Assessment of the efficiency of the continuous improvement system based on Kaizen in an example company

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Abstract. The article presents an attempt to show how the continuous improvement system based on the Kaizen philosophy works and how to evaluate the effectiveness of the system in an example of a production enterprise in Poland. It describes the principles of the Kaizen system and the methods available to allow for the assessment of its effectiveness. The evaluation of the effectiveness of the Kaizen system was based on available economic data, but, due to confidentiality or the inaccessibility of most of the data that could directly demonstrate the efficiency of this system, it was decided to also conduct surveys among workers and low- or mid-level managers. Research has shown, among other things, that the main motivator for employees to undertake activities related to continuous improvement are financial factors (bonuses, financial rewards) and a willingness to show themselves in a good light in front of their superiors, which is not consistent with the original assumptions of the creators of the Kaizen philosophy. Despite these differences, the application of the continuous improvement system in the company studied can be considered effective in light of the economic benefits and quality improvement.

1. Introduction
Enterprises operating on a practically globalized market (in fact only high transport costs over long distances or short shelf life of products may trigger the appearance of niches, in which globalization does not force changes) are subjected to the requirements of the modern economy. Dynamic and continuous changes occurring in the environment of enterprises force them to adapt to this environment [1]. The way to adapt to this environment is continuous improvement of processes taking place in the enterprise [2]. Changes are a natural element of the company's operations, allowing development and opening new opportunities [3]. Companies are looking for opportunities to improve efficiency and quality by using different methods in many areas of their business. Automation and robotisation of production is increasingly being introduced, not only in large companies in the conditions of large-scale and mass production [4], but also in smaller and medium enterprises (SMEs) that run small-series or even customized production to meet the specific needs of customers [5]. Various tools and methodologies are applied at the design [6] and preparation stage of production [7], which are intended to shorten the duration of these stages and improve production processes to enable a reduction of manufacturing costs, while maintaining the high quality and stability of production [8]. Various types of improvements in the field of production engineering are also applied, including, among others, virtual reality [9], modeling [10] and simulation [11] of production processes [12] and
improved scheduling [13][14][15], allowing for a real-time response to changing situations. An important role is also played by the horizontal [16] and vertical integration [17] of various types of control and management systems, supporting the operation of the enterprise, including universal communication methods [18], protocols and interfaces [19], which is strongly emphasized in the Industry 4.0 concept [20].

Continuous progress in the organizational, IT and technological spheres allows companies to maintain competitiveness on the market, and one important element of business management is obtaining information about the current state of the production system [21]. Thanks to these activities, the quality of the product and the possibility to flexibly change the assortment produced are improved, which allows companies to easily adapt to changing customer requirements.

The Japanese Kaizen philosophy, often identified with the Toyota automotive company, is one of the methods of improving organization that are gaining popularity [22]. Toyota, thanks to the use of innovative and well thought-out management methods, has become the world leader in the field of car production, while achieving simultaneous reduction of manufacturing costs. Other companies, including Polish ones, have begun implementing similar solutions. This strategy works well in planning and organizing production processes and improving quality. Kaizen principles make it possible to increase the efficiency of processes, making it easier to achieve market success.

The introduction of the Kaizen system does not require high financial expenditure - its introduction is possible without the use of complicated techniques, advanced and expensive IT systems and the implementation of modern technologies. One of the biggest advantages of the Kaizen concept is the fact that it focuses on cooperation among people, each employee, regardless of their position or experience can take part in creating a growing, employee-friendly company [22].

The article presents the operation of the continuous improvement system, based on the Kaizen philosophy in an example of a manufacturing company in the automotive industry. Companies operating in this industry are subjected to particularly strong pressure to improve quality and reduce production costs.

