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DEVELOPMENT AND IMPLEMENTATION OF THE ENVIRONMENTAL MANAGEMENT SYSTEM GIVEN THE ADAPTATION OF RESOURCE-SAVING TECHNOLOGIES, USING THE EXAMPLE OF THE KOGALYMENERGONEFT SERVICE CENTER

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Abstract. **Problem Statement (Relevance). Problem Statement (Relevance).** The introduction of an environmental management system is an important step for the development of enterprises. It allows you to assess environmental risks and opportunities and monitor compliance with environmental requirements. Using this system, enterprises can develop measures to reduce the negative impact on the environment, which helps improve the environmental situation in the region. The implementation of an environmental management system is a responsible approach to business activities and an important element of sustainable development of enterprises. **Objectives.** The paper aims to solve the environmental sustainability issues of the Kogalymenergoneft Service Center within the framework of the environmental management system. **Methods Applied.** GOST R ISO 14001-2016 "Environmental management systems. Requirements with guidance for use" was used as a development tool. **Originality.** We identified significant environmental aspects of the enterprise's functioning. To determine significance of every environmental aspect, we calculated the total environmental impact and assessed environmental sustainability of the resource extraction enterprise. **Result.** The highest significance among the analyzed aspects is attributed to such environmental aspect as "emissions of pollutants into hydrosphere" caused by a pollutant, iron oxide. Based on the chosen classification of environmental sustainability, we can classify the organization as an enterprise with medium sustainable development. **Practical Relevance.** The obtained results served as the basis for developing a methodology for assessing the role of resource-saving technologies in improving environmental sustainability.

Keywords: environmental management, environmental aspects, environmental sustainability, Kogalymenergoneft SC

Для цитирования

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РАЗРАБОТКА И ВНЕДРЕНИЕ СИСТЕМЫ ЭКОЛОГИЧЕСКОГО МЕНЕДЖМЕНТА В УСЛОВИЯХ АДАПТАЦИИ РЕСУРСОСБЕРЕГАЮЩИХ ТЕХНОЛОГИЙ НА ПРИМЕРЕ СЕРВИСНОГО ЦЕНТРА «КОГАЛЫМЭНЕРГОНЕФТЬ»

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Аннотация. **Постановка задачи (актуальность работы).** Внедрение системы экологического менеджмента является важным шагом для развития предприятий. Она позволяет оценивать связанные с экологией риски и возможности, а также следить за соблюдением требований в области охраны окружающей среды. С помощью этой системы предприятия могут разрабатывать меры по снижению негативного влияния на окружающую среду, что способствует улучшению экологической обстановки в регионе. Внедрение системы экологического менеджмента является ответственным подходом к деловой деятельности и важным элементом устойчивого развития предприятий. **Цель работы.** Целью работы является решение вопросов экологической устойчивости сервисного центра «Когалымэнергонефть» в рамках системы экологического менеджмента. **Используемые методы.** В качестве инструмента разработки использовался ГОСТ Р ИСО 14001-2016 «Системы экологического менеджмента. Требования и руководство по применению». **Новизна.** Выявлены важные экологические аспекты функционирования предприятия. Для определения значимости каждого экологического аспекта рассчитано суммарное воздействие на окружающую среду и выполнена оценка экологической устойчивости ресурсодобывающего предприятия. **Результат.** Проанализирована процессная модель системы экологического менеджмента предприятия. Среди анализируемых аспектов предприятия наибольшее значение имеет такой экологический аспект, как «выбросы загрязняющих веществ в гидросферу», содержащие загрязняющее вещество – оксид железа. На основании выбранной классификации экологической устойчивости можно отнести рассматриваемую организацию к предприятию со средним устойчивым развитием. **Практическая значимость.** Полученные результаты послужили основой для разработки методики оценки роли ресурсосберегающих технологий в повышении экологической устойчивости предприятия.

