happens, when it happens, and the magnitude of the problem and the authors believe there is always some distinction between problem parts and non-problem parts (2000). Alternatively, Jing gives an example of an is/is-not that uses what, where, when, and size as categories (2008).

The Automotive Industry Action Group recommends asking what, where, when, and how big (2005) and recommends those doing an is/is-not to consider facts and not opinions (2005). In addition to asking questions such as where, when, what kind, and how much, an is/is-not matrix also asks the opposite questions (Villarreal and Kleiner 1997) such as where and when did the problem not occur. In addition to where location where the problem occurred, another aspect to consider is where on a part a problem occurred (Raub 2002).

When used for RCA, an is/is-not analysis is not intended to directly identify the root cause of a problem; rather, it is used to localize where specifically the problem is happening so that father analysis can be performed (Barsalou 2015). Patterns, such as overtime, can be detected using an is/is-not matrix (Siebels 2004).

An is/is-not analysis is also useful for eliminating potential problem causes that were incorrect, which leaves the problem solving team free to concentrate on potential causes that may actually be causing the problem (Barsalou 2016). It is important to always question whether there is data to support statements made in an is/is-not (Rucker 2016).

Hypotheses are generated and evaluated during problem solving. When testing a hypothesis, new information may be gained resulting in a new hypothesis (de Mast 2013) and a need to revise the problem statement in light of new evidence because the problem statement may no longer be valid (Bauer, Duffy, and Westcott 2006). In such situations, the is/is not matrix should be updated followed by the problem statement.

Performing an RCA could require extensive effort and significant resources (Soares Ito et. al. 2021) and there is a risk of solving the wrong problems when attempting to solve problems (Nickerson and Argyres 2018). One way problem solving can go wrong is when the definition of the problem is not complete, which is a problem that often results from an incorrect assumption that the problem was understood (Gano 1999). Creating a clear and correct problem statement can help to counter this because a clear problem definition provides focus and save time and helps everybody involved to understand what the problem is (Ammerman 1998).

2.3 Defining Problems with Problem Statements

Many approaches to problem solving already require a problem statement. For example, problem statements are needed when problem solving with an A3 report, which is both a method and a one page document with both text and illustrations that uses the A3 methodology (Chakravorty 2009). An A3 report contains multiple panels which list the team, relevant background information, the current situation, the intended objective, the cause of the problem along with the RCA to determine the cause, the improvement actions, an action plan to implement the improvements, and follow up actions (Lorenzi and Ferreira 2018) with the problem statement listed as part of the background information.

Another method and report that includes a problem statement is the 8D report. An 8D report has eight steps, with a problem statement written during the second step, which is define the problem (Alexa and Kiss 2016).
Six Sigma is based on phases summarized with the term DMAIC (Marques et. al. 2017), which stands for define, measure, analyze, improve, and control, and a problem statement is used in the charter of Six Sigma projects (Sharma et.al. 2018) that is created during the define phase of a Six Sigma project (Desai and Prajapati 2017). Another quality related problem solving methodology that requires a problem description is the QC (quality control) story (Suarez-Barraza et. al. 2021).

Many problem solving approaches require a problem statement. But, simply having a problem statement may not be sufficient if the problem statement does not contain the details required for understanding the problem. For example, the depiction of a problem is not always sufficiently clear such as when a customer complains that a vehicle’s transmissions “shifts funny” and the customer’s statement us used verbatim as the problem statement (Stamatis 2002).

An is/is not analysis is useful both for clearly defining a problem and for performing a root cause analysis (Westcott 2007) and Breyfogle recommends using an is (is-not matrix when writing a problem statement such as when using an 8D report (2003).

An 8D is a both a report and a method for problem solving (Riesenberger and Sousa 2010). The name 8D stands for 8 disciplines, which are the eight steps using in the problem solving process and shown in the 8D report (Zarghami and Benbow 2017). In addition to 8D and 8 discipline report, other names for 8D include Global 8D and Ford TOPS 8D (Kaplik et. Al. 2013).

