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Pareto and Ishikawa Diagrams for Identifying the Causes of Defects in Poultry Meat

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Abstract

Food safety and quality are fundamental factors in production efficiency. Therefore, identifying and preventing manufacturing defects is becoming an integral part of quality management in manufacturing. Statistical control methods allow you to choose the scope and direction of quality management objectively. Thanks to statistical control methods, it is possible to identify defects in all product life cycles and, before the goods enter the market, improve quality and increase their competitiveness. The Ishikawa diagram, or cause-effect diagram, allows you to link problems to potential causes of errors and depict this relationship graphically. A Pareto diagram is a tool that will enable distributing efforts to resolve emerging issues and identify the main reasons to start acting. Using both diagrams made it possible to explain the leading causes of defects encountered and develop recommendations for reducing rejects and improving the quality of products.

Disciplinary: Food Science (Food Safety, Meat Products), Veterinary and Agriculture.

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1 Introduction

Poultry farming is currently the only successfully functioning livestock sector that can stabilize and improve the country's meat market. Compared to other livestock sectors, poultry farming during the transition period showed greater flexibility and survival, retained a significant part of its production potential, and reduced production volumes to a lesser extent (Zheng et al., 2021).

The goal of the agricultural policy at the present stage is measured to ensure the country's food security. Currently, there is a problem of increasing the competitiveness and efficiency of poultry meat production (Vysochyna et al., 2020). It includes decrease costs per unit of production, using deep processing, ensuring sustainably expanded reproduction, and intensive and industry growth main tools that increase the compliance of products with technical requirements and at the same time provide for containing the growth of costs for enterprise management. Along with all of the ways can use statistical methods (Omarkhanova et al., 2019). The task of statistical control methods is to provide the market with safe products and services at the lowest cost. One of the basic principles of quality control using statistical methods is the desire to improve the quality of products by exercising power at various stages of the production process (Amrina and Firmansyah, 2019).

The Ishikawa diagram, or cause-effect diagram, allows you to link problems to potential causes of errors and depict this relationship graphically (de Moraes et al., 2020). An Ishikawa diagram can be constructed as follows:

- a potential or existing problem that needs to be resolved is identified;

- the key categories of reasons influencing the problem under study are indicated. The number of categories may vary depending on the problem at hand. Typically, five or six categories from the above list are used (person, working methods, machinery, material, control, environment);

- oblique lines are drawn from the names of each of the categories of causes to the centerline. They will be the main "branches" of the Ishikawa diagram;

- the causes of the problem identified during the "brainstorming" are distributed according to the established categories and are indicated on the diagram in the form of "branches" adjacent to the main "branches";

- the most significant reasons influencing the problem under study are identified (Hisprastin and Musfiroh, 2021).

A Pareto diagram is a tool that allows you to distribute efforts to resolve emerging problems and identify the main reasons from which to start acting (Vanany et al., 2020). For determining the most significant parameters affecting the process, the so-called ABC analysis is used, in which,

according to the 20-80% rule, the working zone of the abscissa axis is divided into three zones: zone A - the most significant influence, which is approximately 20% of the total number of parameters under consideration, including "other"; zone B - intermediate, which is about 20% of the parameters remaining after the selection of zone A; and zone C is the least affected (Jesujoba and Adenike, 2021).

ABC analysis can be carried out in the form of the Lorentz and Pareto curves (Rynkiewicz and Witkowska, 2019). Such a breakdown allows you to identify those parameters that should be paid attention to and take measures to improve the process and those parameters that can be excluded from consideration in the issue of improving the process because of their insignificant effect on the process (Cao et al., 2020; Miyagawa and Adachi, 2019).

When building a Pareto diagram, you need to perform several actions:

- identify the problem to be solved; take into account all the factors (signs) related to the problem under study;

- to identify the root causes that create the most significant difficulties, to collect data and systematization on them;

- build a Pareto diagram, which objectively represents the actual state of affairs in an understandable and visual form;

- analyze the Pareto diagram (Krehbiel, 2020).

The paper analyzes the causes of inconsistencies that harm poultry meat quality, using the Ishikawa and Pareto diagrams.

2 Materials and Methods

The paper analyzes the causes of inconsistencies that harm poultry meat quality, using the Ishikawa and Pareto diagrams.