An attempt to assess the effectiveness of the system was also presented. The basis for the assessment should be various types of economic indicators, but due to the confidentiality of most economic data that could directly demonstrate the efficiency of this system, surveys were carried out among staff members in different positions (low- and middle-level management, workers in production and maintenance), allowing the determination of their satisfaction with the operation of the system, and, consequently, the commitment levels, that show the success of Kaizen implementation.

2. Methods of improving the operation of enterprises

The introduction of changes in the company may be carried out drastically or gradually. Japanese philosophies of company management assume mainly a gradual, and, at the same time, continuous approach to improvement, referred to as the Kaizen philosophy, while the classic approach of Western companies to improvement assumes introducing innovations [23]. Innovations can be defined as major changes that take place at relatively long intervals, often with the use of significant resources for modern technologies or through the implementation of the latest concepts in the sphere of management. Innovation is a one-off phenomenon (though, of course repeatable) and eye-catching. Kaizen's philosophy is a continuous process, not requiring the allocation of enormous resources for change, and these changes themselves are less spectacular than in the case of innovation. An important difference between the two approaches presented is the issue of implementing changes. In the case of Kaizen it requires the constant effort and commitment of all employees, in contrast to classic innovations, which from the employees' point of view, are implemented from above. Kaizen's approach, process-oriented and human-oriented, results in slow progress, often unnoticed immediately, contrary to the spectacular result of innovation. The western philosophy of innovation better fits the market characterized by fast development pace, while Kaizen better fits the market with a slow pace of development [23].
2.1. Kaizen strategy
The Kaizen strategy plays the most important role in the Japanese management system. The Japanese word *kaizen* means "continuous improvement" [23]. The improvement process is to include not only management, but also rank-and-file workers. The Kaizen concept highlights the differences that exist between Western European and Japanese management. The European way of thinking is focused on quick results and innovations, and Japanese - on the improvement of the process. The term Kaizen appeared for the first time as an English word in 1993 in the New Shorter Oxford English Dictionary, where it meant "continuous improvement of work practices, improvement of personal efficiency (...)". Generally speaking, the basis of Kaizen is the assumption that man should strive for excellence [24]. Contrary to the innovation and emphasis on results preferred in Europe, Kaizen assumes introducing changes, the character of which should be small and gradual, which means continuous improvement. The main tasks of the Kaizen philosophy include the implementation of improvements, standardization and up-to-date standards, and in the event of catching irregularities, process control (treated as a continuous process).

The first step in implementing the Kaizen process should be to start the PDCA (Plan-Do-Check-Act) cycle. The basic systems to be implemented in implementing the Kaizen strategy are [22]:

- TQC/TQM (Total Quality Control / Total Quality Management) - comprehensive quality control,
- JIT - in the sense of the JIT system, all activities that do not generate added value are unnecessary; JIT assumes the use of such methods as timing and cycle time synchronization, flow of one piece, automation, shortening the changeover time,
- TPM (Total Productive Maintenance) - focuses on improving the quality of equipment used in the production process; solutions are implemented to extend the efficiency of devices through its preventive maintenance, and the TQM approach involves the entire staff of the production company,
- hoshin kanri - top management should develop a long-term strategy on the basis of which shorter-times strategies with will be developed; managers should define a strategy from plan to implementation, and then instruct the downstream staff in its implementation; the strategy that goes through the successive stages of the hierarchy should be enriched with more and more specific actions,
- suggestion system - it is mainly about promoting Kaizen thinking and strengthening self-discipline among employees, which is to be achieved by encouraging employees to discuss their suggestions with managers; this is to be a way to interest employees with the Kaizen idea by encouraging them to make even the smallest suggestions possible,
- work in small groups - the creators of the Kaizen philosophy consider as such, voluntary, informal groups within the company, e.g. factory quality circles; their operation can be classified as a manifestation of group activity.

