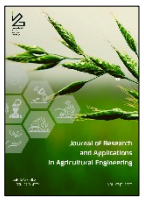
Article citation info:
Niewiadomski P. 2025. Method of improving the quality of the spreading drum of a technological trailer (transport and spreading) – concept and application. *Journal of Research and Applications in Agricultural Engineering* 70 (2): 15–20. https://doi.org/10.53502/jraae-215468

Łukasiewicz Poznań Institute of Technology

Journal of Research and Applications in Agricultural Engineering

Journal website: https://www.jraae.com/



Method of improving the quality of the spreading drum of a technological trailer (transport and spreading) – concept and application

Przemysław Niewiadomski [a*]

[a] Department of Biosystems Engineering, Poznań University of Life Sciences, Poland

Article info
Received: 27 October 2025
Accepted: 11 December 2025
Published: 17 December 2025

Keywords
product quality
spreading drum
process trailer
agricultural transport

Due to the large number of various defects occurring during the production process of the spreading drum of a process trailer, the primary goal of the research was to develop a method for improving its quality and attempt to implement it at a selected company. Achieving the primary goal required a detailed analysis (participant observation) of the spreading drum production technology, diagnosing the causes of the defects, and, based on this, proposing solutions that would eventually eliminate all imperfections (quality orientation). From the perspective of the method's practical application, a set of criteria was proposed for its evaluation. This assessed its suitability for the specific process of producing the spreading drum of a process trailer.

DOI: https://doi.org/10.53502/jraae-215468

1. Starting point

Production improvement poses a major challenge for businesses [1] and is a serious problem when managing many complex processes. Companies increasingly face the dilemmas of global competition, shortening product lifecycles, higher consumer expectations regarding product and service quality, and the need to reduce costs [2]. In recent decades, a focus on quality has emerged, involving the implementation of quality management systems and the use of total quality management (TQM). Only quality understood holistically is the most effective instrument for achieving competitive advantage over market rivals [3].

Therefore, quality management systems are being implemented and a wide range of tools and methods for quality improvement are actively utilized. Tools based on prevention and prevention are the most effective [4]. Anticipating errors and the ability to avoid them are the basis for methods related to risk analysis for processes and products. Increased quality requirements in companies have become the basis for development activities. This article attempts to develop and evaluate a method for maintaining the proper quality of a process trailer's spreading drum, as well as reducing defects and discrepancies during production. This approach is intended to prevent problems during customer operation.

Studying the technology of production of a spreading drum through a case-by-case analysis can be very useful for understanding all the stages and aspects related to the improvement of its production process. Analysing a specific case of the production of spreading drums allowed for: a detailed analysis of the production process of spreading drums, starting from the selection of raw materials, through the production process, to quality control. By using this method, key factors of production, including the selection of

* Corresponding author: przemyslaw.niewiadomski@up.poznan.pl

materials, processes and quality control procedures, were identified, which have a significant impact on the production quality of the spreader drums. The case study made it possible to assess the efficiency of the different stages of the production of the spreader drums, identify areas where improvements could be made, and assess the overall production efficiency. In conclusion, the analysis of the case study of the suspension drum production technology allowed the author to gain a deeper understanding of the production process, identify key factors, evaluate effectiveness and efficiency, analyze production costs, and determine applications and benefits. It is an important tool in the analysis and improvement of production processes and in the development of a business strategy related to the production of spreading drums.

When starting the work, the following thesis was formulated: A detailed analysis of the technology of production of the spreading drum will allow to diagnose the causes of defects and, on this basis, propose solutions that can eliminate all errors in the future.

2. Kaizen in the production of a spreader drum

Kaizen is an approach often implemented in companies producing agricultural machinery parts and components. The etymology of kaizen is a combination of two Japanese words: "kai" – change – and "zen" – for the better. Literally translated, it means continuous improvement. Kaizen refers to small improvements to the existing state, resulting from continuous action [5]. Kaizen is an approach that involves daily improvement throughout the entire organization, from top management, through managers, to production workers. It involves small but systematic changes [6]. It can be said that kaizen is the foundation of good management practices and the link between the philosophy, systems, and problem-solving tools developed in Japan over the last thirty years. This concept assumes that company problems should be solved by creating an appropriate organizational culture.

Kaizen assumes that "excellence" should lead to increased customer satisfaction. The foundation of the kaizen strategy is therefore management, which must seek various ways to increase customer satisfaction by meeting their expectations. Therefore, improvement in areas such as quality is crucial. The kaizen philosophy and methodology, which promotes continuous improvement through small steps, quickly leads to positive results, as increased efficiency can be achieved without major investments and in a short time [7]. Primarily, the effects of the improvement process can include increased efficiency of machines and equipment, optimized material flow, shortened production times, and increased customer satisfaction. This can be achieved through a structured, methodological approach to all processes and the willingness of employees to participate in the continuous improvement process. The foundation of an organization's success, therefore, lies in establishing clear company goals, a clear operational concept, and consistently implementing them in practice [8].

