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IMPLEMENTATION OF A SYSTEM QUALITY TOOL TO REDUCE THE COSTS OF SCRAP LOSS IN INDUSTRIAL ENTERPRISE

Abstract: This study focuses on reducing the costs of scrap loss in industrial enterprise through the quick response control methodology, used in quality management in the automotive industry. Its use can identify various influences causing problems is production, quality, logistics or management. The costs reducing in this study used tools and methods as QRQC, Global 8D, 5 Why, Is/Is Not as well as seven old statistical (japanese) tools, especially Pareto analysis. Using the QRQC methods there were found causes connected with scrap costs and were setted the corrective action to reduce the scrap costs.

Keywords: quality, scrap, costs reducing, problem solving, methods and tools

1. Introduction

The manufacturing organization is situated in Western Slovakia and it is the one of the most important seat manufacturers and their mechanisms, emission control Technologies and interior and exterior car components.

Faurecia Interior Systems, s.r.o. Hlohovec belongs to one of 10 companies with the highest scrap im comparison with other sister companies in the world. In this study we have been working on the NSF assembly division where they are dealing with dashboards assembly.The NSF assebly has an average scrap rate of € 390 per day. That´s why the company decidedto put in place a system of reductionthe scrap by the „Stop Scrap“ system, which was created in Košice in 2014.

Based on the results of Pareto analysis it was discovered that errors in the manufacturing process are caused in the painting process.There is 69% of paint defects on the left – handed dashboard with varnished brackets (pads). Therefore, it is required to assure the quality of the manufacturing process within each production phase.

The monitoring and evaluation of manufacturing process capability presents one of the methods for ensuring and improving processes in the manufacturing organization. It includes the monitoring of stability and normality based on values

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obtained from the manufacturing process and the calculation of manufacturing process capability indices C_p and C_{pk} (ANDRÁSSYOVÁ Z. et al., 2011).

By determining the process capability, we can isolate the estimated process capability (before starting the production) and permanent process capability. The C_p index shows the process variability, and the C_{pk} index shows the position of the process in a tolerance zone (FERANCOVÁ M. 2013).

In mass production the early detection of defects and taking an appropriate corrective action is nessesary. Before taking any corrective action, the defects need to be diagnosed correctly. The proper classification and identification of a particular defect is fundamental for determination of the cause and appropriate corrective action in order to prevent defect recurrence (SÜTŐOVÁ A. 2013).

2. Methodology

To eliminate the scrap we focused on the assembly line where the painted parts are assembled into the dashboard. Our job is not to find out why the painted errors at the internal supplier paintshop occured, but to find out why the operators don´t identify the paint error before the assembly and welding of the painted part with its other parts. It is applied in the enterprise to all departments and activities, i. e. safety and health protection at work, logistics, quality, purchasing, information Technologies, personnel department, scrap reduction and assembly.

Data collecting

Seven basic tools

Seven basic tools have been universally applied to the control of quality. Because the use of these tools has been prevalent through all (first, second, and third) generations of the quality movement they have been tagged the „seven old tools and include Check sheet, pareto chart, Cause – and – effect diagram, Histogram, Stratification, Scatter diagram, Graph or chart, with specific emphasis on the control chart.

Check sheet

Before a problem can be analyzed it needs to be understood. A check sheet, normally in handwritten form on paper, i sused to record raw data in a format that can be easily understood by everyone.

Pareto Chart

The pareto principle posits that only a few causes (the vital 20%) are responsible for the majority (80%) of problems. Improvement benefits can be leveraged by focusing attention on the key issues (that is, the 20%), and while looking at critical factors i tis not uncommon to discover and resolve many of the other lesser important problems by default. When check sheet data are plotted on a Pareto chart, the most important problems are revealed. It is customary to plot a pair of graphs – a bar graph that displays item percentages sorted in descending order, and a line graph that plots the cumulative percentage of items on the sorted list. These two graphs are then plotted on the same chart.

Thesignificant (vital) problems can be separated from the trivial ones byextending a horizontal line from the 80% point on the y-axix over to theline graph, and then dropping a vertical line perpendicular to the x-axis.In this case i tis clear that improvement efforts should target problems.All types of problems do not necessarily have an equal impact on quality (AIKENS C.H. 2011).

Cause – and – Effect Diagram

The cause – and – effect (CE) diagram is also called a fishbone diagram (due to its similarity to the skeletal structure of a fish), and an Ishikawa diagram (in honor of its founder). (ISHIKAWA K. 1982). Once a team decides which problem it wants to solve, possibly from a Pareto analysis, the CE diagram can help it identify candidate causes.

The CE structure is illustrated in Figure 1.

