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EVALUATION OF A3 TOOL IN THE PRODUCTION PROCESS

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Purpose: The purpose of the research is to verify the A3 tools in terms of its use for various production problems.
Design/methodology/approach: There is still little research on A3, so further research in this area is essential. Therefore, any additional research in this area is necessary. The research methodology results from the principles of using the A3 tool in enterprises. The A3 tool was used for various problems of the surveyed enterprises. One problem in the form of a case study is also shown: description of the problem related to the production process and the A3 tool was used.
Findings: The use of A3 tools in the direct contact production process was presented and evaluated six A3 reports that were carried out in three production companies over a period of 1.5 years. The findings are as follows: 50% of reports were successfully closed, objectives met and all actions performed on time. 33% of the reports showed moderate effectiveness, i.e. one of the criteria was not met. 17% are low-performing reports.
Research limitations/implications: More research into and refinement of the A3 tool is being considered in future research directions.
Practical implications: The presented results have an impact on enterprises. They allow for more holistic management and dealing with complex problems. Work is more standardized.
Originality/value: The value of the work is the assessment of the effectiveness of the A3 tool based on four criteria. The indicated and effectiveness assessment criteria also allow for a structured process of educating company employees in solving problems. The article shows the economic and business dimensions of the conducted research.

Keywords: A3 tool, case study, production process.

Category of the paper: Research paper.

1. Introduction

The A3 report constitutes a tool for solving problems of various range, and it can apply to many areas of the company business. The tool is based on Deming's PDCA cycle – plan, do, check and act with the purpose of an improvement. The report should be concise and contain the most important information derived from the analysis of the company's problem. Over the years, the report has undergone evaluations. Its format and PDCA steps have remained unchanged, while the form and notation itself differ depending on the sources or the needs of the enterprise. It is possible to upgrade the report to match the demand of a specific enterprise (Mydlarz, 2018). This can be seen in the examples of tests carried out using the A3 methods: A3 reports were included in the process improvement project in aircraft maintenance and repair operations (Chakravorty, 2009) and the possibility of using the search method and effective implementation of green innovations in the industrial transport of the company (Lenort, Staš, Holman, Wicher, 2017).

The key issue in the A3 report is to effectively go through the designated steps – find the root cause, eliminate it by means of appropriate means and supervise and correct it if necessary.

Today's manufacturing companies face many complex problems. However, the term problem should be understood here as the potential to improve staff skills, as well as eliminate losses, and thus gain a number of business benefits. In order to properly achieve the above benefits, it is most reasonable to use ready-made, effective solutions that guarantee an achievement of the intended goal. This is what the A3 tool allows for – it indicates the right way to proceed, assuming that the user understands each of the steps of the method. According to research (see Piasecka-Głuszak, 2014), the A3 tool is used by 47.22% of respondents. Almost half of them, i.e. 22.22% are large enterprises, followed by very large and medium enterprises.

The article focuses on the use of the A3 tool in an automotive company for a selected production problem. There was also a polemic on the effectiveness of the method, and in particular on the identification of certain practical principles that increase its success.

2. A3 as a narrative from problem to solution

The A3 tool was created at the Toyota factory. It owes its name to the size of a sheet of paper – A3 with dimensions of approximately 297 by 420 mm that includes all information about the problem that is reported: from the goal, compiled with the purpose of looking for the cause and introducing corrective actions as well as validating the implemented solutions. The A3 report was intended to be a clear checklist from the emergence of a problem to its

resolution, which indicates that it is a comprehensive tool. The A3 report is referred to as (https://leanpartner.pl/raport-a3/, 2022):

- a reporting table or a report using the PDCA cycle,
- a mental process occurring throughout the solution of a problem,
- an interaction between the owner of a problem and rest of organization aimed at solving the problem by adopting a common language and understanding.

