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EFFICIENCY OF PRODUCTION LOGISTICS IN THE CIRCULAR ECONOMY

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Abstract

With a sufficiently large number of publications on the circular economy, the scientific literature does not fully reflect the aspects of the circular economy in relation to the sectors of industry and its individual subsystems, in particular, production logistics. These provisions served as the basis for choosing the research topic and setting its goal. The issues of organizing flows from the standpoint of production logistics are considered in studies of both theoretical and practical nature. However, for a circular economy, it is of fundamental importance to analyze the effectiveness of production logistics based on a systematic approach to management. The article contains modeling performance indicators of production logistics and regression model for estimating production logistics. The assessment of key performance indicators of production logistics was carried out on the example of the type of economic activity "production of rubber and plastic products" according to the aggregated data of industrial enterprises of the Republic of Tatarstan. For the study, aggregated data on enterprises producing rubber and plastic products, published on the Rosstat website, were used. The introduction of a set of measures to improve the activities of the production logistics of enterprises producing rubber and plastic products will make it possible to obtain a total effect (the growth rate of production profitability, with the introduction of all recommended measures) - 114.2%.

Keywords: Circular economy, key performance indicators, management, production logistics

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1. Introduction

At the present stage of development, new conditions have developed production, which went beyond the traditional methods of its organization, constraining not only the development of production, but also transport, supply and marketing structures. Changes during many ideas about the organization of the production process at the enterprise were introduced by the circular economy. In the circular economy, new requirements are presented in the organization of material flows, represented by both raw materials, material and energy, as well as finished products. The study of flows in the circular economy is the main task of production logistics.

The relevance of considering production logistics as a separate functional subsystem lies in the fact that in recent years there has been a tendency to reduce the scope of mass and large-scale production. The use of universal equipment, flexible reconfigurable production systems is expanding. Manufacturers are receiving more and more orders for the production of small batches and even single items. At the same time, buyers are increasingly demanding to satisfy the need in the shortest possible time (day, hour) with a high degree of guarantees. Another aspect of the relevance of production logistics is the organization of production within the framework of cooperation for the production of complex products.

The problem of production efficiency in the transition to a circular economy is reflected in the studies of many scientists. De Angelis (2021) indicates the need to study the theoretical issues of managing a circular economy. Garcia-Barragan et al. (2019) develop mathematical methods and methods for assessing the development of a circular economy. Kudryavtseva et al. (2018) highlight innovation as a tool for transforming economic systems. Liu (2018) emphasizes the importance of industrial sectors in the development of a circular economy. Luo (2020) indicates the importance of green transformation of industrial production as a priority. Mayumi and Giampietro (2019) consider the circular economy as an evolution of business systems. Rogowska (2018) pays attention to the fuel industry in the circular economy. Zhou et al. (2013) study the issues of the circular economy at the mesolevel of economic systems management.

With a sufficiently large number of publications on the circular economy, the scientific literature does not fully reflect the aspects of the circular economy in relation to the sectors of industry and its individual subsystems, in particular, production logistics. These provisions served as the basis for choosing the research topic and setting its goal.

2. Problem Statement

The issues of organizing flows from the standpoint of production logistics are considered in studies of both theoretical and practical nature. However, for a circular economy, it is of fundamental importance to analyze the effectiveness of production logistics based on a systematic approach to management. So, we believe that for the circular economy it is important to study the following aspects:

Indicators of the effectiveness of production logistics in terms of the effectiveness of managing flows and production assets;

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Assessment of the relationship between indicators of the efficiency of the use of resources and assets with the final indicator of production and economic activity - the profitability of production.

These identified issues will be considered and analyzed by us below.

3. Research Questions

During the study, the following questions were identified.

What key performance indicators most fully characterize production logistics in a circular economy?

How are key performance indicators of production logistics related?

What is the impact of production logistics performance indicators on the resulting indicator of production activity - on the profitability of production?

4. Purpose of the Study

We believe that the range of identified issues will allow a comprehensive approach to the development of a methodology for assessing the effectiveness of production logistics at industrial enterprises in the context of the transition to a circular economy

5. Research Methods

In the article, the authors used description methods, the index method and the method of correlation and regression analysis.

5.1. Performance Indicators of Production Logistics in the Circular Economy

The assessment of key performance indicators of production logistics was carried out on the example of the type of economic activity "production of rubber and plastic products" according to the aggregated data of industrial enterprises of the Republic of Tatarstan. For the study, aggregated data on enterprises producing rubber and plastic products, published on the Rosstat (2022) website, were used.

The key conditions for building an effective KPI system for enterprises producing rubber and plastic products are the reflection of the main processes (enlarged), achievability, measurability (KPI indicators must be measured in the mode that is adequate in managing a specific business process), objectivity (KPI must objectively reflect the or some other process).