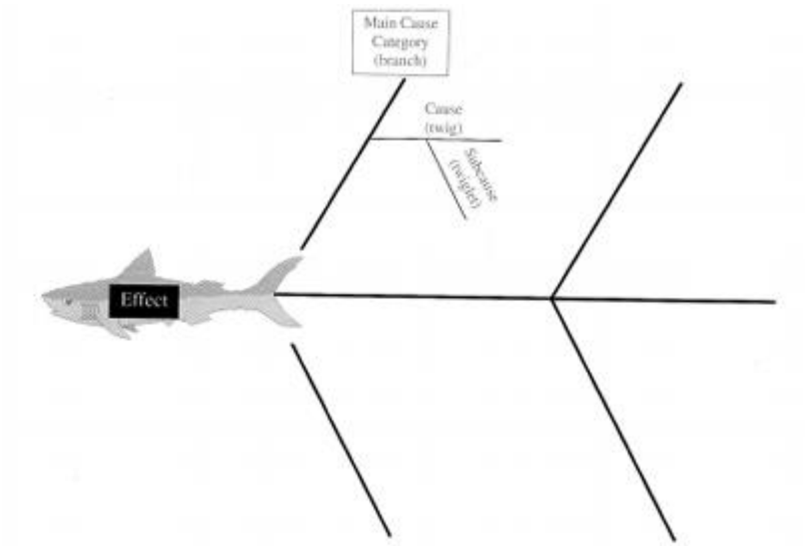


Fig. 1. Ishikawa diagram.

Source: AIKENS C.H. 2011

To construct a CE diagram, the problem, or effect, is placed in a box (analogous to the head of the fish). A horizontal line (the backbone) is drawn from the box, and from the backbone angled fishbones are inserted corresponding to each main problem category. This forms the skeleton of the fishbone diagram (KOTUS M., JANKAJOVÁ E., PETRÍK M. 2015).

Main categories can be anathing relevant to the problem, but the typical ones include materials, methods, personnel, and machines. From each main stem smaller bones (or twigs) are constructed for each candidate cause, and from these, smaller bones (or twiglets) representing subcauses are drawn. The diagram can include as many sublevels as required to get to the root causes.

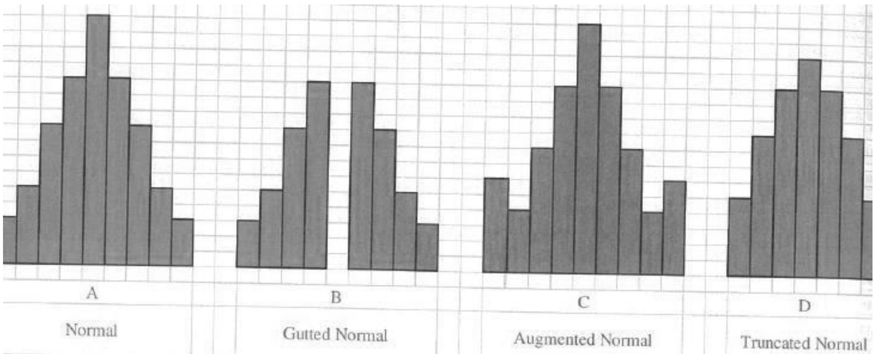
The CE diagram adds structure to brainstormed ideas. It is important that the team understands that all „causes“ shown on the diagram are merely candidates and have not been proven to be true causes of the stated effect. Consequently, i tis essential that all causes suggested by team members should be listed, no mater how bizarre, zany, or unlikely.

When the team is satisfied that most of the likely causes have been captured, the next step is to narrow the list to just a few for detailed study.

Histogram

A histogram provides a graphical picture of process output. Collecting raw measurements is meaningless unless the data can be organized in a way that aids discovery and analysis. To construct the histogram each of the data are assigned to 1 of 11 class intervals. Through pattern recognition, histograms can provide valuable clues leading to improvement opportunities. Figure 2 illustrates eight different histogram shapes (AIKENS C.H. 2011).

Pattern A represents a symmetrical „bell-shaped“ curve that is usually referred to as a normal distribution. This is the shape of the output from many industrial processes, if they are stable and the only sources of variation present are the random fluctuations that are inherent in the system. In a normal distribution, the mean and median are equal – 50% of the output lies to the left of the average (or mean) and 50% to the right.