Shook (2012) even mentions the process of managing through learning according to A3 rules. Thus, A3, in addition to the problem-solving function, has a much broader role, e.g.:

1. Developing employees' competencies – the activities emerging in the process often require the group to engage, analyze on an extensive scale, use common skills and cooperate in developing a satisfactory solution that meets the goal. It develops competences of discussion, compromise, broad view of the process and problem, imagination, presentations in projects and also work on data.
2. The A3 report provides information between people from the group solving the problem and other employees – managers, executives (Kołodziejczak, 2020; Żmigrodzki, 2021).
3. An important role is attributed to A3 tools in supporting knowledge-based design, including the creation of enterprise products (Mohd Saad, Al-Ashaab, Maksimovic, Zhu, Shehab, Ewers, Kassam, 2013).

The idea of a report emerged as a method that combines two important management processes: hoshin kanri (strategic management) and a problem solving aapproach. On the macro-scale of the enterprise, hoshin kanri leads to the setting of operational goals and activities in accordance with organizational goals of a higher order, on the micro-scale, at the individual level, the formalized process of solving problems offers an organization the possibility of continuous learning. The A3 process combines both of these scales (Shook, 2012, p. 3).

The structure of the tool is clearly defined. Figure 1 shows a sample A3 report. As you can see, it is divided into several sections, which is characteristic of this method. Each section and its number plays a key role in the method. By following the order of the digits, a suitable way of solving the problem is possible. The fields direct the user what to do in each step, allowing for free transition to the next tools such as 5why, process map or Ishikawa diagram.