The 8D report begins with administrative details such as report numbers, part numbers, and the names of the customer and supplier as well as the start date and revision date)2016 Barsalou).

Some organizations use a step D0 prior to the official start of an 8D report. Here, the way in which the problem will be addressed is determined (Biban and Dhounchak 2017). For example, an organization may have different processes for solving different types of problems. Alternatively, the decision may be made to simply solve a problem with a clear cause and solution.

The first step in an 8D is D1, where a team is formed (Kumar and Adaveesh. 2017). The second step is D2 where the problem is defined and Datekar et. al. recommend using 5W2H questions consisting of what the problem is, where the problem happened, when the problem happened, how the problem occurs, and how many parts are affected (2013).

The next step is where immediate actions are taken to implement a short term improvement to contain the problem until a permanent corrective action can be implemented (Najmuddin et. al. 2014). The root cause is investigated and then confirmed in step D4 (Bibin et. al. 2017).

Permanent corrective actions are then defined and their effectiveness is verified prior to implementation (Alexa and Kiss 2016) and the permanent corrective actions are implemented in step D6 (Chen and Cheng 2010). Actions are taken to ensure the problem cannot occur again in step D7 (Barosani et. al. 2017). The problem solving team is congratulated for their success in the final step of an 8D (Shubham 2016).

3. RESEARCH METHODOLOGY

3.1 Data Collection

The authors attempted to determine if problems with a well-defined problem statement required less time to find the root cause of the problem than problems will a less well-defined problem statement. Therefore, a study was performed using real world data from a large manufacturing organization.

Quality problems were exported form an 8D tracking database. The database contained both a field for the problem statement and a field listing the time till the root cause was discovered in days.

The organization used reports in an 8D form sheet for reporting on problems and key details were copied to the 8D database. The database was online and only accessible for registered users with a password. The software was a commercially available off-the shelf program that was customized to better fit the organization’s needs.

There were 452 problems in the database. There were 205 problems there were copied in from an older spreadsheet for archival purposes and these were discarded due to minimal details being copied to the database. Of the remaining 248, seven listed zero days till root cause identification with one entered as a test by the software vendor and six were problems where the root cause was immediately know such as when a part was returned from the customer after testing under conditions that the part was never intended to survive.

There were an additional 32 problems with no timing for root cause identification; these problems were still unsolved at the time the data was exported from the database. The reduction in problems resulted in 210 cases available for analysis purposes.

3.2 Analysis and Results

A table with the problem descriptions was created and each problem description was read and assessed for the presence of who experienced the problem, what the problem was, when the problem occurred, where the problem occurred, how the problem was happening, and how many parts were affected. The database was not assessed for the question "why?" as the problem solving teams that entered information the database only list why the failure happened as part of the problem description and not root cause.

A 1 was assigned if the needed information was present. Figure 1 depicts a hypothetical example of the table used. The problem statement in the example was created just for this example, to avoid releasing organizational internal data.

Problem description	Customer ABC reported 2 out of 10 brackets (p/n 6847) with cracks
Who experienced the problem?	1
What part has a problem?	1
When did the problem happen?	
Where did the problem happen?	
How is the problem happening?	1
How many parts have a problem?	1
% of 4W2H	50
Time to find root cause	27

Figure 1. Example of rating problem descriptions

The total percent of 4W2H information present was determined by adding 16.67 for each occurrence of a required piece of information. The resulting degrees of fulfilment in percent were 16.7, 33.3, 50.0, 66.7, 83.3, and 100.0 after rounding. The time to find the root cause was divided by a number to avoid releasing proprietary information. The first three percentages, 16.7, 33.3, and 50.0, were rated as a low degree of fulfillment and the next three percentages, 66.7, 83.3, and 100., were rated as high degrees of fulfillment.

The mean of high rated problems was 34.1 and the mean of low rate problems was 48.0. A one-tailed two-sample Student's T-test was then performed to determine if there was a statistically significance difference in the mean time till the root causes of the problems in the low and high groups were found.