In this paper, "kaizen" is treated as an approach to improvement based on common sense and low costs. In practice, this also meant that every employee in the organization was involved in the improvement process. Importantly, the kaizen process was implemented by changing the production method of the spreading drum [9], and not by large financial expenditures [10].

3. Research problem

The research discussed in this paper was conducted at a manufacturing company operating in the agricultural mechanization sector. The company's primary activity is the production of spare parts and components for agricultural machinery – the vast majority for agricultural transport vehicles (process trailers, manure spreaders, and slurry tankers).

The company's main problem was the relatively high number of defects that occurred during the production process of the spreading drum of the Fortschritt T-088 process trailer (Fig. 1).

Fig. 1. Fortschritt T-088 technological trailer
Source: www.zpcz.pl

In light of the above, analyses were undertaken to develop a method for improving the quality of the spreading drum. This focused on actions to eliminate the causes of defects. Based on this, a catalogue of solutions was proposed that would eventually eliminate all the imperfections identified in the process. Although the improvement actions presented in this work were aimed at improving the quality of

manufactured products, they encompassed the logistics and production areas of the company's operations. These actions led to the improvement of manufacturing processes implemented during the spreading drum production process.

4. Method of improving the quality of the spreading drum of the technological trailer - characteristics of the introduced changes

In the first stage of the research, the purpose and subject of the analysis, as well as the areas in which potential defects should be sought, were defined in detail. This allowed for the identification of specific problems. A problem-based approach was used to compile a list of the defects under consideration (analysis was performed on areas where problems were identified), and a systemic approach, where the product, design, or process was considered holistically. The second stage involved the analysis itself, focusing on three indicators: (1) the significance of the defect, (2) the frequency of occurrence, and (3) the detectability of the defect). At this stage, the relationship between cause and defect, problem and effect, was established. The next stage was to determine the significance of the defect, define the potential causes of the defects, and determine their frequency. Next, it was necessary to determine how often a given defect was implied by an incorrect production process. After the analyses, the next stage was to implement and monitor preventive measures. Corrective measures were applied to the specific defect and its cause.

As a result of the analysis, key causes of specific defects in the spreading drum of the processing trailer were identified. A list of potential causes that could lead to defects is presented in table 1. The factors were focused on three groups: (1) material, (2) machines, means and work items, (3) technology.

Table 1. Causes of quality defects

MATERIAL / RAW MATERIAL	MACHINES, MEANS AND OBJECTS OF WORK	TECHNOLOGY
– Low-quality material	– Failure rate of machines and equipment – poor technical condition of machines (worn-out devices)	– Outdated technologies
– Manufacturing defect	– Instability of energy supply	– Lack of proprietary solutions in manufacturing methods
– Incorrectly selected raw material	– Inaccurately set parameters	– Technology not adapted to requirements
– Lack of raw material input control	– Lack of modernization and maintenance activities	– Highly repetitive operations
– Unstable material supply	– Excessively worn-out devices	– Inappropriate operating procedures
		– Improper transport and loading
		– Illegible operating instructions

Source: own study.

Due to the large number of various defects that occurred during the production process of the spreading drum of the Fortschritt T-088 process trailer (Fig. 2), an analysis of the so-called "bottlenecks" was performed. Initial observations showed that outdated technologies, a lack of individual (dedicated) solutions in manufacturing methods, and worn-out devices (holders, fasteners, etc.) contributed most to the defects.

Fig. 2. Spreading drum of the Fortschritt T-088 technological trailer

Source: www.zpcz.pl

Selecting appropriate directions for improving the production process is one of the most important organizational and management issues in the development of a spreading drum. The primary selection criterion should be the pursuit of maximizing the benefits obtained from the implemented change. Therefore, during the research and development work, attention was paid to:

– the ability to integrate, reconfigure, acquire, and release production resources to respond to market changes or to provoke them spontaneously;
– the ability to use technological resources to manipulate existing enterprise resources to create new configurations.

Furthermore, it was assumed that the primary selection criterion should be the pursuit of maximizing the benefits obtained from the implemented

innovation. The degree of universality of the implemented innovation, the payback period of the invested capital, and the projected lifespan of the innovation are equally important. Based on the above, it was determined that the implemented changes should be focused on introducing quality-related solutions covering production means (machines, equipment, tools, devices), work items (raw materials, materials, semi-finished products, energy), and production technology (workflow).