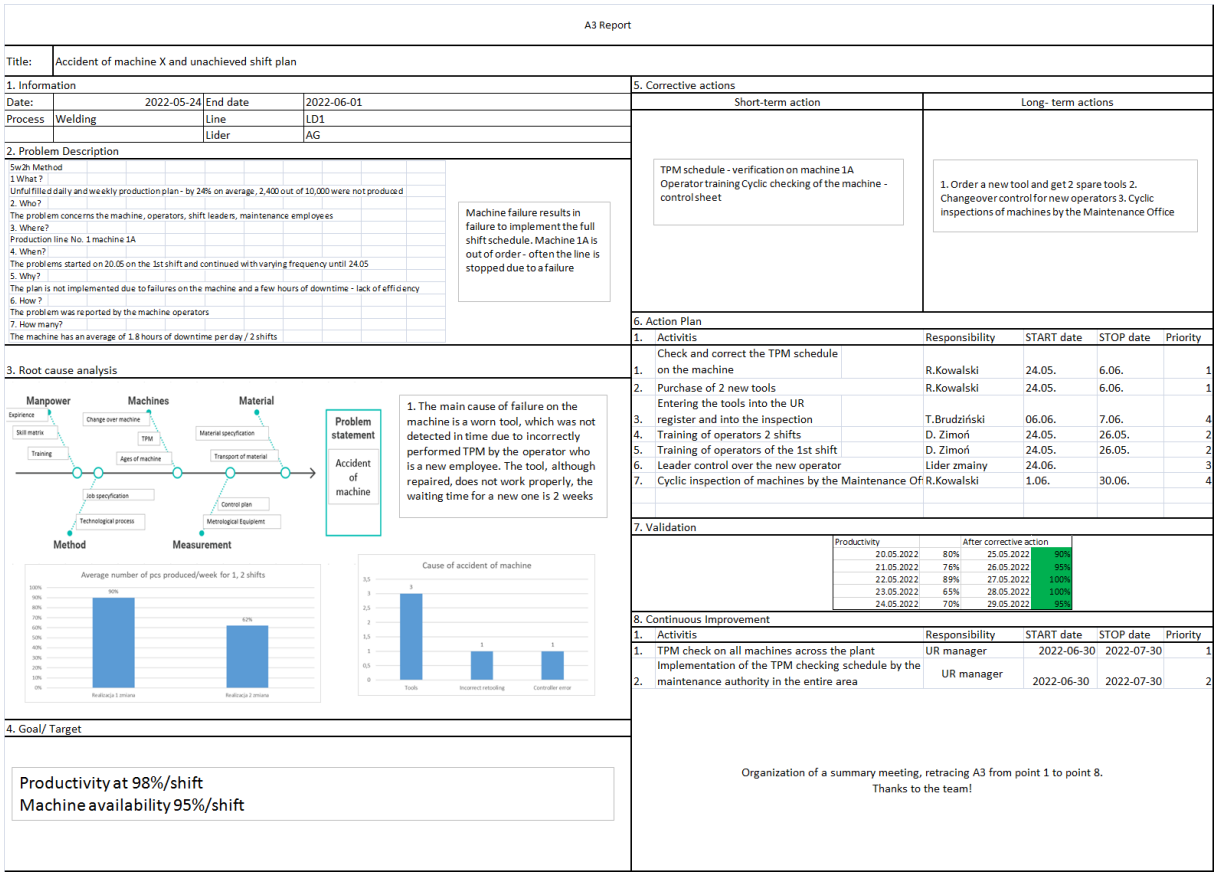

Figure 1. Example of the A3 report.

The steps in the A3 tool are the folowing (Dobrowolski, 2021; Mydlarz, 2017; Sobek, Jimmerson, 2004):

1. Information - i.e. the most important information about the examined problem in terms of: process, area, start date of A3 and the person of the leader.
2. Description of the problem – this is the information that the group has at the time of starting the activities – what, when, how a problem initiated happened, what are the outcomes of the problem. This step utilizes the 5W2H method.
3. Root cause analysis - one of the most important points in the report. All kinds of analysis and observations should be made in this section. Tools such as the Ishikawa diagram, 5why, process map, brainstorming are utilized for this purpose. The output from this section provides insight into the root cause of the problem, which, when properly identified and removed, offer the means to permanently overcome the problem.
4. Goal – as each project, activity serve a purpose, and this is also the case with the report. After defining the root cause, a goal should be set - measurable and clear for the whole group, often consulted with top management. The goal may eliminate the cause completely, but it is worth taking into account the cost of such elimination, often the focus is on bringing the problem to the lowest possible negative impact, because elimination is associated with a large financial outlay that the management may not be able to afford at the moment.

5. Corrective actions – both short - and long - term – both types of action should be implemented. Short - term actions, i.e. preventing the recurrence of a problem; the simplest available methods, which last for a short time, because they will be replaced by long-term actions - more expensive, requiring more organization and commitment, but they are effective and meet the previously set goal.
6. Action plan - tasks should be properly assigned and supervised. Therefore, in section six, there is a list for recording specific actions along with the planned implementation dates and the responsible person.
7. Monitoring - supervision of progress in the report, implementation of activities, updating statuses and progress towards the goal. Monitoring should be done by the A3 leader.
8. Improvement and conclusions – following the diagnosis of the actions that were implemented, it is time for revision and summary. The group asks itself questions about what has been implemented successfully and what needs improvement both in the implemented solutions and in joint work.

3. Application of the A3 tool in the production process based on a practical example

3.1. Production process problem description

The process consists in installing components inside a twin-tube shock absorber. A recurring problem led to considerable levels of scrap at the end of the process. The gasket applied to protect the interior of the shock absorber and does interface properly with each element, which affects the efficiency of damping during the operation of a shock absorber. The fault is irreversible, so losses are generated that cannot be repaired.

3.2. Application of the A3 method for the problem: high level of scrap cause by a defective gasket

The A3 methodology begins with a meeting attended by the staff affected by the problem – i.e. the region's manager, process and quality engineers, the leader of production, a maintenance worker and a third party, usually an employee from the LEAN department. During the initial meeting, the first two points from the A3 report were compiled – *Problem identification and description* – in this case it was: the level of scrap shown in the chart, photos with defects on the shock absorber, customer complaints and reports regarding the stalled production on the line due to incorrect gaskets. All information was recorded by application of the 5W2H tool. At the first meeting, a series of meetings and the time frame for A3 should also be agreed.

Then, a brainstorming session was carried out in the group was in order to answer the question: “What do you think causes damage to the gasket?”. All potential causes have been placed in the Ishikawa chart in appropriate places. The group then proceeded to GEMBA – the source of the problem – to write down the ideas that would come up while observing the process.

The following step involved categorizing the potential causes into three categories of impact: large, medium, and small. Later, it was checked whether the indicated causes are well protected from the point of view of the production system. The time of data collection and analysis usually takes the longest time among all steps.