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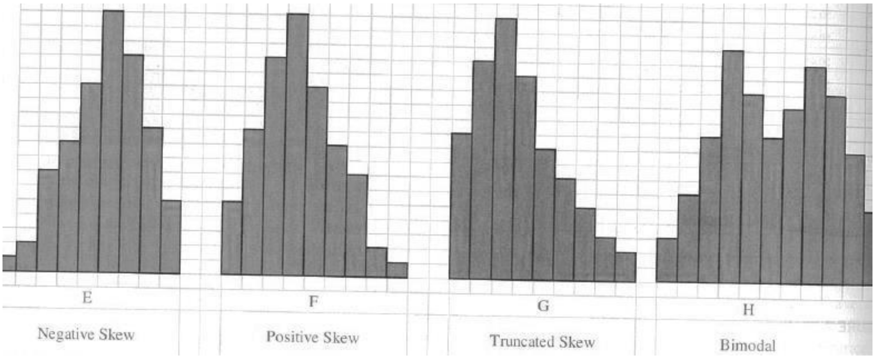

Fig. 2 Histogram shapes.

Source: AIKENS C.H. 2011

In pattern B, the distribution looks as i fit may have originated as a normal distribution, but the middle of the distribution (the highest-quality product) has been carved out. This gutted norma lis typical of cases where a supplier can sell product that is of the highest quality – produced near the target with small variation – at a higher price than product of a lower grade. Even though all output may fall within the allowed specification range and the average is on target and the variance can be substantially greater than if the original distribution were intact.

The augmented normal, shown as pattern C, could result from an inspector reclassifying output that is just below or above the specification limits. Hence, there is a „lumping“ effect at the first and last class intervals where the specification cutoffs occur.

Pattern D is a truncated normal. A pattern such as this could occur if a process is centered on target, its spread is wider than the tolerance limits, and the unacceptable output has not been reported in the data. A distribution can also truncate if a natural barrier, such as zero (when no negative values are possible), is encountered.

Pattern E and F represent distributions that have a skew – that is, they lack the symmetry of the normal distribution. In a negatively skewed distribution more than 50% of the distribution and the median are to the left of the mean.

Pattern G could have two possible interpretations. One scenario is that defective product was sorted from the good, because the process was incorrectly targeted. Alternatively, if negative numbers are not posiible (e.g., weights), truncation at a measurement equal to zero can produce this pattern.

Pattern H could be the resulting picture when several normal processes are overlaid , called bimodal; for example, if samples represent the output from several machines, each having a different process average (AIKENS C.H. 2011).

Stratification

Stratification is the process of sorting data into meaningful classifications so that clues as to the who, what, where, when, why, and how relative to an issue at hand can easily be found. For example, a random selection of product at a packing operation might reveal that a certain percentage is outside the specification range, and more disturbing, the data suggest that the proces is not capable of meeting specs. Stratifying the data by machine, operator, or shift could lead directly to the source of the unacceptable variability and its subsequent reduction (PETRÍK J., GENGEĽ P. 2009).

Scatter Diagram

Like histograms, scatter diagram aid in pattern recognition. A scatter diagram, also called a scatterplot, can be used to gain insights into the relationship between two factors (or variables). If a relationship is found, it cannot necessarily be inferred that one variable is the cause of the other; however, the scatter diagram can provide graphical evidence that the relationship is real and will provide some knowledge regarding the strength of the relationship.

A scatter diagram is constructed by plotting the values of one variable on the horizontal (x) axix, and the corresponding value of the other variable on the vertical (y) axis. A relationship (association) between the two variables is evident if the resulting plot produces some nonrandom pattern of points. The strength of the relationship is determined by the variability of the cluster of points relative to a mathematical expression describing the association. A relationship can be linear or nonlinear.

Graphs and charts

Run Chart - is the simplest time-ordered chart. Individual measurements are plotted in the order in which they occur, and although unnecessary, it is a good idea to connect the points for ease in interpretation. One way to check for a change in average is to count the number of „runs“.

A run is defined as a buildup of consecutive points on the same side of the average (or centerline). A run length of seven or more points provides statistical evidence that the average has changed. An alternative to the number of runs is a test for trends. Six consecutive points either increasing or decreasing with no reversal in direction provides evidence that the average is trending (AIKENS C.H. 2011).

The run chart can be seen in Figure 3.