A one-tailed test was chosen because the mean of high was clearly, lower than the mean of low and a one-tailed Student's two-sample-test can be used to determine if the difference is statistically significant or just due to random variation when the interest is not just if there is a difference in two means, but also if the difference is in a specific direction (Montgomery et. al. 2001). In this case, the null hypothesis is that there is no difference in the means and the alternative hypothesis is that the mean of high is less than the mean of low.

The resulting one-tailed Student's two-sample T-test is shown in Figure 2. The resulting P-value is less than the critical value of 0.05; therefore, the null hypothesis is rejected. There is a statistically significant difference between the two groups with an alpha of 0.05.

Two-Sample T-Test and CI: Timing to D4 Completion; % of 4W2H Method

μ_1: mean of Timing to D4 Completion when % of 5W2H = High

μ_2: mean of Timing to D4 Completion when % of 5W2H = Low

Difference: $\mu_1 - \mu_2$

Equal variances are assumed for this analysis.

Descriptive Statistics: Timing to D4 Completion

% of 5W2H	N	Mean	StDev	SE Mean
High	92	34,1	34,1	3,6
Low	118	48,0	62,2	5,7

Estimation for Difference

Difference	Pooled StDev	95% Upper Bound for Difference
-13,88	51,84	-1,97

Test

Null hypothesis	H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis	H_1: $\mu_1 - \mu_2 < 0$

T-Value	DF	P-Value
-1,93	208	0,028

Figure 2. One-tailed Student's two-sample T-test

3.3 Discussion

Problems with a problem statement rated as having a high level of detail were solved with a mean of 34.1 days and those with problem statements rated as having a low level of detail were solved with a mean if 48.0 days. In other words, finding the root cause of a highly problem with a highly detailed problem statement only took 70% of the time it takes when the problem statement is less detailed.

The cases analyzed were pulled from a database where not all of the problems rated as highly detailed had 100% of the 4W2H information. Mandating the use of 4W2H questions and providing a tool and method as well as training in the tool and method may increase the amount of information and further decrease the time required to identify the root cause of a problem.

A problem statement should include who is affected by the problem, details regarding the exact nature of the nonconformance or unwanted state, time when the problem started, how often the problem occurs, location where the problem happens, and what is happening when the problem occurs (Berstene 2018). This information can be captured with 4W2H in the form of an is/is-not matrix.

4. CONCLUSION

These results capture quantitatively what the authors have observed qualitatively for many years of dedicated problem solving. Beyond the clear benefit of attacking a problem with more information, with obvious benefits, the authors have seen many other benefits as well:

- **Internal prioritization** of problems based on a clear understanding of the problem scope. In a corporate setting a properly defined problem statement provides objective information about the appropriate urgency of the problem, separating this decision making from non-objective factors such as the customer's general timing expectations or general relationship status with the organization. In the observation of the authors, in many cases problems of great business impact were tremendously under-recognized based on initial, incomplete information about the failure scope. In many other cases, intensive customer pressure has been applied to problems with comparatively low failure rates. In those cases, elevated customer pressure has driven highly disproportionate internal prioritization that challenges finite internal resources.
- **Internal alignment** around the actual nature of the problem. Inherently corporate project teams invariably migrate to historic or common assumptions about the failure mode, a properly quantified problem statement provides clarity about the appropriateness of these assumptions. In the experience of the authors, separating the facts surrounding a problem from the expectations and biases of the problem-solving team based on their experience is critical to making progress. The detailed, quantified problem statement forces a distinct team agreement on the nature and scope of the actual problem.
- **External customer alignment** about the nature and scope of the problem. A properly quantified problem statement will drive an appropriate focus for the entire customer/supplier problem solving team. In the absence of such information, the same biases regarding historic root causes enter the discussion, but in this case with the authority and urgency of the external customer to supplier dynamic. Even worse, the authors frequently see cases where the customer understanding of the fundamental problem and the understanding of the problem-solving team are completely different. In these cases the problem-solving team must ultimately have a reconciliation with the customer that is often painful and commonly leads to degradation of the relationship and a suboptimal outcome in determining a better problem statement.
- **Tremendous narrowing of the root cause** scope based on the actual, detailed facts of the problem. In the authors' experience, the field of possible failure hypotheses could be greatly winnowed based on excluding hypotheses that could not be consistent with the observed facts, once known in detail. This qualitative observation surely explains much of the quantitative benefit. Indeed, in many circumstances, with proper delineation of the problem statement the root cause options are sufficiently excluded that minimal nor no further root cause analysis is required.