Employees of Japanese companies should fulfill two main functions: maintenance and improvement. Employees who perform the maintenance function should take care of maintaining the current technological, management and operating standards, and employees whose task is to improve should take actions related to the improvement of existing standards. Persons performing managerial functions should fulfill their tasks based on the Standard Operating Procedure, which assumes that rules and standards should be set first to determine how the main activities should be performed. Once the directives and regulations are established, you can go on to monitor compliance. Standards for performing various activities are determined by management and imposed on employees at lower levels. Their compliance refers to the enforcement of their compliance by discipline and training for employees. Improvements are to concern employees at all levels. A new, inexperienced employee should adhere to established rules and instructions, but after some time, when he reaches proficiency, he can propose improvements at his workplace [25].
2.2. Potential problems during Kaizen implementation

Implementation of the Kaizen system in a company is not an easy task in practice due to problems that hinder implementation or even make Kaizen not taken into account. Among the frequently occurring problems with the implementation of the Kaizen system the following problems are mentioned [25]:

- lack of funds for introducing the system - the argument often put forward by the reluctant managerial staff to abandon the implementation of the system - the introduction of the Kaizen philosophy, however, does not require large financial expenditures, and the expenses incurred may quickly pay off,
- insufficient time to introduce the system - the management staff may be afraid that the system will consume a lot of time, which employees should spend on performing their basic tasks,
- lack of enthusiasm of the management staff - the management staff may not want to fully engage in the implementation of the system, discharging full responsibility for lower-level employees - this situation may occur when the managerial staff does not receive remuneration for additional work related to system supervision and employee motivation,
- lack of the system or incorrect suggestion system - the problem occurs when the company does not allow the participation of employees in the improvement of the company or only for some of them are allowed; forcing employees to create new ideas is also inappropriate,
- lack of system or inappropriate motivational system - it makes employees reluctant to propose new ideas - they expect remuneration for their additional work; also the motivational system that offers employees rewards that do not meet their expectations will also be unattractive for them.
- lack of cooperation between company's departments - the company's departments are often treated as separate units, which makes it difficult for the managerial staff to coordinate changes related to Kaizen implementation,
- aversion of employees to changes - may result from worries about the workplace as a result of introducing too effective improvements; this may lead to sabotage of the system implementation by employees.

2.3. Stages of implementing the Kaizen strategy

Each attempt to implement the Kaizen system in an enterprise is a long-term and multi-stage process, and the stages are interrelated. Some implementation stages can be implemented simultaneously, however the majority must follow each other in a specific order [26].

- information campaign among employees - it is necessary to familiarize employees with the basics of the Kaizen system and the principles of its implementation; information campaign can be conducted through posters posted at the workplace, leaflets and training; it is important to train lower-level management in order to clearly define their tasks and responsibilities in the functioning of the system,
- creating a reward system - it is necessary to motivate employees to engage in Kaizen; rewards for the introduced improvements will keep interest in the Kaizen system,
- preparation of documentation - it is necessary to create documentation, which should include: regulations (along with the system of rewards), procedures for examining and approving applications and implementing improvements, Kaizen proposal form card and exemplary completed Kaizen form,
- development and creation of a database - it is an important element during the implementation of the Kaizen system, allowing the management of Kaizen applications and the process of their evaluation and implementation; the use of IT resources can increase the functionality and efficiency of the system, as well as increase the speed of implementation of proposals and improve the flow of information about applications and implemented ideas,
- creating a Kaizen workshop - it allows employees to implement improvements themselves; this allows for reducing the costs of implementing improvements, because it does not require the employment of external companies; it can also contribute to the development of knowledge and
skills of employees who will first be trained in the use of machines and equipment in the workshop and then acquire practical skills.

- system tests - they consist of acquiring the first applications, conducting their analysis and implementing approved ideas; during the test period, it is possible to detect system flaws and perform corrective actions.

3. Evaluation of the effectiveness of the continuous improvement system

Due to the fact that the system operates on many different levels of the company structure, it is difficult to indicate a universal method that could be used to measure the effectiveness of the Kaizen system. Also, the goals that were to be achieved may be different depending on the specificity of the company, and they are not always measurable.