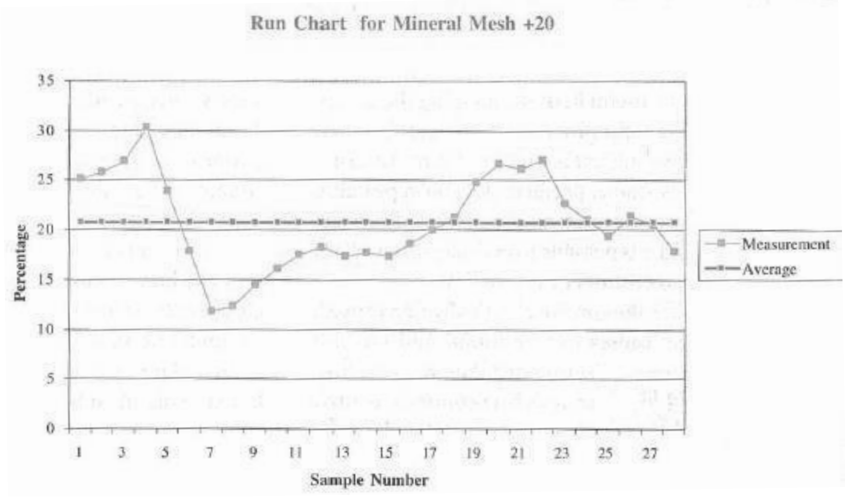

Fig. 3. Run chart.

Source: AIKENS C.H. 2011

Control chart – is a run chart with control limits. These limits represent the maximum and minimum allowable values for any individual plotted point. Any point that exceeds these limits provides statistical evidence that the process average has changed and that the chart´s centerline is no longer a reliable approximation. The maximum value is called the upper control limit and the minimum value the lower control limit. The range of permissible values that lie between the two limits represents expected variability that is due to random causes (JANKAJOVÁ E. 2015).

Random variability is present in all samples and is aptly called common cause variability. If certain sources of variability are present in some samples, but not others, one would expect the variability to exceed the bounds imposed by the control limits – such sporadic fluctuations are called special cause variability. The purpose of a control chart is to expose the presence of special cause variation. This can be done by detecting nonrandom patterns or observing any plotted points outside the control limits. There is a fundamental difference between a run chart and a control chart. The points plotted on run charts typically represent individual measurements (e.g. machine downtime, percentage yields, or scrap). Control charts can also be constructed to analyze individual measurements; however, the points normally represent a statistic (e.g., the mean, range, or standard deviation) that is computed from a sample of several measurements taken at random from the process (KOTUS M. 2015).

A control chart can be useful in understanding the underlying behavior of a process. If the process is in control (i.e., there is no statistical evidence to suggest any nonrandom patterns), we say that the process is stable, predictable, and repeatable.

This means that the process output can be predicted forward and backward in time, and i tis possible to evaluate how well the process is doing relative to customer expectations. If a process is unstable, the control chart will often provide hints as to where special causes can be found and possibly eliminated (AIKENS C.H. 2011).

Seven new tools for problem solving

In the early 1970s it had become clear to the Japanese that the effective implementation of TQM required that managers know more than simply how to apply basic statistical tools. Although the tools of numerical analysis are essential, the Japanese recognized that much of the information processed by middle to senior management is nonnumeric and often takes the form of verbal data and communication. Consequently in 1972 a committee chaired by Yoshinobu Nayatani was established to develop some new quality control tools for management. The commitee´s research took more than five years and resulted in a set of techniques called the „seven new tools“. In 1978 the Japanese Union of Scientists and Engineers invited Professor Shigeru Mizuno, Professor Emeritus of the Tokyo Institute of Technology, and Professor Yoshio Kondo, head of the faculty of engineering at Kyoto University, to guide the education and advocacy of the new set of tools. The Japanese committee did not invent the seven new tools, most of which were developed in America and elsewhere. However, by the late 1970s most of these tools had not been applied to quality management programs. The set of new tools includes: Affinity diagram, Relations diagram or interrelationship digraph, Systematic diagram or dendrogram (tree diagram), Matrix diagram, Matrix data analysis, process decision program chart (PDPC), Arrow diagram/activity network diagram/project evaluation and review technique (PERT)/critical path method (CPM).

Affinity diagram

Also called: affinity chart, K–J method Variation: thematic analysis. The affinity diagram organizes a large number of ideas into their natural relationships. This method taps a team's creativity and intuition. It was created in the 1960s by Japanese anthropologist Jiro Kawakita.

When to Use an Affinity Diagram:

- When you are confronted with many facts or ideas in apparent chaos
- When issues seem too large and complex to grasp
- When group consensus is necessary

Typical situations are:

- After a brainstorming exercise
- When analyzing verbal data, such as survey results.

Affinity Diagram Procedure

Materials needed: sticky notes or cards, marking pens, large work surface (wall, table, or floor).

