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ORIGINAL PAPER

THE IMPLEMENTATION OF THE KAIZEN SYSTEM FOR MANUFACTURING ENTERPRISES QUALITY MANAGEMENT

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Abstract. The article discusses the theoretical, methodological and practice aspects of quality management in a manufacturing enterprise, presents the results of an analysis of the costs of quality management. The relevance of the study is due to the modern business conditions among the owners of manufacturing enterprises associated with the production of products at the lowest cost and the highest profit, regardless of the quality of the products. This situation has negative consequences for all participants in the production process, since it contributes to the weakening of the manufacturing sector as a whole; negatively affects product manufacturers in terms of reducing their competitiveness; and increases the number of end consumers of products dissatisfied with its quality. The purpose of the study is to analyze the costs of continuous improvement of the quality management system of manufacturing enterprises that contribute to the growth and development of industries and increase their competitiveness in the world market. Kaizen is used as a methodology, its main principles and types, the benefits that an enterprise receives when using this method are described. The results of the analysis of the possibilities of using the Kaizen methodology in production and its role in reducing the cost of quality in manufacturing enterprises are presented. The authors conducted a study of the proposed methodology to reduce the costs associated with defective products, showed the most important results and made some recommendations to detect suspicious results and reduce quality costs. The paper emphasizes the importance of applying the Kaizen methodology in the activities of manufacturing enterprises on the example of the object of study – the General Company of the Tire Industry in the Iraqi city of An-Najaf.

Keywords: Kaizen, manufacturing enterprises, quality costs, quality management

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ОРИГИНАЛЬНАЯ СТАТЬЯ

ВНЕДРЕНИЕ СИСТЕМЫ КАЙДЗЕН ДЛЯ УПРАВЛЕНИЯ КАЧЕСТВОМ НА ПРОИЗВОДСТВЕННЫХ ПРЕДПРИЯТИЯХ

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Аннотация. В статье исследуются теоретико-методологические и практические аспекты управления качеством на производственных предприятиях; представлены результаты анализа затрат на управление качеством. Актуальность исследования обусловлена современными условиями хозяйствования, в которых владельцы бизнеса заинтересованы в производстве продукции с минимальными затратами и максимальной прибылью вне зависимости от достигнутого качества выпускаемой продукции. Данная ситуация имеет негативные последствия для всех участников производственного процесса, поскольку способствует ослаблению производственного сектора в целом, отрицательно влияет на производителей продукции в вопросах снижения их конкурентоспособности, увеличивает количество конечных потребителей продукции, неудовлетворенных ее качеством. Целью исследования является анализ затрат на постоянное совершенствование системы менеджмента качества производственных предприятий, способствующих росту и развитию отраслей промышленности и повышению их конкурентоспособности на мировом рынке. В качестве методологии используется философия Кайдзен; описываются ее основные принципы и виды, преимущества, которые получает предприятие при использовании данной практики. Представлены результаты анализа возможностей использования методологии Кайдзен в производстве и ее роли в снижении затрат на управление качеством производственных предприятий. Авторами проведено исследование предложенной методологии в отношении снижения затрат, связанных с бракованной продукцией, представлены наиболее важные результаты и даны некоторые рекомендации, касающиеся методов постоянного улучшения и их роли в снижении затрат на качество. Подчеркивается важность применения методологии Кайдзен в деятельности производственных предприятий на примере объекта исследования – General Company of the Tire Industry в г. Эн-Наджаф (Ирак).

Ключевые слова: Кайдзен, производственные предприятия, затраты на качество, управление качеством

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Introduction

The purpose of this study is to analyze the costs for continuous improvement of the quality management system of manufacturing enterprises, which will lead to a change in the enter-

prise owners' way of thinking in matters of their focus on quality, and their conviction that the application of continuous improvement of quality management methods in order to saving production costs will promote the growth and development and

development of local industries and their competition in the world market.

The importance of the research stems from trying to reduce operating costs by reducing defective production by applying improvement methodologies, which leads to an increase in the volume of profits and is reflected in competitiveness, in addition to studying the costs involved in following quality in any facility and trying to reduce them to a minimum by following some of the methods of continuous improvement.

Kaizen is used as a main methodology of this research [1].

Let us highlight basic principles of Kaizen [2-4]:

- 1) improvement has no end, as it is continuous as long as the facility exists, and it is one of the requirements for its existence;
- 2) continuous improvement is a comprehensive process;
- 3) improvement processes need the efforts of everyone who works in the facility;
- 4) the absence of errors does not mean that there is no need for improvement;
- 5) exploiting the time to be ahead of the competitors and to be the first.