Efficiency can be defined as the relationship between the goal and the obtained result, but in the case of a continuous improvement system, it is impossible to directly assess the results, but only to estimate the impact of the system on the operating company. The evaluation of the effectiveness of the Kaizen system can be carried out in relation to the objectives of the system and the areas in which Kaizen operates. Objectives that can be evaluated are, for example, Kaizen goals, such as reducing wastage, improving efficiency, reducing costs or engaging employees in improving the business. An attempt to evaluate the effectiveness of the system can be made by using several methods described in the following subsections [27].

3.1. Internal and external audits

Research in the form of an audit is to provide information on the policies and procedures introduced. The result of the audit should be a report showing errors in the operation of the system. Among the disadvantages of external audits, one can indicate doubts about their reliability, the lack of which may be caused by the omission of some less well-functioning areas, for fear of losing a client. Correctly carried out audits can, however, be a good source of information about the company and the status of the systems implemented.

3.2. Survey research

Surveys are one of the most popular but not always accurate and fully reliable research techniques. They can be used to examine the satisfaction of employees and their opinions about the operation of the system, to improve motivational systems or to obtain feedback from the client in terms of his expectations. Some companies are skeptically oriented to surveys because of their time-consuming nature and errors appearing in surveys.

3.3. Rating through indicators

Assessment using indicators is based on the assessment of various areas of the company's activity by analyzing the various measurable data available in the enterprise. It allows for analysis of implementation at various angles, but requires the involvement of many company departments and the coordination of work between them. Examples of indicators that can be used when assessing the Kaizen system are [27]:

- OEE (Overall Equipment Effectiveness) - a commonly used measure of the degree of utilization of positions, its designation takes into account three main components: availability, usage and quality,
- DTR (Downtime Ratio) - failure rate of machines, expressed by the ratio of machine failure time to total available machine time,
- DPMO (Defect per Million Opportunities) - Six Sigma tool pointer; it means the number of defects per million possibilities of their creation,
- Yield - quality index comparing the ratio of good quality products to all produced,
- savings due to the Kaizen system - this can be one of the main measures to assess the effectiveness of the Kaizen system; data for the analysis can be obtained from the estimated calculations.
contained in Kaizen's applications or through the cost account and comparing it with the previous state,

- indicators in the field of occupational health and safety and ergonomics - the analysis of the effectiveness of the Kaizen system can be made for changes in health and safety or ergonomics; indicators for analysis are then measurable factors affecting the safety and ergonomics of work, which were improved through Kaizen, such as noise, vibrations, microclimate, radiation, dustiness or energy expenditure of the worker [28]; due to the difficulty of determining the link between a specific Kaizen idea and the possibility of an accident, it is possible to analyze the number of accidents per year or the length of accident-free periods in the company, however taking into account the randomness of some accidents and the possibility of contributing to them by the employee,

- employee engagement - this is one of the main objectives of the Kaizen system; without the involvement of employees, it is not possible to effectively implement the system; the indicator may be the number of Kaizen applications submitted over a period of time or the annual number of ideas implemented [29]; it should be remembered that this ratio will not be credible in enterprises in which submission of Kaizen applications is formally enforced by management [30].

4. Kaizen system in an exemplary company from the automotive industry
The Kaizen system was evaluated in the Polish branch of an international enterprise producing components for cars. The plant employs approximately 2,500 people, is run in accordance with ISO 9001, ISO 14001 and OHSAS 18001. In the group of ISO 9000 norms, the norm that refers to the continuous improvement of the plant is the ISO 9004 standard. Its strategic goal is to continuously improve processes to optimise the quality of plant operation.