1. Record each idea with a marking pen on a separate sticky note or card. (During a brainstorming session, write directly onto sticky notes or cards if you suspect you will be following the brainstorm with an affinity diagram.) Randomly spread notes on a large work surface so all notes are visible to everyone. The entire team gathers around the notes and participates in the next steps.
2. It is very important that no one talk during this step. Look for ideas that seem to be related in some way. Place them side by side. Repeat until all notes are grouped. It's okay to have "loners" that don't seem to fit a group. It's all right to move a note someone else has already moved. If a note seems to belong in two groups, make a second note.
3. You can talk now. Participants can discuss the shape of the chart, any surprising patterns, and especially reasons for moving controversial notes. A few more changes may be made. When ideas are grouped, select a heading for each group. Look for a note in each grouping that captures the meaning of the group. Place it at the top of the group. If there is no such note, write one. Often it is useful to write or highlight this note in a different color.
4. Combine groups into "supergroups" if appropriate. (asq.org).

Relations diagram

Relations Diagrams are drawn to show all the different relationships between factors, areas, or processes. Why are they worthwhile? Because they make it easy to pick out the factors in a situation which are the ones which are driving many of the other symptoms or factors

Instead of one item following another in a logical sequence, each item is connected to many other pieces, showing that they have an impact on each one. Once all the relevant connections between items have been drawn, the connections are counted. Those with the most connections will usually be the most important factors to focus on.

While the relations diagram is one of the 7 New QC Tools described in the Japanese classic "Management for Quality Improvement", it is less frequently used than some of its stablemates. However, in a fairly tangled situation, it is a powerful means of forcing a group to map out the interactions between factors, and usually helps bring the most important issues into focus.

To create a Relations Diagram:

1. Agree on the issue or question.
2. Add a symbol to the diagram for every element involved in the issue.

3. Compare each element to all others. Use an "influence" arrow to connect related elements.
4. The arrows should be drawn from the element that influences to the one influenced.
5. If two elements influence each other, the arrow should be drawn to reflect the stronger influence.
6. Count the arrows.
7. The elements with the most outgoing arrows will be root causes or drivers.
8. The ones with the most incoming arrows will be key outcomes or results. (www.skymark.com).

Tree diagram

Tree diagram is the graphic display of the dependencies or relationship between elements in the network. It is used for the project structure plan in the project management. The different charts are available according to the structure type: for the resources, costs, company or project organization. The tree diagram of the organizational structure displays the subordination level with the connecting lines. Its arrangement shows the authority level. Each element displays the completed work, responsibilities and the work division of the organization. (www.inloox.com).

Matrix diagram

The matrix diagram shows the relationship between two, three or four groups of information. It also can give information about the relationship, such as its strength, the roles played by various individuals or measurements.

Six differently shaped matrices are possible: L, T, Y, X, C and roof–shaped, depending on how many groups must be compared.

When to Use Each Matrix Diagram Shape

We can summarize when to use each type of matrix.

– An L–shaped matrix relates two groups of items to each other (or one group to itself).
– A T–shaped matrix relates three groups of items: groups B and C are each related to A. Groups B and C are not related to each other.
– A Y–shaped matrix relates three groups of items. Each group is related to the other two in a circular fashion.
– A C–shaped matrix relates three groups of items all together simultaneously, in 3-D.
– An X–shaped matrix relates four groups of items. Each group is related to two others in a circular fashion.

– A roof–shaped matrix relates one group of items to itself. It is usually used along with an L – or T–shaped matrix. (www.syque.com).

Matrix data analysis

The most sophisticated of the new tools, as proposed by Mizuno (MIZUNO S. 1988), is called matri data analysis, and is an application of principal components analysis. The idea is to take a matrix of relationships between factors and to convert it into a set of preference vectors (called eigenvectors) that consist of sums of fractions of those factors that significantly contribute to process variance. The vectors of composite preferencews can then be used to determine which characteristics are important. Matrix data analysis can be useful in determining the product or service features that result in the most customer satisfaction, and those that can be eliminated with little or no customer satisfaction (AIKENS, C. HAROLD. 2011).

Process Decision Program Chart (PDPC)

A Process Decision Program Chart (PDPC) is a tool for identifying and documenting the steps required to complete a process. It is also useful for anticipating any issues and problems that might surface in the implementation of the process, therefore affording the opportunity to devise countermeasures. (www.sixsigmadaily.com).

Arrow diagram

Arrow diagram is a tool graphically describes the relationship between planned activities, which make up the execution of a particular project. It graphically (visually) represents a deliberate plan of work, paying attention to the critical operations and inventory time. This technique is related to critical path analysis.