Kaizen objectives are:

- 1) reducing costs by constantly reducing the costs of activities that do not add value, reduce waste and improve;
- 2) continuously improving quality for various reasons, either because of intense competition in the markets, complaints from customers or the desire to increase sales;
- 3) customer satisfaction, where the importance of the customer and the necessity of achieving his requirements as well as retaining existing customers and attracting new customers to strengthen the relationship with him.

Let us highlight the five basic elements of Kaizen methodology [5, 6]:

- 1) the work teams;
- 2) personal discipline;
- 3) high morale;
- 4) quality circles;
- 5) suggestions for improvement.

Methodologies used in applying Kaizen:

To implement Kaizen, several methodologies are used, but the most important and most famous are the following two methods:

- 1 Method – 5S Methodology (it is also called the five steps of Kaizen application), which means the following steps [7, 8]:

1.1 Liquidation (it means to do the following):

- separation of essential and non-essential things;
- getting rid of unnecessary things;
- classifying the necessary things according to the frequency of their use.

1.2 Keeping the necessary things that were kept organized and tidy, allocating a place for each of them, and keeping everything in its allotted place in order to achieve the following requirements:

- ease of extraction of things;
- ease of use;
- ease of returning to the same place.

1.3 Cleaning (it aims to keep the workplace, tools and all items clean, free from waste and foreign materials). Cleaning is linked to inspection and examination processes to ensure that cleanliness is maintained and each must do the following:

- constant examination of all things;
- maintaining cleanliness in the workplace clearly.

1.4 Standardization (Standardization of work methods). It means maintenance of all the above. Standardization of work methods is related to providing and developing the means and tools that enable everyone in the workplace to perform the correct work in the same way and setting evaluation methods according to the required standards. This can be applied through:

- developing clear and understandable work instructions;
- putting the evaluation elements in accordance with the required standards;
- putting indicators of boundaries that should not be crossed in the form of a question and answer.

1.5 Training and discipline. The goal of training and discipline is to arrange and make work with the previous four items as a habit in human behavior, so that all employees in the company abide by the laws, regulations and work instructions and implement them correctly and effectively. When workers do not perform their work properly, this means that they did not receive adequate training or did not realize the importance of their work and the damages that may result from their neglect of work instructions. Therefore, the training must be repeated until the workers reach the level of understanding and persuasion that makes the work environment a healthy one of cooperation [9, 10].

2 Method – Edward Deming's P.D.C.A Quartet. It includes the following elements [11, 12]:

- planning (defining the problem or subject of change);
- performance (finding the solution to the problem);
- auditing (testing the feasibility of the solution);
- application (application of the solution after studying its feasibility).

Each of the previous steps contains a lot of actions and details and requires a work team or group of work teams to perform.

In this research we applied the Kaizen method through some simple improvements that he made in the factory, which led to a noticeable improvement in the cost of quality. These results will also be discussed and some recommendations will be given that help improve the cost of quality when applying the Kaizen method in continuous improvement.

Results and Discussion

At the beginning of the study some information will be presented about the object of the research – General Company for the Tire Industry in the Iraqi city of Najaf. The company is located in the Najaf governorate in the State of Iraq. The company produces and manufactures tires and tubes of various sizes and types, in addition to rubber products of both natural and industrial types, in accordance with the approved specifications. The main objective of the project is to produce modern tires that keep pace with scientific development in order to meet the local need of tires and of the radial type with a capacity of two million tires annually, subject to increase when needed and of various sizes to suit both saloon cars, light loads, agricultural tractors and other vehicles, as the plan was Exporting the surplus and the excess of the need to neighboring countries and in all the volumes that are produced.

When studying the needs of the Iraqi local market, a great demand was noted for rubber parts for special uses for some public and private industrial companies. As a result, the rubber goods production unit was purchased, installed, and operated, until the factory produces the following products: bicycle tires; bicycle tire tubes; pipes made of low-density polyethylene; rubber belts for cars; rubber hoses for cars; rubber goods.

As a result of the analysis of the accounting system approved in the company, the following was revealed:

- the company was unable to reach its target or planned output during this year for all products, as sales rates are reported to range from 14% for rubber products to 34% for recycled rubber;
- achieved reduction in production rates across all products compared to design and available capacity, as rates fluctuated within 10%, 23%, 12% and 38% respectively;
- the target capacity for bio recycled rubber is 509 tons per year, which exceeds the available capacity of 450 tons per year, an expected increase of 59 tons;
- it is also noted that the production of tubes for car tires was not planned due to the lack of economic feasibility of their production, as indicated in the management report and the company's planning letter.