Once we are familiar with the root cause or several causes responsible, the time has come is to define the goal. This is the right moment for this action, because on the basis of available analyzes it is possible to estimate whether the problem is large and how much resources it can consume. In this case, the goal was to reduce the monthly scrap to 0.02 per problem – faulty gasket and zero reported complaints from the customer. The root cause turned out to be an non-conforming tool applied in the machine. The tool was purchased several years ago. The problem was not detected because the machine was operating properly, no errors were noted in the system, and what's more, TPM (Total Productive Maintenance) was performed suitably, i.e. one of the elements of lean manufacturing, whose task is to ensure maximum availability and efficiency of the production equipment owned (machines and devices). Introducing a new range of shock absorbers, seemingly similar to others, the tool required modifications and changes in the parameters of the machine. In the subsequent stages, on short and long term actions need to be performed. The following short-term actions have been identified:

- short-term production halt of the parts listed on the assortment that included the gasket,
- operator training with regard to the adequate TPM on the machine,
- reporting all problems on the specific machine that was used to install the gasket.

Long-term actions include designing and purchasing the correct tool, adding a new program to the machine and installing sensors that provide a warning in the future in case the tool does not fit in a given shock absorber model. Changes have also been performed to the documentation for new launches in order to check and confirm that all parts of the machine are compatible with the specific shock absorber. The process engineer and the maintenance engineer were identified as responsible for the original analysis. The dates completion and have been identified and responsible individual agreed. The implementation of the longest task was estimated at 4 months.

Until the completion of the final task, the schedule of short-term actions was followed. The team leader met on a weekly basis to check the condition of the machine and the verify the progress of the operators. The leader monitored and communicated to the team the implementation of the goal, which indicated a decreasing trend in the amount of scrap and a 0 level of complaints counting from the moment of implementation of the action. After 4 months, a new tool and sensors were installed and training was carried out.

Finally, the assumed goal was achieved. A point of checking the operator's knowledge regarding the damaged gasket, causes and actions taken, as well as TPM verification, was added to the layered audits.

The last step was a final meeting with attending the top managers where a summary was offered to the whole team, based on the A3 report, so that the story with the gasket could be traced and the path the team took to achieve the assumed goal. Each step in the project was recorded in the A3 report by the leader (Król, 2021).

4. Evaluation of effectiveness of A3 tool in the process of problem solving

4.1. Evaluation criteria

The application of the A3 tool for the problem specified above turned out to be the correct approach – as the goal was achieved, and the problem was successfully solved. However, this is not always the case. During the process of solving a problem with A3, we may have to do with many obstacles, such as in the case when the problem that is too complex, a solution that consumes too many resources – it is unprofitable, the staff fluctuations occur. The effectiveness of the A3 report in the problem-solving process can be considered in the following categories:

- establishing the root cause,
- goal fulfillment,
- implementation of the action plan,
- problem solution within a given period.

From a business point of view, these are the four key tasks in the A3 method.

1. Establishing the root cause is defined on the basis of binary criterion: 0-1, i.e. “YES” or “NO”. When it is known that the root cause has been found – in such a case after the corrective, long-term actions are introduced, the goal is fulfilled – the problem should never appear again.
2. Goal fulfillment – it is defined as – “yes” or “no”, i.e. also the criterion: 0-1; specific information should be given as to why the objective has not been met.
3. Implementation of the action plan – defined as “yes”, “no”, as well as “partly achieved”, i.e. – 0.1 or 0.5. There are two cases of implementing a partial plan – the profitability of actions or external factors over which no one has any influence. The final decisions are most commonly carried out by the chief managers, as they base their decisions on reliable data prepared by a team headed by a report leader. The action plan directly affects the implementation of the goal.

4. Solving the problem within a given time frame – it can be defined as "yes" or "no", which also uses the binary criterion: 0–1. Often the implementation depends on external subjects, therefore the time of resolution may be postponed. If A3 cannot be completed in time, this should be supported by specific reasons.

Table 1 presents details of the effectiveness of the A3 report, taking into account all the criteria along with external risk, such as: lack of availability of raw materials on the market, closing of companies that support the infrastructure in a given enterprise, low profitability from operations, staff changes affecting the implementation of the goal established in the report (Sułkowski, Wolniak, 2013).