According to Chaudhry (1999), problem solving skills can be developed through training, experience, or the use of a standardized problem solving process within an organization (1999) and the authors highly recommend all three starting with training in the use of the organization's clearly defined problem solving process. Experience can be useful, but experience alone may result in employees who are highly proficient in using the wrong approach. The authors instituted a comprehensive problem-solving training program in their organization that provided a consistent process baseline and assured a structured approach. This had the additional benefit of providing a consistent, documented process for global customers at any "contact point" around the world.

The authors' included in that problem-solving training significant guidance on communication with their customers. With that emphasis the teams had much more effective customer alignment around the problem statement, with greatly reduced effort applied to reconciliation the misalignment discussed above.

The use of 4W2H questions in an is/is-not matrix also serves as a checklist to ensure all needed information is either available, or the information is actively being collected. Another advantage of having a defined problem-solving process with is/is-not is that it is possible to perform audits to ensure that the process is being followed.

A survey has found that 5W2H is used in industry; however, it is not used by many organizations (Starzyńska 2014). Embedding a modified version of 5W2H using 4W2H into an is/is-not matrix as part of an organization's problem solving can help to ensure the critical questions are asked before creating a problem statement and the authors propose organizations mandate the use of an is/is-not diagram with 4W2H questions for writing problem statements as part of their problem-solving processes. Figure 3 depicts an example of an is/is-not matrix than an organization can use for the creation of a problem statement.

	Is	Is-Not	Difference
Who experienced the problem? (Which customer or department)			
What part has a problem? (Part type and part number)			
When did the problem happen? (Date)			
When did the problem happen? (Operation, usage)			
Where did the problem happen? (Customer, department)			
Where did the problem happen? (Location on the part)			
How is the problem happening? (The symptom and not the cause)			
How many parts have a problem? (Quantity OK, not OK, and %)			

Figure 3. Example of an is/is-not © Barsalou 2022

In this version of an is/is-not matrix, the who question refers to who experienced the problem and the what is in regards to what part, assembly, or complete system experienced the problem. When pertains to when the problem happened including both the time in which the problem happened and when in the process or product's life cycle the problem happened. The where question is in regards to both where the problem happened such as in production or the customer's facility and where on the part the problem happened, such as on a flange.

There is no why question as nobody should be explain why the failure happened without actually investigating it. An alternative version of why is why the failure is a problem, but this would not fit with an is/is-not analysis.

How the problem is happening is a question that refers to the way in which the part fails, such as length too short or failed to complete test. The second how is for how many parts failed, which should be expressed as both a quantity and a percentage. For example, 12 parts failing out of 12 is not the same as 12 out of 12,000,000.

The answers to the 4W2H questions in the is/is not can then be used to write a problem statement as a correct problem statement is absolutely essential for starting an investigation into the source of a problem. As the is/is-not is filled out, the identified differences may help to localize the root case and thereby speed up the problem solving process even more.

An organization should adapt the is/is-not matrix and 4W2H questions to fit their specific needs. For example, a service organization should refer to processes in place of parts and should also require the exact location in the process where the problem happens in place of the location on the part.

Speed is of an essence when searching for the root cause of a problem because the problem's root cause must be understood before improvement actions can be identified and implemented (Mahto and Kumar 2008). Therefore, a good problem statement is essential when attempting to solve a problem. Without a good problem statement, valuable time may be lost looking down dead ends.