The implemented solutions were linked to individual components of the manufacturing process, i.e., they concerned specific areas, ongoing processes, and technological activities. The proposed changes indicate the need for ongoing transformations in manufacturing processes, including changes within individual technological operations. The tooling and technology developed and applied in the drilling (subtractive machining) process, aimed at eliminating the defect of incorrect hole positioning, was mandatory in the context of the conducted assessment. Currently, outdated technology, means, and work items were being used, therefore, it was demonstrated that the implemented changes eliminated the technological inadequacies that resulted in a deterioration in the quality of the final product. In this regard, it was determined that the process of implementing the innovation did not require significant financial investment, which was an added value of the introduced change. Therefore, to eliminate the problem of incorrect hole positioning, fixtures were used [mounting fixtures] enabling drilling operations for the drum journal base by manually transferring the workpiece to the fixture. Special fixtures and drilling jigs were used to secure the workpieces, allowing for drilling holes in workpieces with differently spaced holes. Furthermore, the fixtures were adapted to a wide range of similar workpieces, requiring minimal fixture changeover times. The entire technological process was carried out using double-spindle drilling machines, designed to simultaneously machine two holes.

The spindles of these drilling machines are mounted in a head that slides along the guides of the stand. To eliminate uneven screw spacing relative to the main drum, misalignment resulting in vibration, and asymmetrical mounting of the cutting knives and upper journal, welding fixtures were used to ensure complete dimensional repeatability of the structure. During the welding process, all drum components are precisely positioned and properly pressed against the mounting bases in the welding fixtures, ensuring limited welding shrinkage and maintaining the required settings and tolerances. The innovative design solution used in the welding fixture allows for easy and precise adjustment of the mounting bases, significantly reducing the time required for any dimensional corrections.

5. Expert evaluation of the method for improving the quality of the spreading drum of the technological trailer

Analysis of the production of the next drum batch manufactured after implementing the recommended solutions showed that in the case of non-conformities – in each of the above-mentioned areas – they were significantly reduced (quality optimization). As a result of participant observation and analysis of production documentation, it was determined that the implemented changes resulted in significant benefits, namely a complete reduction of defects arising during the drum production process – defects that prevented its release for further sale. The following are illustrated in Table 2.

Table 2. Analysis of defects before and after introducing changes in the spreading drum manufacturing process

Type of defect	Before	After
Incorrect hole dimensions	29	1
Asymmetrical mounting of cutting knives	19	0
Misalignment resulting in vibration	25	0
Asymmetrical mounting of the upper journal	16	0
Incorrectly positioned weld (uneven coating)	12	1
Uneven screw position relative to the main drum	22	0

Source: own study.

The presented direction of change allowed for the correction of product defects and, taking into account the measurement of selected criteria, enabled verification of the accuracy of initial assumptions regarding the outdated technologies used by the company and the lack of individual solutions in terms of product manufacturing methods.

To substantively evaluate the proposed and implemented method for improving the quality of the spreading drum of the technological trailer, a creative

discussion was held. Four individuals directly associated with the company were invited to participate in the discussion (the company owner with many years of experience in implementation processes, the production manager, the chief technologist, and the designer). The selection of experts was based primarily on their competences, including professional experience in production logistics. In each case, these individuals were professionally active, actively participating in the production processes of the company from which they currently originated and for which they worked.

The equipment and technology developed and implemented in the drilling process, designed to eliminate the defect of incorrect hole positioning, received very high marks. During the discussion, it was clearly indicated that outdated technologies, a lack of individual solutions in manufacturing methods, and worn-out equipment are the greatest contributors to drum quality defects. It was noted that in the analyzed case, it was crucial not only to identify the direction of change but also to identify the type, methods, and manner of their implementation.

The solutions identified were linked to individual components of the manufacturing process (specific areas, processes, and technological solutions), which was argued to be an added value of the proposed improvement method. Many positive comments concerned the implemented welding equipment. Attention was drawn to the possibility of eliminating the uneven arrangement of the screw relative to the main drum, which was crucial for improving the quality of the spreading drum. It was noted that the scope of the eliminated inconveniences, including eliminating the problem of concentricity, required a solution presented during the ongoing research.