As a result of the analysis of the marketing plan approved in the company, the following was revealed: the company was unable to achieve its marketing plan for all products, and the implementation rates ranged between 13% and 36%. We also note that there is damage to all products within 10%, while the standard ratio is 4%, which means that there is an excess in the percentage of damage up to 6%.

The results of the analysis of the marketing plan approved in the company can be obtained with 2 documents:

- 1) List of current operations – a statement of current operations is prepared for the purpose of arriving at the net current operations of profit or loss during monthly, quarterly or annual periods, as it is prepared by the cost accountant in addition to the planned profit for the same period and the actual for a previous period, in order to conduct comparison and analysis and to know the extent of development or improvement in the progress of the company's work at the planned level on the one hand, and to see the extent to which performance has improved from one period to another on the other.
- 2) Production cost statement – it provides a detailed report on the products manufactured by the company during the period studied. This statement also includes the fixed and variable costs for each product separately, as these data are obtained from the trial balance in addition to the quantitative reports received from the production departments and stores.

As for the reserve materials and other expenses, they represent the total expenses of the spare materials and others distributed according to the weight of the products. The Kaizen method is directed towards cost reduction by focusing on the variable industrial costs represented by direct materials, direct labor, and variable indirect industrial costs.

The following results of the cost analysis were obtained:

- 1) Direct materials. They are rubber, plastic, and other materials, and each of these materials is found by weight, and it can be traced, diagnosed, and identified easily relative to the product unit as it is directly involved in the product.
- 2) Direct wages. It is the cost of the wage workers who work on the machine directly, given that these wages are related to the cost of production, but the cost of the employed worker is considered fixed costs because they are paid in the form of salaries, and therefore we have two types of wages offered to workers, which are direct and indirect and with the aim of making a budget Kaizen for direct work. The average hourly wage for each production stage will be dealt with separately.
- 3) Indirect industrial costs are variable: they are represent-

ed by secondary materials such as linen threads, spare tools, and other expenses. A budget can be made to reduce costs using the Kaizen method by using the improvement methodology in each element of variable costs, according to the available and available capabilities in addition to the suggestions that can occur. When adopting Kaizen by senior management, despite the presence of many improvement opportunities that can be exploited to improve the company's position and reduce costs.

- 4) When conducting a comprehensive study of the previous investigation, several things become clear, including:
 - it is possible to benefit from the previous disclosure in planning for the future, in addition to developing production plans to absorb the required costs and then analyzing them with the aim of reducing them to a minimum;
 - giving a detailed view of the products and their production costs, which leads to a significant benefit in pricing the products in addition to reducing the inventory when prepared in a sound and fair manner;
 - obtained results are useful in making comparisons and evaluating the performance of production cost centers and production service centers, which leads to improved control and auditing.

According to the goals of the study, the following results were obtained, which are necessary to improve the quality of the company's products using the Kaizen method. In general, the company does not have accurate and detailed information that can be directly adopted for quality improvement using the Kaizen method (there is the availability of general or generalized information, also, some of this information may not be ready for use due to the company's disinterest in this).

Considering the fact that the adoption of the Kaizen method requires first of all the support and faith of top management to provide such information, in addition to securing accountants who work on detailing its implementation by measuring, analyzing and translating current operations in financial and non-financial form, since the information, that can be provided and that is related to quality and improvement within Kaizen, includes information on the costs and benefits of quality in the company:

- 1 Quality costs. It is noted in the company that the quality costs have risen significantly due to the increase in the cost resulting from defective or damaged products during the production process, in addition to the failure to use the Kaizen method to reduce defects and damage in the company by developing a plan to reduce these defects or re-examining the process to find out the defect in the production process.
- 2 Evaluation costs. These are costs resulting from the examination of received materials and sales inspection in addition to product tests, for which the total amount in 2009 was approximately 150.255.000 dinars, where it was found that this amount was divided as follows:
 - 2.1 The costs of examining the received materials: the costs of the wages and salaries of the workers responsible for examining the raw materials that were supplied from the suppliers, as these wages and salaries amounted to about 15.105.000 dinars, and they are in the form of a committee composed of a number of individuals whose tasks are to inspect the raw materials represented by rubber and plastic, in addition to sorting it according to quality into excellent, first class and second class, and then each degree is priced at a certain price, and there-

fore this committee is the most important point of examination in the facility because it inspects the quality of inputs and often such committees fall into unaccredited errors through the difference in the division and change of grades And the qualities from first to excellent or from second to first.