Table 1.
Criteria of effectiveness of A3 report

Criteria of effectiveness	YES (1)	NO(0)	PARTLY(0.5)
Establishing root cause	1		
Goal realization	1		
Implementation of action plan	1		
Solving the problem in a given time frame	1		
Total	4		
Total in %	100%		

4.2. Evaluation of effectiveness of A3 report for high scrap level caused by the faulty gasket

A summary of the evaluation criteria can be found in Table 2. Table 2 presents the details of the effectiveness of the A3 report method for the problem analyzed earlier: high level of scrap generated by the faulty gasket installed in the shock absorber.

Table 2.
Effectiveness of A3 report

Method effectiveness	
High effectiveness	100% - 80%
Modertate effectiveness	79% - 50%
Low effectiveness	below 50%

The requirements specified in the report were fulfilled, short - and long - term activities were executed within the agreed time frame, without major complications from the outside and the management's disapproval of profitability. However, in most cases there are major or minor issues involved. Table 3 evaluates six A3 reports that were carried out at three manufacturing companies over a period of 1.5 years. The ranks of the problems as well as the goals were varied.

1. A3 P3/P4 – two A3 reports related to high failure rates of machinery at two different production centers. An attempt was made to solve the problem using method A3, due to the complexity of the problem. Failures occurred at unique moments of operation, regardless of who operated it and what assortment was produced (serial production). The failure rate led to a decrease in productivity, and thus unmet customer orders – and the resulting losses that were generated. The group working on the issue included individuals directly involved in the process as well as engineers and specialists from the maintenance department. A3 followed two paths – the problem required immediate action as well as the complete elimination of the root cause, which had to be found. In P4 the problem was revealed to be so complex that the production was moved to another machine, for which the workshop immediately added tools for a specific assortment. Thus, the occupancy on the next machine was too high, work was started on weekends, as a result, 100% of the production plan was not provided at the output. It was one of the key actions to stem the problem. The root cause could not be estimated to a 100% extent since the machine was so old and worn that the external service was unable to clearly determine the reasons responsible for so many failures in various places on the machine. The management decided to purchase a new machine, but the waiting time after the pandemic and the long waiting time for parts turned out to be long: 3-4 months of machine production and time for validation and training. As a result, all steps A3 were performed, the involved team worked to resolve the problem, but the machine could not be restored to its original state. The production plan could not be implemented even in 70%, which resulted in the cancellation of orders and a financial penalty imposed on the company. In A3 stage P4, the assumed action plan was implemented, while the project was postponed due to parts that had to be re-designed and ordered. Ultimately, the production plan was generated, failures were removed and normal productivity was restored.
2. A3 P2 – in this case of A3 analysis, the problem was related to the high level of quality errors that were revealed at the stage of final inspection on the assembly line. The project started in a standard way: the team was assembled, data collected, the Ishikawa diagram was produced and the area with the greatest impact was determined, followed by the stage of verifying the points indicated in the Ishikawa diagram began. The main reason was the lack of repeatability of the operations performed on the assembly line. After presenting the results of the first analysis and brainstorming in the team – what actions need to be taken, the management stopped A3 when it was already known at this stage that it was necessary to purchase new software to supervise the operator's work and force a specific step to be taken. As this turned out to be a very expensive project, the company could not afford such an expense. The documentation and the A3 report were saved, activities were suspended until further notice.

3. A3 P5/P6. The reports related to less serious problems than the above, they were a related to a need to decrease the level of scrap on a given range of products. Finally, the problems turned out to be eliminated quickly – as the root causes were: low awareness of operators, mainly foreigners - lack of records in the training matrix (what the training of new employees should look like), lack of complete documentation in different languages and a new foreman who did not control the level of scrap. The activities were limited to training, supervision over employees who do not speak fluent Polish, in some places substitute employees were needed. As a consequence of this, they increased their skills in the skill matrix. The foreman was given clear guidelines on their responsibilities. The action plan was divided into smaller tasks with a relatively short execution time, not everywhere it was possible to complete the tasks on time. In particular, where provisions standardizing the process were added – approvals had to be gained from all departments and corrections were to take a long time, but it is necessary according to ISO 9001.