Procedure:

1. Define the proposed project (e.g. to determine the beginning and end of project)
2. Define a list of actions necessary to proceed with the project
3. Estimate duration (execution) of the individual steps (should be the same unit of time)
4. Define the order of occurrence of these steps (some steps may be performed simultaneously)
5. Draw a diagram (network operations) (depending on the type of network should be drawn to mark the vertices and arrows, part of the graph operations and the execution time of each of them, sometimes supplemented with a diagram for additional information, such as the earliest and latest dates for commencement of operations, the unit responsible for their execution, etc.)
6. The diagram analysis

- Define inventory time for each activity
- The designation of the critical path (longest path in the network, which determines the shortest possible time of completion of the project, in which there are critical steps, i.e. those that have no slack time)
- Calculate the time needed to complete the entire project
- Analyse the measures that should be used to implement the project within (www. ceopedia.org).

Is – Is not

"IS – IS NOT" is a problem solving tool that explain the rational process for finding the possible root cause of the problem. This technique also helps user to avoid jumping to a false cause. At the end of the IS – IS NOT exercise user gets a confirmed true cause which helps to establish a plan to fix the problem and prevent it to recur. (asqtoronto.org).

5 Why

Asking "Why?" may be a favorite technique of your three year old child in driving you crazy, but it could teach you a valuable Six Sigma quality lesson. The 5 Whys is a technique used in the Analyze phase of the Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology. It is a great Six Sigma tool that does not involve data segmentation, hypothesis testing, regression or other advanced statistical tools, and in many cases can be completed without a data collection plan.

By repeatedly asking the question "Why" (five is a good rule of thumb), you can peel away the layers of symptoms which can lead to the root cause of a problem. Very often the ostensible reason for a problem will lead you to another question. Although this technique is called "5 Whys," you may find that you will need to ask the question fewer or more times than five before you find the issue related to a problem. (www.isixsigma.com).

QRQC

QRQC – or Quick Response Quality Control – is not only a quality control tool and method for troubleshooting but also an innovative concept in the field of global quality management. QRQC integrates a simple and logical solution to a given production or business operation problem within 24 hours' time and has applications in many different segments along supply chains, including project management, manufacturing, logistics and others. QRQC focuses on quality control to ensure that any problem is identified and isolated and that a solution is found and implemented quickly and effectively.

QRQC is based on a Japanese concept known as San Gen Shugi, meaning "3 reals". San Gen Shugi is a scientific method and concept of problem solving and analysis with far-reaching applications. The 3 reals are defined as follows:

1. Real Situation – understanding what is really happening.
2. Real Place – going to the real location of production.
3. Real Problem – investigating the real problem or issue (www.globalsources.com).

Step 1: Problem Detection

Can the problem be detected and recorded as well? A "red box" is a an effective method for isolating defective units found on the production line. A red box is a receptacle used for depositing problematic or defective units or components identified by workers on the production line. Red boxes should be easily accessible to workers, and each product or semi-product in the red box must be logged in a QRQC list to serve as a record of production issues.

Step 2: Problem Communication

When we're discussing Quick Response Quality Control, there is emphasis placed on "quick". That's why any problems with production should be communicated quickly to the relevant person or team. If a particular process is being worked in the wrong manner resulting in defects, the issue cannot be corrected until the relevant person is made aware of the problem and advised on how to respond.

Step 3: Problem Analysis

How do we analyze and develop an approach to the problem so that we can begin to resolve it? Plan-Do-Check-Act (PDCA) is an iterative, four-step problem-solving process typically used in process improvement. It is also known as the Deming cycle, Shewhart cycle, Deming wheel, or Plan-Do-Study-Act.

Step 4: Problem Verification

Has the problem been fully resolved to meet expectations? Take the time to monitor the production run. Normally, a QRQC check list will be created for use at the production line to follow-up on all steps of the process in order to arrive at a clear determination and clearly and accurately record results. (www.globalsources.com).

Global 8D

The eight disciplines (8D) model is a problem solving approach typically employed by quality engineers or other professionals and commonly used by the automotive industry. Its purpose is to identify, correct, and eliminate recurring problems, and it is useful in product and process improvement.

The approach establishes a permanent corrective action based on statistical analysis of the problem and focuses on the origin of the problem by determining its root causes. Although it originally comprised eight stages, or disciplines, it was later augmented by an initial planning stage. (asq.org).

The disciplines are:

- D0: Plan—Plan for solving the problem and determine the prerequisites.
- D1: Use a team—Establish a team of people with product/process knowledge.