As the product defects had designated the dislocation in the joint, bruising, feather stump on the carcass, fracture of a limb with a bared bone, fracture of a limb without a bared bone, rupture of the skin, abrasion on the carcasses, punctate bleeding, and scratch on the carcass. And also were determining the factors leading to these defects. There was using the checklist to register the types of defects. The products batch delivered to stores and made to order contained 400 broiler carcasses. The average weight of the minimum batch was 800 kg.

The accumulated sum of the defects number is finding as the sum of the previous number of defects and the subsequent number of defects, i.e., the cumulative sum of the number of defects is the cumulative sum of all defects. Next, calculate the percentage of the number of defects for each feature using

$$P = \frac{n}{\sum_{i=1}^{n} x_i} 100\% \quad (1),$$

Where

P – the percentage of defects of a specific type;

n – number of defects of a specific type;

x_i – the value of the total number of defects.

The calculated percentage of the number of defects for each feature to the total amount is needed to calculate further the accumulated percentage of the number of defects ($P_н$).

3 Result and Discussion

Analyzing the causes of inconsistencies made it possible to expand the presentation of the main reasons using a causal diagram (see Figure 1).

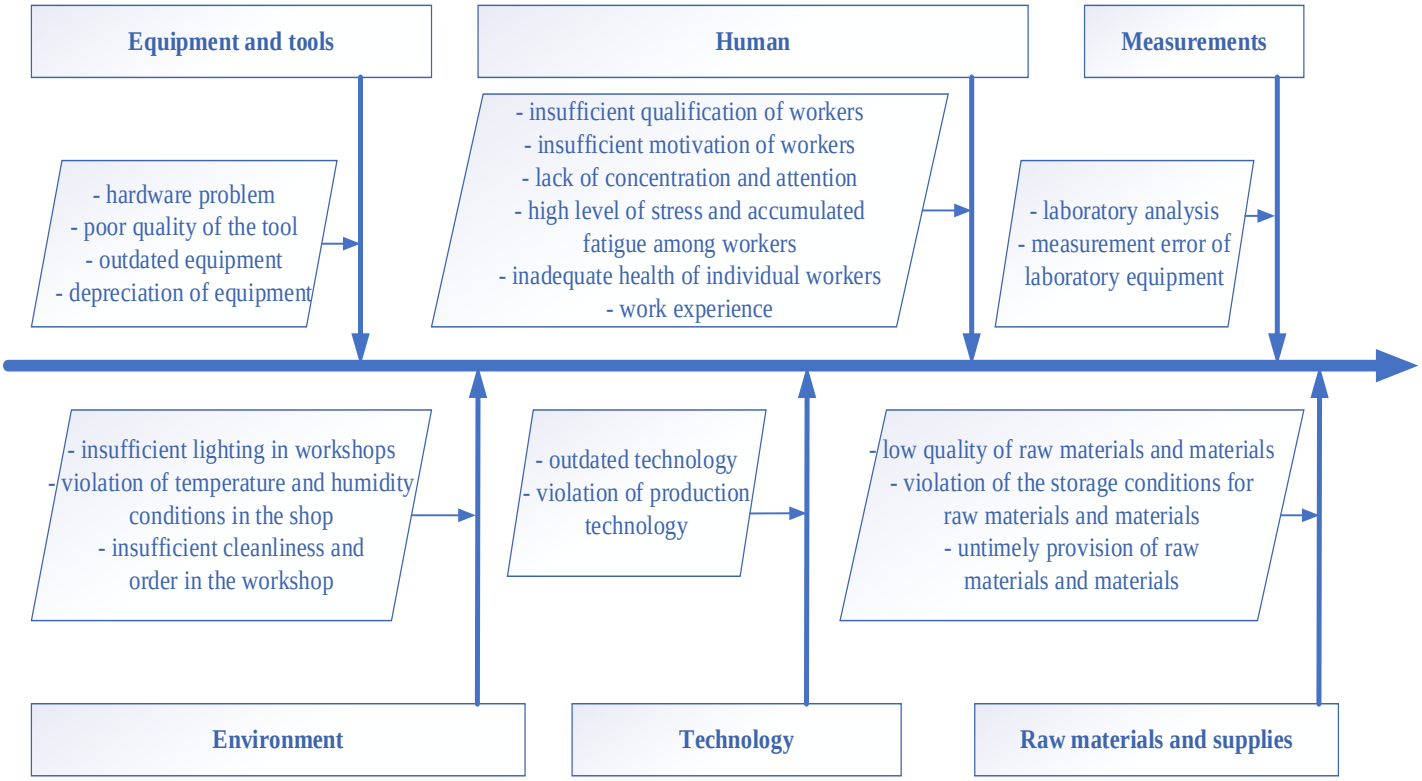

Figure 1: Causal diagram of finished product scrap

Human:

The most common reason for the defect at an enterprise is the fault of the personnel: insufficient qualifications of workers; insufficient motivation of workers; lack of focus and attention; high levels of stress and accumulated fatigue among workers; poor health of individual workers, work experience. That is, a simple human factor as a whole affects the competitiveness of an enterprise.

Measurements:

Laboratory analysis; measurement error of laboratory equipment

Errors in laboratory control: a mistake in choosing a method for assessing the quality of raw materials; inaccuracies in measuring laboratory equipment. To prevent inconsistencies in raw

materials and products management, it is necessary to hire only motivated and highly qualified specialists with work experience.

Environment:

Insufficient lighting in workshops; violation of the temperature and humidity conditions in the shop; lack of cleanliness and order in the workshop. Creating a comfortable working environment will be of great importance in increasing labor productivity and reducing manufacturing defects.

Technology:

Outdated technology; violation of production technology.

The company must never forget that the use of innovations often contributes to the intensification of technological processes, increased efficiency and improved quality of finished products, and more rational use of raw materials.

Raw Materials and Supply Materials:

Poor quality of raw materials and supplies; violation of the storage conditions for raw materials and materials; untimely provision of raw materials and materials - all these factors will negatively affect the quality of products.

A checklist was used to register the types of defects. The checklist for assessing the quality of poultry meat for the month is on the Table. 1.

Table 1: Checklist for the registration of defects in poultry carcasses

Defect type	Number of defects
Fractures	610
Poor bleeding	324
Poor cut	42
Skin breaks	18
Other	6
Total	1000

The accumulated sum of the number of factors was found as the sum of the last number of the factor. Therefore, the following number of elements, i.e., the accumulated sum of the number of factors, is the cumulative sum of all aspects. Next, we calculate the percentage of the number of factors for each attribute. Then, the calculated percentage of the number of factors for each point to the total amount is needed to calculate the accumulated percentage of the number of factors. Finally, based on the data obtained, there was compile Table 2.

Table 2: Data for constructing a Pareto diagram by type of discrepancy

Defect type	Number of defects, pcs.	The accumulated amount of defects number, pcs.	Defects percentage, %	Cumulative percentage of defects, %
Fractures	610	610	61.0	61.00
Poor bleeding	324	934	32.4	93.40
Poor cut	42	976	4.20	97.60
Skin breaks	18	994	1.80	99.40
Other	6	1000	0.60	100
Total	1000			

According to Table 2, build a Pareto diagram with a cumulative curve - the Lawrence curve. For example, the Pareto diagram for the analysis of defects in poultry carcasses by types of nonconformities is in Figure 2.

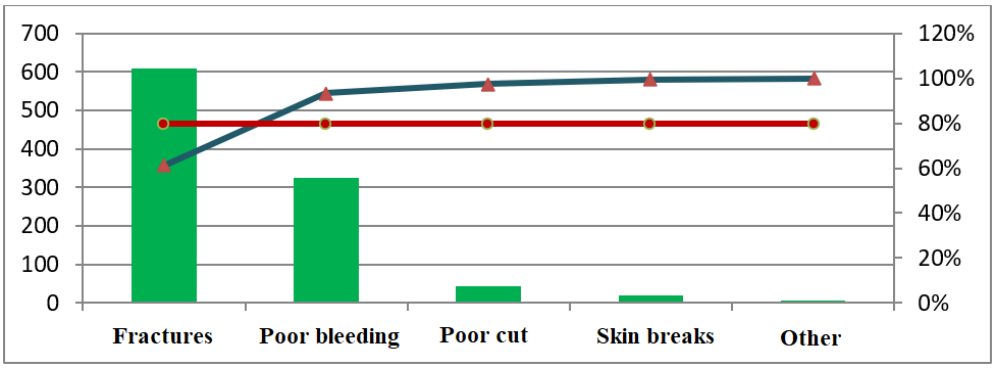

Figure 2: Pareto Chart by Type of Nonconformity

For the presented Pareto diagram, the "ABC-analysis" was applied. The graph shows that group A includes defects: fractures and poor exsanguination. These are the most significant defects that the company needs to pay attention to and eliminate. In total, they account for 93.4% of scrap.