References:

Abellana, D. P. (2020). A proposed hybrid root cause analysis technique for quality management. *International Journal of Quality & Reliability Management*, *38*(3), 704–721. https://doi.org/10.1108/IJQRM-11-2019-0356

Alexa, V., & Kiss, I. (2016). Complaint analysis using 8d method within the companies in the field of automotive. *Analecta Technica Szegedinensia*, *10*(1), 16–21. https://doi.org/10.14232/analecta.2016.1.16-21

Ammerman, M. (1998). *The Root Cause Analysis Handbook: A Simplified Approach to Identifying, Correcting, and Reporting Workplace Errors*. Portland, OR: Productivity Press.

Anderson, B., & Fagerhaug, T. (2000). *Root Cause Analysis: Simplified Tools and Techniques.* Milwaukee, WI: Quality Press.

Automotive Industry Action Group. (2005). *CQI-10: Effective Problem Solving Guide*. Southfield, MI: Automotive Industry Action group.

Barosani, S., N. Bhalwankar, V. Deshmukh, S. Kokane, & P. R. Kulkarni. (2017). A Review on 8D Problem Solving Process. *International Research Journal of Engineering and Technology*, *4*(4), 529-535.

Barsalou, M. A. (2015). *Root Cause Analysis: A Step-by-Step Guide to Using the Right Tool at the Right Time*. Boca Raton, FL: CRC Press.

Barsalou, M. (2016). A Better Way. *Quality Progress*, *49*(11), 38-42.

Barsalou, M., & Perkin, R. (2015). Structured, Yet Flexible, Approach. *Six Sigma Forum Magazine*, *14*(4), 22-25

Bauer, J. E., G. L. Duffy, & Westcott, R.l T. (2006). *The Quality Improvement Handbook*. (2nd ed.). Milwaukee, WI: ASQ Quality Press.

Berstene, T.G. (2018). *The Root Cause Analysis Memory Jogger: A Process Based Approach to Root Cause Analysis.* Methuen, MA: GOAL/QOC.

Biban, L. K., & Dhounchak, D. (2017). 8D Methodology and Its Application. *Journal of Emerging Technologies and Innovative Research*, *4*(10), 533-540.

Biban, L. K., Dhounchak, D., & Shakti. (2017). 8D Methodology: From Concept to Application Across Manufacturing Industries. *International Journal of Scientific Research in Science, Engineering and Technology*, *3*(6), 558-563.

Breyfogle III, F. W. (2003). *Implementing Six Sigma: Smarter Solutions Using Statistical Methods*. (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Carnerud, D., Jaca, C., & Bäckström, I. (2018). Kaizen and continuous improvement – trends and patterns over 30 years. *The TQM Journal*, *30*(4), 371–390. https://doi.org/10.1108/TQM-03-2018-0037

Chakravorty, S. S. (2009). Process improvement: Using toyota's a3 reports. *Quality Management Journal*, *16*(4), 7–26. https://doi.org/10.1080/10686967.2009.11918247

Chaudhry, A. M. (1999). To Be A Problem Solver, Be A Classicist. *Quality Progress*, *32*(6), 47-51.

Chen, H.-R., & Cheng, B.-W. (2010). A case study in solving customer complaints based on the 8Ds method and Kano model. *Journal of the Chinese Institute of Industrial Engineers*, *27*(5), 339–350. https://doi.org/10.1080/10170669.2010.495508

De Mast, J. (2013). Diagnostic quality problem solving: A conceptual framework and six strategies. *Quality Management Journal*, *20*(4), 21–36. https://doi.org/10.1080/10686967.2013.11918362

Desai, D., & Prajapati, B. N. (2017). Competitive advantage through Six Sigma at plastic injection molded parts manufacturing unit: A case study. *International Journal of Lean Six Sigma*, *8*(4), 411–435. https://doi.org/10.1108/IJLSS-06-2016-0022

Donauer, M., Peças, P., & Azevedo, A. (2015). Identifying nonconformity root causes using applied knowledge discovery. *Robotics and Computer-Integrated Manufacturing*, *36*, 84–92. https://doi.org/10.1016/j.rcim.2014.12.012

Finlow-Bates, T., Visser, B., & Finlow-Bates, C. (2000). An integrated approach to problem solving: Linking K-T, TQM and RCA to TPM. *The TQM Magazine*, *12*(4), 284–289. https://doi.org/10.1108/09544780010325912

Gano, D. L. (1999). *Apollo Root Cause Analysis: Effective Solutions to Everyday Problems Every Time.* Yakima, WA: Apollonian Publications.