In accordance with ISO 9004, the philosophy of improvement due to small steps should be based on the creativity and actions of employees. Each employee must have the appropriate qualifications and have the necessary technical support. The company's role is to stimulate employees to continuously work on improvements. In addition to providing technical support and resources to employees, company should also:

- create an appropriate, friendly atmosphere,
- support the development of knowledge of employees at all levels,
- set simple goals,
- appropriately reward achievements in the field of continuous improvement,
- respond to all, even the smallest, suggestions for improving the company's operations.

In the example company, appropriate solutions and procedures were implemented, in accordance with the guidelines on creating a continuous improvement system available in the literature - regulations, procedures and relevant forms of Kaizen documents were developed.

4.1. The procedure for implementing the Kaizen proposal
The employee presents his idea of improvement in the Kaizen application form. The sections available in it include: Department / Machine, Date of application, Name and Surname of the originator (maximum number of originators is 8 people, as stated in the regulations), description of the current status, description of improvement (needed resources and expected effect). As part of the current status description, it is necessary to present how a machine functioned to-date or how the organization, measurement, workflow over a given activity looked like, etc. The employee's task is to describe the diagnosed problem. In the next column, the employee describes his idea to improve the given solution. This description can be supplemented with sketches, calculations, photographs, etc.

The application is submitted in paper form to the appropriate Shift Leader (SL). Then, after acceptance, SL enters the application into database and sends a notification to Team Leader (TL) - department manager. If Team Leader approves the idea, it is passed on to the people from the acceptance list, containing the employees of the following departments: maintenance, health and
safety, Process Engineering, Continuous Improvement and other departments, depending on the type of improvement. If Kaizen is accepted by the persons responsible for its consideration in these departments, the process of implementation takes place. Kaizen can be implemented by the originator, implementation group or by external company.

5. Evaluation of the effectiveness of the continuous improvement system in the example company
The evaluation of the effectiveness of the implementation of the Kaizen system in the example company was carried out using indicators showing the efficiency of production, savings made as a result of conducting Kaizen policy or improving ergonomics and work safety. Surveys were also conducted among employees employed at various levels in the company hierarchy. The results are presented in the following subsections.

5.1. Evaluation via selected indicators
The first indicator is the trend of savings obtained by the company thanks to the Kaizen system. The chart (figure 1) shows the estimated annual savings that the company obtained thanks to the Kaizen policy in a given year. Kaizen's policy has been conducted in the company since 2006. Until 2012, the company recorded profits thanks to the Kaizen system, but there was no visible growth trend in the savings accumulated thanks to the employees' ideas, in 2011 there was even a drop. The increase in the estimated savings from 2013 was caused by the change of the Kaizen database - at the end of 2011, it was decided to replace the traditional paper database with an electronic database. The implementation of this solution resulted in a better flow of information and a shorter implementation time of ideas, which resulted in an increase in the number of valid applications submitted, and thus in an increase in the company's savings. Kaizen ideas from many categories were decisive for financial savings, ranging from those that eliminate waste, to those that improve machine performance indicators, quality and work organization.

Figure 1. Estimated savings obtained thanks to the Kaizen system.

The OEE indicator in the surveyed company has been at a high level for many years. Its change depends on many components, such as the quality or cycle of the machines. The failure of machines, which can be expressed by the DTR indicator, also has an impact on the OEE indicator. Figure 2 shows a graph of changes in the OEE indicator in 2009-2015. Growth trend is visible, but the changes are small. Some of the Kaizen ideas implemented in the company contributed to the improvement of
this indicator. They concerned, among others, the elimination of idle movements of machines, as well as the improvement of the tact of the machine's work cycle.

![Graph of OEE indicator in specific years of the Kaizen system operation.](image)

**Figure 2.** OEE indicator in specific years of the Kaizen system operation.

The DTR (Downtime Ratio) indicator is an indicator showing the time of machine failures in relation to the available time. Figure 3 shows the time of machine failures in 2009-2015 in percentage terms. It is clearly visible that in 2015, machine failure rates were three times lower than in 2009. This situation is the result of the implementation of many Kaizen ideas regarding the use of machines, prevention of failures, or faster and more effective machine repairs. The company pays a lot of attention to keeping the machines in good condition, which helps to eliminate the number of failures occurring during production. The plant has implemented over a dozen Kaizen improvements regarding TPM, in particular machine maintenance. An example of another type of improvement that improved the DTR indicator was the change in the mounting of machine cover elements - instead of bolts, latches were used, which significantly shortened the time of reparation.