In summary: where the goal is achievable (the company can afford various solutions, is open to new technologies, implement changes) A3 constitutes a very suitable tool. The problem arises when, in the analysis, the root cause turns out to be a big problem that the company is unable to ”overcome” issues such as lack of resources, inexperienced employees, reluctance to a different concept, etc. A3 is executed correctly, according to the assumption, but it cannot be rated high when the goal cannot be achieved. Often the work that needs to be done in connection with the analysis of facts, observations, meetings, supplementing the report turns out to be partly a waste of time - the only benefit is to obtain data and draw conclusions – the root cause, but the problem will not be solved, it has not been implemented purpose.

Table 3.
Effectiveness of A3 method - evaluation

Reports	A3 P1	A3 P2	A3 P3	A3 P4	A3 P5	A3 P6
Effectiveness of methodology	100%	25%	88%	63%	75%	88%

Figure 2 presents the details of assessment of the effectiveness of the A3 tool based on 6 reports prepared over 1.5 years for 3 different companies. 50% of reports were successfully completed, assumptions were met and all action plans were executed on time. 33% of the reports showed moderate effectiveness, i.e. one of the criteria was not met. Most often, these were not performed all activities or exceeded the time of task implementation, most often for external reasons. On the other hand, 17% reports were performing poorly. These were those in which the root cause was not found correctly, and thus the problem was not solved correctly (the goal was not met), despite the fact that the long - and short-term action plan was met.

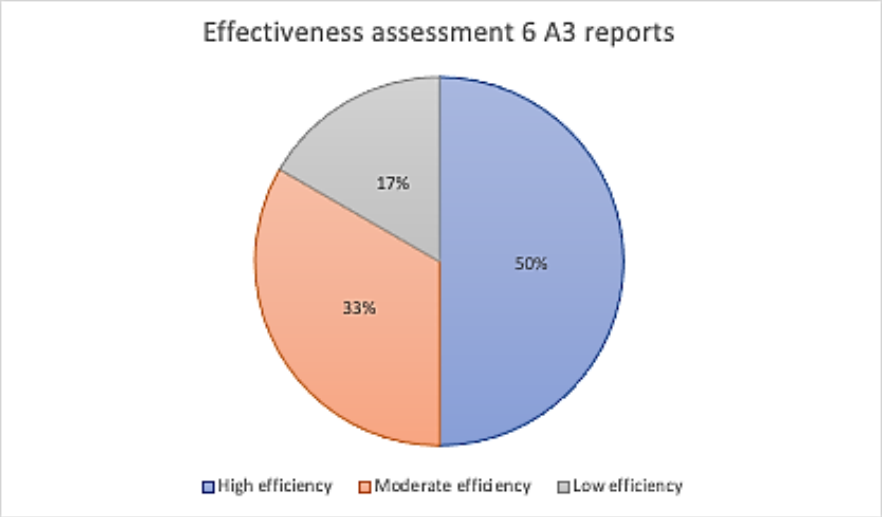

Figure 2. Assessment of effectiveness of A3 report in per cent.

5. Conclusion

The article reported the study concerned with introducing the principles of using the A3 tool, and presented a problem faced by a company that was solved using this tool. The assessment of the effectiveness of the tool formed an important element of the article. Therefore, the effectiveness of the implemented changes can be said if the progress is properly monitored. The effectiveness of the action should be visible in process indicators. Achieving an improvement in a short time does not prove anything - only the improvement of the process parameters in the longer term may indicate that the changes actually brought the expected result and translated into an improvement in the quality of work (the so called *Voice of the Process*) (https://3iconsulting.pl/blog/raport-a3/, 2022). This will also allow you to build a learning organization and present the resulting project in teams as part of the Lessons Learned process. This leads to the A3 template being useless without thinking (Flinchbaugh, 2012). The strength of the A3 report comes from the mindset required to implement A3 (Sobek, Smalley, 2008). Understanding thinking according to A3 offers the means to investigate the tool broadly and promote actions based on adequate procedures that include its use. The indicated and discussed effectiveness assessment criteria also allow for a structured process of educating company employees in solving problems.

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