Key performance indicators of enterprises for the production of rubber and plastic products are developed in accordance with the directions of technological development, and also meet the objectives of management and control. Key performance indicators should be quantitatively measurable and correspond to the directions of industrial development in the context of the development of a circular economy (Table 1).

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Table 1. Key Performance Indicators

Indicator index	Name of indicator	Calculation of indicators
1	Share of R&D expenses in revenue, %	R&D costs/enterprise revenue
2	Specific consumption of fuel and energy resources for transportation, own technological needs and losses, %	Fuel and energy costs/total costs
3	Frequency of industrial accidents (decrease), once a year	Number of accidents at work in the period under review / Number of accidents at work in the previous period
4	Labor productivity, thousand rubles	Revenue/number of employees
5	Profitability of production, %	Net income/output
6	The cost of the workplace, rub.	Total cost of maintaining a workplace
7	Equipment absolute load factor	Operating time of one machine / workshop operating time
8	Duration of unplanned downtime due to disruption of supplies, h	Total downtime for the period
9	The share of finished products recognized as manufacturing defects, %	The volume of defective products / the volume of production of finished products

To assess the dynamics of the profitability of manufactured products, the KPI5 indicator is used. To assess the savings in energy resources in the main business processes of O, the KPI2 indicator is used, which also allows you to evaluate the dynamics of the environmental friendliness of the production process and the disposal of production waste.

To assess the improvement of consumer properties of manufactured products, KPI9 indicators are used. KPI4 is used to assess labor productivity.

5.2. Assessment of Key Performance Indicators

The dynamics of key performance indicators for enterprises producing rubber and plastic products is presented in Table 2.

Table 2. Key Performance Indicators for enterprises producing rubber and plastic products

Indicator index	Name of indicator	2018	2019	2020
1	Share of R&D expenses in revenue, %	8	11	13
2	Specific consumption of fuel and energy resources for transportation, own technological needs and losses, %	4.56	5.7	6.84
3	Frequency of industrial accidents (decrease), once a year	1	1	2
4	Labor productivity, thousand rubles	74.3	117.9	319.3
5	Profitability of production, %	2.1	89.9	34.9
6	The cost of the workplace, rub.	56	58	65
7	Equipment absolute load factor	0,88	0,91	0,95
8	Duration of unplanned downtime due to	0	185	110

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	disruption of supplies, h			
9	The share of finished products recognized as manufacturing defects, %	2	4	5

Thus, based on the results of assessing the KPIs of enterprises producing rubber and plastic products, it can be concluded that the indicators are growing annually during the period under review (2018-2020). In 2018-2020 at the enterprises for the production of rubber and plastic products, an increase in the consumption of fuel and energy resources for their own technological needs and losses was noted, which is due to an increase in the output of the enterprise. In 2020, the consumption of fuel and energy resources for own technological needs and losses amounted to 6.84%, against 4.56% in 2018. In addition, the enterprise recorded an increase in industrial accidents in the period under review: 2 cases in 2020, 1 case in 2019 and 2018. Such negative trends are associated with an increase in the scale of production, and not with a decrease in the efficiency of production activities. In 2018-2020 at the enterprises for the production of rubber and plastic products, there is a positive trend in key performance indicators of the enterprise's technological processes. Thus, in 2020, the absolute load factor of equipment increased and amounted to 0.95, which is 4% higher than the level of 2019 (0.91), and 8% higher than the level of 2018. However, a negative trend was also noted in this period growth of finished products recognized as manufacturing defects, which in 2020 amounted to 5%, against 4% in 2019 and 2% in 2018, which is also due to an increase in the scale of production.

6. Findings

6.1. Modeling Performance Indicators of Production Logistics

To monitor and improve the efficiency of the enterprise, it is necessary to use a balanced scorecard. If you set the correct key performance indicators, then the flexibility in modernization and management depending on changes in the enterprise will be increased, and the risks of loss will be reduced.

Mathematical substantiation of the rationality of investments in improving the efficiency of the production activities of the enterprise is possible through economic and mathematical modeling of the production logistics of the enterprise. In this regard, we will build a correlation-regression model that allows us to identify refined directions for improving the efficiency of production logistics of enterprises producing rubber and plastic products in a circular economy.

In constructing the correlation matrix and the regression model, aggregated indicators for enterprises producing rubber and plastic products were used:

X1 Profitability of production, %

X2 Share of R&D expenses in revenue, %

X3 Specific consumption of fuel and energy resources for transportation, own technological needs and losses, %

X4 Frequency of accidents at work (decrease), once a year

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X5 Labor productivity, thousand rubles

X6 Workplace cost, rub.

X7 Equipment absolute load factor

X8 Share of finished products recognized as manufacturing defects, %.