Soares Ito, A., Ylipää, T., Gullander, P., Bokrantz, J., & Skoogh, A. (2022). Prioritisation of root cause analysis in production disturbance management. *International Journal of Quality & Reliability Management*, *39*(5), 1133–1150. https://doi.org/10.1108/IJQRM-12-2020-0402

Jing, G. G. (2008). Digging for the Root Cause. *Six Sigma Forum Magazine*, *7*(3), 19-24

Kaplík, P., Prístavka, M., Bujna, M., & Viderňan, J. (2013). Use of 8d method to solve problems. *Advanced Materials Research*, *801*, 95–101. https://doi.org/10.4028/www.scientific.net/AMR.801.95

Kepner, C. H., & Tregoe, B. B. (1973). *Executive Problem Analysis and Decision Making*. Princeton, NJ: Kepner-Tregoe, Inc.

Kepner, C. H., & Tregoe, B. B. (2006). *The New Rational Manager: An Updated Edition for a New World*. Princeton, NJ: Kepner-Tregoe, Inc.

Kumar, T. S. M. & Adaveesh, B. (2017). Application of "8d methodology" for the root cause analysis and reduction of valve spring rejection in a valve spring manufacturing company: A case study. *Indian Journal of Science and Technology*, *10*(11), 1–11. https://doi.org/10.17485/ijst/2017/v10i11/106137

Latino, R. J., Latino, K. C., & Latino, M. A. (2002). *Root Cause Analysis: Improving Performance for Bottom-Line Results*. (2nd ed.). Boca Raton, FL: CRC Press.

Levinson, W. A. (2006). One Good Idea: Bringing the Fishbone Diagram into the Computer Age. *Quality Progress*, *39*(12), 88.

Lorenzi, C. I., & Ferreira, J. C. E. (2018). Failure mapping using FMEA and A3 in engineering to order product development: A case study in the industrial automation sector. *International Journal of Quality & Reliability Management*, *35*(7), 1399–1422. https://doi.org/10.1108/IJQRM-10-2016-0179

MacDuffie, J. P. (1997). The road to "root cause": Shop-floor problem-solving at three auto assembly plants. *Management Science*, *43*(4), 479–502. https://doi.org/10.1287/mnsc.43.4.479

Mahto, D., & Kumar, A. (2008). Application of Root Cause Analysis in Improvement of Product Quality and Productivity. *Journal of Industrial Engineering and Management*, *1*(2), 16-53.

Marques, P. A. de A., & Matthé, R. (2017). Six Sigma DMAIC project to improve the performance of an aluminum die casting operation in Portugal. *International Journal of Quality & Reliability Management*, *34*(2), 307–330. https://doi.org/10.1108/IJQRM-05-2015-0086

Mohaghegh, M., & Furlan, A. (2020). Systematic problem-solving and its antecedents: A synthesis of the literature. *Management Research Review*, *43*(9), 1033–1062. https://doi.org/10.1108/MRR-06-2019-0284

Montgomery, D.C., Runger, G. C., & Hubele, N. F. (2001). *Engineering Statistics*. (2nd ed.). New York: John Wiley and Sons.

Najmuddin, W. A., Saidin, W., Ibrahim, A. M., Azir, M. Z., Ngah, H., Noor, N. M., & Norhidayah, M.H. (2014). 8D Methodology: An Effective Approach for Problem Solving in Automotive Assembly Line. *Australian Journal of Basic and Applied Sciences*, *8*(22), 31-34.

Nickerson, J., & Argyres, N. (2018). Strategizing before strategic decision making. *Strategy Science*, *3*(4), 592–605. https://doi.org/10.1287/stsc.2018.0066

Okes, D. (2009). *Root Cause Analysis: The Core of Problem Solving and Corrective Action*. Milwaukee, WI: Quality Press.