- D2: Define and describe the problem—Specify the problem by identifying in quantifiable terms the who, what, where, when, why, how, and how many (5W2H) for the problem.
- D3: Develop interim containment plan; implement and verify interim actions—Define and implement containment actions to isolate the problem from any customer.
- D4: Determine, identify, and verify root causes and escape points—Identify all applicable causes that could explain why the problem occurred. Also identify why the problem was not noticed at the time it occurred. All causes shall be verified or proved, not determined by fuzzy brainstorming. One can use 5 Whys and cause and effect diagrams to map causes against the effect or problem identified.
- D5: Choose and verify permanent corrections (PCs) for problem/nonconformity—Through preproduction programs, quantitatively confirm that the selected correction will resolve the problem for the customer.
- D6: Implement and validate corrective actions—Define and implement the best corrective actions.
- D7: Take preventive measures—Modify the management systems, operation systems, practices, and procedures to prevent recurrence of this and all similar problems.
- D8: Congratulate your team—Recognize the collective efforts of the team. The team needs to be formally thanked by the organization. (asq.org).

3. Results and discussion

At the beginning, we completed the QRQC form. This form contains individual steps of 8D report. The first question was „what is the problem“? And the answer was: „Insufficient conditions for checking the painted part called Welded IP LHD High vib2“. The problem occured on vib2 position (welding machine 2). The next step were an immediate actions to protect the customers in 24 hours. These action include the gap leader´s standardized work auditing and operators at assembly. Responsible for this realization are supervisors. Time of realization of this action is until October 23rd, 2015 and it is necessary to answer if this action was effective – marked as Y (yes) or not – marked as N (No). The new risk has been discovered, so we will mark Y.

The first deficiency was that the operator takes the part by his two hands and hang them on the hook. This hook wasn´t secured by tape and the part was scratched. The revision is focused on operators work, so it sonsists of points like control of standardized work respect, respect of work orders, respect of the working instructions and the ability to reach the cycle standard time. There was issued the extraordinary instruction for the console checking before its assembling. It consists in 100% control of painted consols before they are inserted into the welding machine Vib2. In the case that the painted error is occured, it should be marked by red fix and call the gap leader. The end of the process was on October 23rd, 2015. The control of pads before welding was effective and no new risks were discovered.

The D1 step consists of identifying the problem. Based on the operator´s reactions, who pointed on insufficient control conditions.

At this place, it is an area for 5W and 2H:

- Why did the problem arise? The problem arose during the console was welded and by final control founded by operator,
- When did the problem arise? It was arose in 42nd week,
- Who found the problem? The UAP manager found it,
- Where was the problem found? The problem was discovered on the Stop Scrap table during a meeting with the director,
- How was the problem found? It was found by Pareto analysis,
- How much Money will be the problem cost? The problem costs € 280 per day.

The D2 step consists of risks analysis, which were discovered on right – handed dashboard (IP RHD High), but by 50% less.

The D3 step consists of immediate actions to protect the enterprise Faurecia. The immediate action is to train the operators to detect the paint errors before the pad is assembled to the dashboard.

For identifying the corrective actions the enterprise prefer using the analysis Is/Is Not (Table 1).

Table 1. Is/Is Not analysis

Is (problem)	**Is Not (problem)**	**Action**
Lighting by one duct	Lighting according to VDA 6.3	Lighting
Control time 11 s	Control time 30 s	Time control

Source: HUBÁČIKOVÁ L. 2016

The lighting by Vib2 is very weak, only 688 Lux in comparison with the final control (2000 Lux). The final control is situated 12 meter from Vib2. The next problem is, that operators have 11 seconds to control the painted part. The audit of standardized work founded that the operators don´t comply a defined cycle time 90 seconds. There was found that the time reamining for one operator is 30 seconds and this time can be used for more thorough control of painted parts. These information will be used for D4 step – Root causes determining.

These root causes consist in light correction according to VDA 6.3 between polish and welding machine Vib2. Responsible for realization has the method engineer a the completion date is until November 3rd, 2015. The second action is the time increasing of pads control from 11 seconds to 30 seconds. Responsible for this acts are supervisors and the completion date is until November 3rd, 2015.

The next step is to define the D5 step – focused on removing errors. This step concerns the complaint to internal supplier paintshop, which this complain solves through an action plan application. This department must at the next step subsequently introduce the corrective actions to reduce the painted error in the action plan. The corrective actions in the action plan consist of tasks assigned to responsible persons. An important part are filling dates.

D6 step – Corrective actions. The corrective actions consist of increasing the luminosity at the Vib2 workstation from 688 Lux to 2 000 Lux. The second corrective action is to increase the time control from 11 seconds to 30 second. There was discovered by the audit of standardized work, that the operator has its own working cycle in average of 62 seconds. In the work standards is defined the working cycle of 90 seconds. The operator has 30 seconds for the painted part control before the assemly.

D7 step – preventive measures. This step is focused on monitoring the scrap in the period from November 4th, 2015 till February 29th, 2016. In the Table 2 can be seen the costs of the dashboard with welded painted part. The observed period is in weeks from 51st till 11th. The 52nd and 53rd were not monitored because of Christmas holidays.