X9 Inventory turnover, days

X10 Implementation of the procurement plan, %

X11 Share of the value of the insurance stock of the total cost of goods, %.

The conducted correlation analysis showed that the profitability of production is most affected by: X3 - specific consumption of fuel and energy resources for transportation, own technological needs and losses, %; X8 - the share of finished products recognized as manufacturing defects, %; X11 - the share of the value of the insurance stock of the total cost of goods, % (the correlation coefficient modulo exceeded 0.7 and was statistically significant – $P \leq 0.05$).

6.2. Regression Model for Estimating Production Logistics

Based on the data provided, the following multiple regression model was built:

$$Y=310.5-84.3\times X1-4.65\times X2-25.5\times X3,$$

where Y is the profitability of production, %;

X1 – specific consumption of fuel and energy resources for transportation, own technological needs and losses, %;

X2 - the share of finished products recognized as manufacturing defects, %;

X3 - the share of the value of the insurance stock of the total cost of goods, %.

Next, we calculated the reduction of each of the factors by 5% and saw their influence on other factors.

Cost optimization by 5% will increase the forecast value of production profitability by 114.2%, while the share of profit in revenue will be 41.9%. Thus, we have identified the most significant factors influencing the increase in the profitability of the production of enterprises producing rubber and plastic products - the specific consumption of fuel and energy resources for transportation, their own technological needs and losses, the share of finished products recognized as manufacturing defects, the turnover of the commodity stock, which will make it possible to predict the behavior of the dependent variable y in the future, as well as to increase the efficiency of enterprises producing rubber and plastic products.

7. Conclusion

Summing up, we can conclude that in order to eliminate the identified problems, the study developed a set of measures to eliminate them:

Reduction of the specific consumption of fuel and energy resources for transportation, own technological needs and losses is recommended through the implementation of "1C: TMS Logistics. Transportation management", which will increase profitability by 6.7%;

to reduce the share of finished products recognized as manufacturing defects, it is recommended to introduce the lean manufacturing tool Poka-yoke - an increase in profitability by 2.1%;

in order to reduce the share of the cost of the insurance stock, a "Program of measures to reduce the share of the cost of the insurance stock in the total cost of goods" was developed, the expected effect from the implementation of which is an increase in profitability by 5.4%.

Thus, the introduction of a set of measures to improve the activities of the production logistics of enterprises producing rubber and plastic products will make it possible to obtain a total effect (the growth rate of production profitability, with the introduction of all recommended measures) - 114.2%. This effect can be achieved by reducing the specific consumption of fuel and energy resources for transportation, own technological needs and losses, the share of finished products recognized as manufacturing defects, the share of the cost of insurance stock from the total cost of goods.

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References

De Angelis, R. (2021). Circular economy: laying the foundations for conceptual and theoretical development in management studies. *Management decision*, *59*(6), 1209-1227. https://doi.org/10.1108/MD-05-2019-0587

Garcia-Barragan, J. F., Eyckmans, J., & Rousseau, S. (2019). Defining and Measuring the Circular Economy: A Mathematical Approach. *Ecological economics*, *157*, 369-372. https://doi.org/10.1016/j.ecolecon.2018.12.003

Kudryavtseva, S. S., Galimulina, F. F., Zaraychenko, I. A., & Barsegyan, N. V. (2018). Modeling the management system of open innovation in the transition to E-economy. *Modern Journal of Language Teaching Methods*, *8*(10), 163-171.

Liu, Y. Y. (2018). Research on the development mode of ecological agriculture based on the theory of circular economy. *4th International Conference on Education Technology, Management and Humanities Science (ETMHS), 194,* 385-389. https://doi.org/10.2991/etmhs-18.2018.84

Luo, J. H. (2020). Green transformation of circular economy from the perspective of ecological environment protection. *Journal of environmental protection and ecology*, *21*(4), 1517-1525.

Mayumi, K., & Giampietro, M. (2019). Reconsidering "circular economy" in terms of irreversible evolution of economic activity and interplay between technosphere and biosphere. *Romanian journal of economic forecasting*, *22*(2), 196-206.

Rogowska, D. (2018). Biofuel production as part of a circular economy. *NAFTA-GAZ*, *74*(2), 156-163. https://doi.org/10.18668/NG.2018.02.10

ROSSTAT (2022). Company official Retrieved on 06 May, 2022 from https://rosstat.gov.ru

Zhou, B, Chen, L. L., & Mu, S. L. (2013). Dynamic assessment of the development of circular economy of Ningbo City, Zhejiang Province. 2nd International Conference on Energy and Environmental Protection (ICEEP 2013). *Resources and sustainable development, PTS, 1-4,* 734-737. https://doi.org/10.4028/www.scientific.net/AMR.734-737.2059