![Graph of DTR in the example company.](image)

**Figure 3.** DTR in the example company.
The employees' involvement in the Kaizen system is presented in a graph showing the number of applications submitted by them (figure 4). The chart also presents the number of ideas that have been implemented and their percentage share in all ideas submitted.

![Graph showing number of submitted and implemented Kaizen applications](image)

**Figure 4.** The number of submitted and implemented Kaizen applications.

The Kaizen system has been well received by the employees from the very beginning of its operation. In the first year of implementation, there was quite a large inflow of ideas aimed at improving the company, but only a part of them was fit for implementation. In the following year, an even greater inflow of applications was noted, and the percentage of applications implemented was also improved. In the following years, until 2011, the interest in the system weakened somewhat. The number of folded ideas and their quality dropped because a large part of them was rejected. After 2011, interest in the system revived. This change in the database could have an impact on this. Systematically from 2012 the number of applications completed has also increased. In 2015, 66% of submitted applications were implemented, which could have been influenced by a better understanding of the Kaizen philosophy, which has been present in the company for a long time. To increase the relevance of ideas could also contribute to the employee training program, which allowed them to acquire more knowledge about the issues they meet on a daily basis at work and a better understanding of the production process.

5.2. **Assessment of the Kaizen system through surveys conducted among employees**

The survey was conducted on a group of 35 employees. Its purpose was to get to know employees' opinions regarding the Kaizen system in operation. The first part of the survey contained the characteristics of the respondents. The questions concerned the length of employment in the company and the position held. The second part concerned the employees' opinion on the usefulness of the Kaizen system in the company, motivation of employees to submit ideas, motivation system and attractiveness of the company using Kaizen-based management.

The analysis of the results showed that the majority of operators and all employees in the SL position believe that Kaizen's policy is needed in companies. There was no correlation between the position and the recognition of Kaizen's policy as needed or unnecessary in the company. About half of the employees have several or a dozen or so applications developed. 11% of employees recognize that they often develop new Kaizen proposals, the largest group (37%) develops them sometimes. At
least half of the company's employees can be expected to work for the company good in the form of new Kaizen applications.

The survey shows, that the reason for working on the Kaizen applications in the vast majority stems from willingness to get a cash reward. Applications are more often developed for personal satisfaction by employees at the SL position, than at the operator's position. Among employees at the SL position, the main motivation is the desire to get a monetary reward, potential satisfaction and higher assessment of work by the supervisor. Among the operators there are similar motives as among employees in the SL position, but it is also declared to facilitate their work, catch up with other employees and the desire to gain recognition of the employer or participation in the development of the plant. Over 80% of employees of the company recognize that the frequency of applications by employees would be lower if the company did not reward them in cash. This indicates that the main motivation of almost all employees to develop ideas to improve the company are cash rewards. Employees of the company in the absence of financial motivation are not likely to work on new ideas only for company development or satisfaction.

6. Conclusion
On the basis of indicators examined and surveys conducted, it can be concluded that the implementation of the Kaizen system in the example company was successful. However, the motives of the company's employees differ from the original Japanese design. The Kaizen system should prevail with the motives of satisfaction and willingness to participate in the development of the plant. Polish employees of example company are counting on cash prizes and a higher assessment of work by superiors, which translates into increases and additions to salaries. High commitment of employees is one of the fundamental goals of the Kaizen system. Contributing to this was the management, which supported employees in implementing the system as well as ideas. An important role was also played by the motivation system that met employees' expectations.

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