Palady, P., & Snabb, T. (2000). *TAPS: A Total Approach to Problem Solving*. USA: PAL Publishing.

Raub, G. R., III. (2002). Back To Basics: A Good Problem Description Is Key You Can Cause More Difficulties If You Don't Get Off To The Right Start. *Quality Progress*, *35*(9), 129.

Reid, I., & Smyth-Renshaw, J. (2012). Exploring the fundamentals of root cause analysis: Are we asking the right questions in defining the problem? : root cause analysis-‘5w + 1h.’ *Quality and Reliability Engineering International*, *28*(5), 535–545. https://doi.org/10.1002/qre.1435

Riesenberger, C. A., & Sousa, S. D. (2010). The 8D Methodology: An Effective Way to Reduce Recurrence of Customer Complaints? *Proceedings of the World Congress on Engineering Vol III*. WCE 2010, June 30 - July 2, 2010, London, U.K.

Rucker, D. M. (2016). Best of Back to Basics: Get to the Root of It. *Quality Progress*, *49*(1), 50.

Schnoll, L. (2011). Standards Outlook: Righting the Wrongs. *Quality Progress*, *44*(2), 64-66.

Shubham, V. (2016). Managing Project Using 8D Technique. *International Journal of Management*, *7*(6), 67-76.

Sharma, P., Malik, S. C., Gupta, A., & Jha, P. C. (2018). A DMAIC Six Sigma approach to quality improvement in the anodising stage of the amplifier production process. *International Journal of Quality & Reliability Management*, *35*(9), 1868–1880. https://doi.org/10.1108/IJQRM-08-2017-0155

Siebels, D. (2004). *The Quality Improvement Glossary*. Milwaukee, WI: Quality Press.

Smith, G. F. (1994). Quality Problem Solving: Scope and Prospects. *Quality Management Journal*, *2*(1), 25-40.

Stamatis, D. H. (2002). *Six Sigma and Beyond: Problem Solving and Basic Mathematics*. Boca Raton, FL: St. Lucie Press.

Starzyńska, B. (2014). Practical Applications of Quality Tools in Polish Manufacturing Companies. *Organizacija*, *47*(3), 153-64.

Suárez-Barraza, M. F., & Rodríguez-González, F. G. (2019). Cornerstone root causes through the analysis of the Ishikawa diagram, is it possible to find them?: A first research approach. *International Journal of Quality and Service Sciences*, *11*(2), 302–316. https://doi.org/10.1108/IJQSS-12-2017-0113

Tague, N. R. (2005). *The Quality Toolbox*. (2nd ed.). Milwaukee, WI: The ASQ Quality Press.

Tortorella, G. L., Viana, S., & Fettermann, D. (2015). Learning cycles and focus groups: A complementary approach to the A3 thinking methodology. *The Learning Organization*, *22*(4), 229–240. https://doi.org/10.1108/TLO-02-2015-0008

Verband der Automobilindustrie e. V. (VDA). (2018). *Quality Management in the Automotive Industry: 8D – Problem Solving in 8 Disciplines: Method, Process, Report*. Berlin, Germany: Verband der Automobilindustrie e. V. (VDA) / Qualität Management Center (QMC).

Villarreal, Margie and Brian H. Kleiner. (1997). Analytical Tools for Facilitating Task Group Performance. *Journal of Workplace Learning*, *9*(3), 94-97.

Wagner, C. (1993). Problem Solving and Diagnosis. *Omega*, *21*(5), 645-656.

Westcott, Russell T. (2007). Back to Basics: Have You Adequately Defined Your Situation? *Quality Progress*, *40*(8), -.

Zarghami, A., & Benbow, D. (2017). *An Introduction to 8D Problem Solving: Including Practical Applications and Examples*. ASQ Quality Press, Milwaukee, WI.

Matthew Barsalou
Poznan University of Technology
Poznan,
Poland
matthew.a.barsalou@gmail.com
ORCID: 0000-0003-3117-0216

Robert Perkin
Quality Director in the Automotive Industry
Asheville,
USA
rRperkin4@yahoo.com
ORCID: 0000-0002-1327-0291