6. Discussion and conclusions

Due to the occurrence of defects during the production process of the Fortschritt T-088 spreading drum of the processing trailer, it was decided to implement preventive measures intended to significantly reduce their number, which would ultimately impact the quality of the product during its development and operation. Therefore, a catalog of solutions was proposed that would eliminate key deficiencies in the long run. Many of the adopted measures relate to improvement activities characteristic of the lean manufacturing method [11]. While solving the problem is crucial, it must be remembered that preventing its recurrence, i.e., eliminating the cause, is equally important. Therefore, the corrective actions taken are nothing more than "learning from mistakes" and drawing conclusions. The results of the analysis of the resulting discrepancies, the implementation of corrective and preventive strategies, and the verification of the entire spreading drum production process demonstrated the effectiveness of the proposed measures, as the manufacturer managed to eliminate the cause of the specific problem. The research results clearly indicate that, based on professional analysis and cause-and-effect diagnosis, it is possible to develop and implement a solution that will improve efficiency and enable a sustainable competitive advantage in the market. These include numerous interconnected processes and activities that change the scope of the production management system.

Remedial recommendations should include a holistic program of changes and improvements to selected processes, including a detailed remedial program and its implementation schedule, as well as a financial plan and budget for implementing the improvement program. The author emphasizes the rationalization of capital utilization, the possibility of creating new production resources with the introduction of changes, and the implementation of manufacturing methods and techniques, which will ultimately contribute to increased production efficiency of the spreading drum. The paper unanimously concluded that the proposed technological changes concern dimensions such as means of production, work items, and technology. The paper emphasizes the need to leverage knowledge and experience to quickly capitalize on the opportunities associated with emerging changes [12]. The work highlights the importance of fluidity in production resources, which implies the internal reconfigurability of the logistics and production system, allowing for rapid transformation and improvement of the production model.

Although the paper provides a detailed analysis of the technology of production of the sizzling drum, using a case study, it is necessary to pay attention to methodological limitations, including the wider application of the results of the study. A small sample of experts, limited quantitative analysis can lead to interpretations of results that prevent their direct translation into the production of other products. To overcome these limitations and allow for wider application of the study results, several steps can be considered. It is reasonable to widen the research sample or expand the expert group to better reflect the representativeness of the results. The use of additional test methods, both quantitative and qualitative, should also be considered. In the long run, this can provide a more comprehensive and deeper understanding of the problem. In addition, it is recommended to be careful in drawing generalizations and to clearly define the boundaries and context of the application of the study results. To sum up, it is reasonable to undertake research initiatives aimed at improving the quality of research and enabling wider application of its results [13].

References

[1] Piasecka-Głuszak A.: Główne przesłanki i bariery utrudniające wdrażanie kaizen w przedsiębiorstwach na polskim rynku. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, 2015, no 406, 289-305.

[2] Rof L. M.: Kaizen Costing Method and Its Role in the Management of an Entity. Revista Tinerilor Economisti (Young Economists Journal), 2011, vol. 1(16), 104-109.

[3] Fatimah F., Solikin S.: The Effects of Total Quality Management Implementation on Employees' Performance: The Case of PT Pertamina Refinery Unit III Plaju, Palembang-Indonesia. Business Management and Strategy, 2016, no 7(1), 96-102. https://doi.org/10.5296/bms.v7i1.9080

[4] Szuster M.: Kaizen w firmach produkcyjnych, in: Kultura kaizen. Rozważania nad wartościami ciągłego doskonalenia, ed. G. Wróbel. Wydawnictwo WSIiZ, Rzeszów, 2011.

[5] Niewiadomski P., Pawlak N.: Menedżer Kaizen – model kompetencji lidera, in: Człowiek w organizacji. Teoria i praktyka, ed. P. Wachowiak. Oficyna Wydawnicza SGH w Warszawie, Warszawa, 2012, 113-122.

[6] Tesler D., Wiśniewska-Dobosz M.: Kompetencje menedżera Kaizen. Zmienianiu firm na lepsze przychodzi z pomocą filozofia Wschodu. Logistyka a Jakość, 2007, nr 3.

[7] Rokita S.: Filozofia kaizen i kaizen costing jako narzędzia wspierające zarządzanie w JST. Studia Ekonomiczne, 2017, nr 333, 178-189.

[8] Niewiadomski P.: Determinanty elastyczności funkcjonowania przedsiębiorstwa produkcyjnego sektora maszyn rolniczych. Wydawnictwo Politechniki Poznańskiej, Poznań, 2016.

[9] Hamel M. R.: Warsztaty kaizen. Praktyczny poradnik, jak prowadzić skuteczne warsztaty doskonalenia procesów. Wydawnictwo Lean Enterprise Institute Polska, Wrocław, 2014.

[10] Imai M.: Kaizen Klucz do konkurencyjnego sukcesu Japonii, MT Biznes. Warszawa, 2007.

[11] Imai M.: Gemba Kaizen. Zdroworozsądkowe podejście do strategii ciągłego rozwoju, PROFES. Warszawa, 2012.

[12] Liker J. K., Convis G. L.: Droga Toyoty do Lean Leadership, MT Biznes. Warszawa, 2012.