- 2.2 Product inspection costs: These are the costs of product inspection during the production process in addition to the costs of checking sales, which amounted to 125.300.000 dinars, where the task is to discover defects and damage at each stage of production, in addition to preparing statements that show the quantities of damaged and defective at the end of each stage and from Then it is sent to the cost accounting department for pricing.
- 2.3 Product testing cost: They are chemists who examine and test the quality of the product at each stage and give the product quality rate. These costs amounted to 9.850.000 dinars.
- 3 Internal failure costs. These costs are represented in the company by exhaust costs, as it has been noted that there is a defective percentage of damage and exhaust at each production stage and the amount of this waste is a percentage of the total input, as for rubber it has been noted that the percentage of damage has reached approximately 10% in 2009, the total amount of rubber used was 170.000 kg and the damaged rubber amounted to about 17.000 kg. As for the non-financial costs of quality, it can be noted and recorded the number of defects for each production stage, as well as the ratio of good outputs to the total outputs. As for the manufacturing period, the conversion of raw materials into a final product amounted to 375 kg/hour. On the other hand, it was found that there are recurrent costs due to low quality, represented by a 30% lower selling price than the cost, in addition to the presence of a stagnant and unsold production quantity that the company is forced to sell at discounted prices in the markets and auctions.
- 4 Quality revenue: Because of the low level of quality in most of the company's products, which led to it incurring financial and non-financial quality costs. As for the company's high-quality products (car tires), it has led to higher and improved financial quality revenues through the increasing number of customers and consumers of this product, this led to the expansion of its market space. There are also non-financial revenues for quality, represented by increasing the experience and skill of production planners, which led to the production of al-

most similar tires.

This information was displayed to improve quality of the production and it requires arranging this information according to the importance of each defect or damage in terms of its significant impact on quality. These defects and damaged ones are also reduced and treated to prevent their reoccurrence in the future by developing an annual or monthly plan to reduce emissions and improve quality, in addition to improving quality. This can be done by choosing a competitive company in the market, a production line in the same company, or a worker in the same line with high efficiency and skill, resulting in a positive reflection of product quality, in addition to reducing damage and defects in production, and makes this factor some balance that is being carried out. Comparisons with other workers can make it a good incentive to push workers on the same production line or other production lines to improve product quality and reduce scrap and emissions in addition to reducing the time needed to produce for each step. This process requires constant support and trust from management.

The results of the analysis of reporting according to the Kaizen methodology.

This information should always be reported and sent to senior management for management to remain.

Companies' budgets are divided into specific periods, such as quarterly or monthly. They are also based on the study and analysis of all kaizen accounting information and the development of proposals that help. On the other hand, suggestions made by employees are considered, as the top management provided the necessary support and motivation to implement this method in the company. On the other hand, it is necessary to convince employees of the importance of the success of the Kaizen method by spreading the spirit of ownership among the company's employees and raising their awareness of the importance of current product costs lower than in previous years, in order to continue the company's operation and increase its profits, which will lead to the continuation of their work in it and achieve profit for them, including through a system of incentives and rewards. These budgets take many forms as they differ depending on the materials studied. For example, for direct materials: where is the budget for direct raw materials and how to reduce their cost by using machines and equipment for the production and manufacture of tires that are better than previously used machines, in addition to focusing on the raw materials involved in production and their compliance technical conditions.

Table 1 shows the company's budget. Regarding direct wages: because of the interview with officials and technicians in the production departments, improvement rates in production time were set at a rate of 1.5%.

Table 1 / Таблица 1

The Results of Applying the Kaizen Methodology to Reduce the Direct Material Costs of the Enterprise / Результаты применения методологии Кайдзен для снижения прямых материальных затрат предприятия

Period / Период	Percentage of Decreasing of Costs / Процент снижения затрат	Raw Materials Costs / Затраты на сырье	Method of Implementation to Get the Decreasing of the Costs / Метод реализации, позволяющий снизить затраты
First quarter of the year of study	1%	691.7	1 – Replacing the current tire making machine with a newer one. 2 – Focusing on plastic and rubber in production, which can be imported from abroad at competitive prices. 3 – Careful examination of the raw materials entering.
Second quarter of the year of study	1%	792.9	
Third quarter of the year of study	2%	618.2	
Fourth quarter of the year of study	2%	518.5	

Source: compiled by the authors based on the results of the study / Источник: получено авторами по результатам исследования

On this basis, the budget for direct wages was shown in the *Table 2*.