Group B includes poor-quality incisions and skin breaks. In total, these types of defects account for 6% of rejects. Group C has other kinds of defects. In total, they give 0.6% of marriage. These are the most insignificant defects identified using the "ABC-analysis."

Let's build a Pareto chart for reasons of inconsistencies. For this, we use the data in Table 3.

Table 3: Data for building a Pareto diagram for reasons of inconsistencies

Reasons for the discrepancy	Number of defects, pcs.	The accumulated amount of defects number, pcs.	Defects percentage, %	Cumulative percentage of defects, %
Staff	980	980	67.0	67
Equipment	380	1360	25.83	92
Raw materials	96	1456	6.53	99
Other	15	1471	1.02	100
Total	1471			

Table 3 shows a Pareto diagram with a cumulative curve - the Lawrence curve. The Pareto diagram for the analysis of defects in poultry carcasses due to nonconformities is in Figure 3.

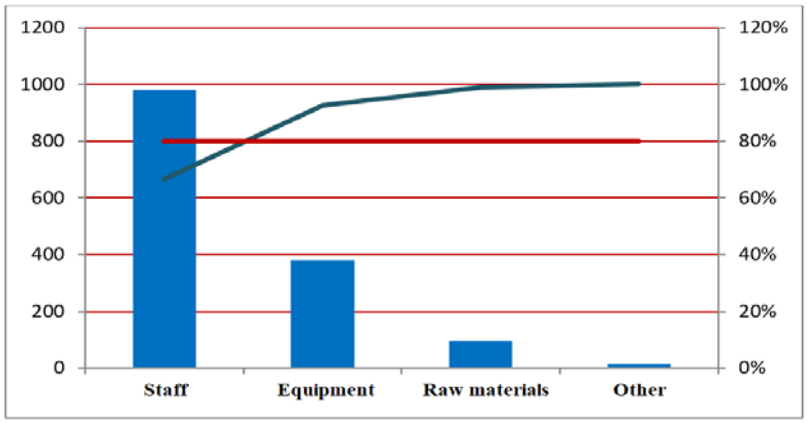

Figure 3: Pareto Chart for Mismatch Reasons.

From the Pareto chart, for reasons of inconsistencies, it can be seen that 3 main reasons lead to these types of inconsistencies (personnel, equipment, raw materials). Consequently, the development of recommendations to eliminate these causes is a priority task in achieving the overall goal - to ensure the quality of the production process.

Consequently, the development of recommendations to eliminate these causes should be based on a joint analysis of products' types and causes of nonconformity. This will make it possible to timely detect deviations from the established requirements, promptly identify and eliminate the reasons for the decline in product quality, preventing their occurrence in the future.

4 Conclusion

The use of cross-sectional analysis to identify the main product defects and the causes of their occurrence made it possible to identify critical points in poultry meat production. Analysis of the diagrams showed that defects of group A (fractures and poor exsanguination), constituting 93.4% of the marriage, were caused, first of all, by mistakes of the enterprise personnel (in 67% of cases). At the same time, the unsatisfactory operation of the equipment (26% of cases) forms 32% of the total share of rejected products due to poor bleeding, which requires an automatic line for bleeding broiler chickens to be checked. For eliminating negative factors, the following recommendations have been developed. First, improve transportation conditions to avoid injury to the bird. Second, introduce regulations for the repair and maintenance of equipment. Third, submit a schedule of planned retraining of employees of the enterprise. Survey personnel to increase satisfaction with working conditions. Finally, ensure strict incoming inspection of raw materials and materials. Using Pareto and Ishikawa diagrams made it possible to explain the leading causes of defects encountered and develop recommendations for reducing rejections and improving the quality of products.

5 Availability of Data and Material

Data can be made available by contacting the corresponding authors.

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