Table 2. Costs monitoring of scrap

Weeks	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Costs, €	200	180	120	110	120	100	90	80	50	40	30	28	25	25

Source: HUBÁČIKOVÁ L. 2016

D 8 step – Lessons learned. The lessons in this step is based on veifying that the actions were effective. This is a certain prevention of errors recurrence in the process. The lesson consists of the following points:

- Creating or updating of the standardized work. It was realized by updating of the standardized work (working instruction). It was added a thorough inspection of painted part before welding and the working cycle time was changed,
- Risk assessment. Lighting can be considered as a possible risk, because it didn´t meet the VDA 6.3 conditions,
- Checking plan. This plan wasn´t updated,

– Implementation of all actions. All actions were realized in setted time.

Implementation of corrective actions

Lighting change

It was recommended to use one liminaire with two ducts with 2 000 Lux radiation. It will be provided the same lighting as they are used for the final inspection.

Editing working instructions focused on painted error detection

The working instruction for pad assembling starts with the kanban card taking. The pad is taken from the package by the operator. Every painted pads can be released for assembling at least two hours after painting. The pad is removed from the pack by the operator with two hands to avoid damage. The reinforcement PS is taken, checked and installed on the pad. The reinforcement can be released for assembly at least one hour after molding. The pad joined with the reinforcement is inserted into Vib2 welding machine and then pressed down the grid.

Then the operator selects a small console from the pack, in the enterprise called as Pad DS M3. On this pad is inserted a small reinforcement DS. After that the pad with its reinforcement is inserted into Vib2 welding machine, where can be found the pad PS. Before welding, the frequency of 100% control of pads PS and DS is valid. It is necessary that there is no defect on their surface.

If the part is alright, it is marked in the enterprise as OK. If not, it is marked as NOK. In addition to the scratches, the painting errors are the most often errors at the painted parts. Less often, defects occur from the molding.

After the part is welded, the operator picks up the Pad PS M3 with one hand at the point the circular hole (for the insertion of the blower) and with the other hand grabs the same part at the place of the car radio insertion. After that carefully select the part from the welding machine. He check the part again and especially in the places of welding reinforcement with the pad.

If the Pad PS M3 is after welding marked as OK, operator inserts the pad into the dashboard. After that takes the Pad DS M3 from the welding machine and inserts it by pressing to the left side of the dashboard. Next the operator checks the clicking of Pad PS and DS M3 all around the dashboard.

Threading the protective creelings on the hooks

The operators hang the painted parts on the hooks, which are made from metallic material. It causes scratching in the place of the circular hole intended to accommodate the blower. The best choise is to put the rubber creeling to help to reduce the scrap.

Sticking the form of the welding machine and power switches

By inserting the painted pads into the welding machine, the edge parts of the parts may be scratched. The damage can be avoided by wrapping the form with the paper tape. We can decrease the number of scratches or abrasions.

By manipulation with the pad it is necessary to stick every power switches with a warning tape. It will prevent to an operator´s injury or the part´s bumping on the welding button.

Create a workplace for operators training

In many companies, workers are not well trained for a certain position, because the gap leaders don´t have enough time and the rules are not setted. Therefore we recommed that new workers, in case of painted errors detection, have their place, where the gap leader or quality engineer can train them for painted errors.

To implementation of this proposal it is necessary to need a place with a table with hangers for painted parts (painted errors) placement. It is also important for workers to have enough time for studying the working instruction and have the opportunity to consult some of the uncertainties with the supervisor.

4.Conclusion

The problem found at the beginning was insufficient conditions of the painted parts before its assembling to a dashboard. The problem was identifying by Pareto analysis, also the place of its occurance and the error. The root cause was insufficient lighting – it was not according to VDA standards and the worker can ´t find the painted error. The corrective action was defined by increasing the lighting according VDA standard. The next problem was the insufficient time for painted part control before the part is inserted into the welding machine. The audit of standardized work was found, that the worker´s time for the operation is 62 seconds. The standard defines this time for 90 seconds. The worker´s time for the control was only 11 seconds, which was increased to 30 seconds. The next problem founded in the process were the unprotected power switches. The recommendation was to mark them by yellow – black warning tape. By inserting the part into the welding machine occured the damage of the parts. Therefore we recommend to stick the edge of the mold by paper adhesive tape. For operators training it is appropriate to create a training workplace where the operator can see the types of painted errors on the scrap.

The proposal of all actions led to scrap reduction in six months by almost € 247, that means the scrap reduction of 50%.

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