As for the variable indirect industrial costs: when thinking about setting a budget for the facility as a whole and for each

material, it was found that the indirect variable costs for each material are the spare tools and other expenses. Results of applying Kaizen methodology for variable indirect industrial costs are shown in the *Table 3*.

Table 2 / Таблица 2

Budgeting Using the Kaizen Methodology to Increase Production in Production Departments / Бюджетирование с применением методологии Кайдзен для увеличения производства в производственных отделах

Period / Период	Percentage of Production Increasing / Процент увеличения производства	Method of Implementation to Get the Production Increasing / Метод реализации, позволяющий увеличить производство
First quarter of the year of study	5.07%	1 – Renewing the oversight of machine workers to follow up on production directly. 2 – Calculating the incentives for workers with higher production to push the rest to improve production. 3 – Maintaining existing machines and repairing broken ones.
Second quarter of the year of study	5.15%	
Third quarter of the year of study	5.2%	
Fourth quarter of the year of study	5.3%	

Source: compiled by the authors based on the results of the study / Источник: получено авторами по результатам исследования

Table 3 / Таблица 3

Analyzing Spare Equipment Costs Using the Kaizen Methodology / Анализ затрат на запасное оборудование с помощью методологии Кайдзен

Period / Период	Percentage of Production Increasing / Процент увеличения производства	Method of Implementation to Get the Production Increasing / Метод реализации, позволяющий увеличить производство
First quarter of the year of study	45.3%	Importing the original reserve materials from abroad with higher efficiency and effectiveness than the materials manufactured internally
Second quarter of the year of study	44.6%	
Third quarter of the year of study	43.9%	
Fourth quarter of the year of study	43.3%	

Source: compiled by the authors based on the results of the study / Источник: получено авторами по результатам исследования

Conclusion

After research, several conclusions were drawn concerning the results of the situation before and after the implementation of the Kaizen methodology in the enterprise.

Before applying Kaizen methodology, the following results were obtained.

Rubber: defective percentage = 10%.

The percentage of accuracy in operations = 90%.

There is a 30% sales price decrease due to reclassification of idle and unsold products.

Number of defects per million opportunities = 100.000.

Production costs = 510952 Iraqi Dinar.

After applying Kaizen methodology, the following results were obtained.

Rubber: defective percentage = 7%.

The percentage of accuracy in operations = 93%.

Number of defects per million opportunities = 70000.

Production costs = 25547.6 Iraqi Dinar.

As a result, a decrease in production costs when applying the Kaizen methodology by 5%, as the costs before the application were 510952 Iraqi dinars, while the costs after application became 25547.6, and thus savings accrued to the company by 485404.4 dinars during the study period.

According to the results of the previous study, we recommend the following:

- urging production and service companies and establishments to follow methods of continuous improvement due to their importance and their great role in reducing costs;
- when thinking about applying one of the methods of

continuous improvement, it must be considered that the reduction in costs will not be direct and fast, but rather it takes time for the results to appear.

Summarizing the above, we conclude that the Kaizen method for implementation in any manufacturing enterprise requires that the top management believe in this method and apply it, because it is the top management that orders, directs, and plans the goals of Kaizen. In addition, top management must support everyone, not just workers, to only offer suggestions and improvements.

Rather, the objectives of the enterprise should be expanded to support the quality team, whose task it is to plan for this method, define goals and create an appropriate structure to achieve these goals, in addition to supporting Kaizen accounting information producers.

This is necessary because this information is the basis for the implementation and placement of the method in production lines, and accountants should respond to this support by examining and detailing all relevant accounting information that can be accepted and used to maintain this method in accordance with the location, classification and distribution, and then convey this information in the form of reports or graphs, so that it can be understood and accepted by senior management, finding appropriate factors to reduce costs and providing appropriate information based on the adoption of Kaizen and determining the quality and role of this information received.

Cost reduction at any professional stage of the production of the enterprise and for any kind of cost and quality improvement is translated into a financial side, and the top man-

agement is informed and informed, showing the benefits of the Kaizen methodology in improving the operation of the enterprise.

Authors' Contribution

The authors have made an equal contribution to the research. Fatema Fakhro collected and analyzed the research material, studied the activities of the enterprise. Christina V. Drokina carried out work to determine the goals and objectives of the study, systematize and scientifically substantiate the results obtained.

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