Ключевые слова: экологический менеджмент, экологические аспекты, экологическая устойчивость, СЦ «Когалымэнергонефть»

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Introduction

Currently, a significant amount of experience in the operation of environmental management systems has already been accumulated, which has made it possible to form the necessary documentation and recommendations for use on an international scale [3, 14, 15]. Thus, the study [2] considers the practical task of classifying industrial enterprises by the level of sustainable development. The problem is studied as a multi-criteria classification problem. The study described the procedure for applying the CYCLE method for the problem under consideration. In [17], the authors studied the relationship between environmental management and the economic performance of 246 Chinese companies. This study divides environmental management into two dimensions: the breadth of environmental management breadth (EMB) and the depth of environmental management depth (EMD). Verification of the hypotheses put forward is carried out using multiple regression analysis. The results of the study showed an inverted U-shaped relationship between EMB and economic indicators. EMD has a positive effect on economic indicators. Green innovation mediates the relationship between EMB (EMD) and economic performance. The study [6] notes that as the understanding of interactions present in socio-ecological systems develops, simulation using emulation can help reduce the complexity and necessary computational resources of models used to describe systems. Although emulation is commonly used in meta-analysis and parameterization of models, it is less studied in environmental management. Reducing simulation execution time is an essential motivation because emulators allow stakeholders to interact directly with the model.

The study [9] showed that small and medium-sized companies in their production processes and supply chains should go beyond the mandatory actions imposed by governments regarding environmental management. In addition, the environmental requirements of large companies can contribute to the consolidation of environmental management practices in small and medium-sized companies through cooperation, knowledge expansion, and the development of responsible behavior. In the study

[16], the authors conclude that the effectiveness of the integration of quality management and environmental management may depend on the internalization of both qualitative and environmental components. When the implementation of a system is superficial, it leads to excessive formalization and separation from daily activities and to an increase in bureaucracy in the organization. Conversely, if environment and quality are introduced into the organization's management system everywhere, this fact contributes to strengthening the effect of implementation, motivating organizational learning, developing internal competencies, and improving organizational efficiency, as a resource-oriented approach suggests.

Based on the analysis of existing approaches to forming an environmental strategy, the authors [13] developed an algorithm for forming an organization's environmental development strategy consisting of eight stages. Researchers assume that the structure and content of the proposed stages for individual organizations will vary depending on the form of ownership, size of the organization, industry affiliation, organizational structure, specifics of activity, etc. [13].

The authors [10] note that the implementation and use of environmental management systems (EMS) depend on the reliability of their certificates. To assess the degree of trust in the study, focus group interviews were conducted with 20 representatives of the manufacturing industry, the education sector, certification bodies, and non-profit environmental organizations. The paper emphasizes the importance of strict audit and control systems for certification. The paper [4] considers the possibility of integrating a closed-loop economy into an EMS based on ISO 14001. The authors suggest using a mixed strategy consisting of three stages. The authors of the studies [8, 11] confirm the importance of implementing environmental management systems in accordance with the ISO 14001 standard for enterprises in the electricity generation sector. The result of the implementation of EMS at the enterprise is a clear reduction in environmental impact. Competent management of the organization in environmental issues becomes an essential factor of sustainable development.

Materials and methods

The object of the study is the organization Kogalymenergoneft Service Center (SC). It is engaged in the maintenance and operation of electrical equipment and heat supply in the Khanty-Mansiysk and Yamalo-Nenets Autonomous Okrug. Kogalymenergoneft is the largest service center in the West Siberian Department. The main types of technological equipment in the Kogalymenergoneft SC are:

- Pump units (Artesian wells, network, water make-up, circulation pumps);
- Boilers;
- Water treatment equipment (Water storage tanks, filters);
- Heating networks (Main pipelines, water pipelines).

The tasks of effective management of the enterprise's equipment are:

- Reduction of energy resource costs for the operation and maintenance of equipment;
- Increased equipment performance;
- Reduction of energy loss in the production of heat, water supply, and sanitation.

The management manual "Industrial safety, labor protection and Environmental management system" has been developed at the Kogalymenergoneft SC enterprise. The manual was developed for improving the company's mechanisms for implementing procedures and unified information and regulatory support for work aimed at ensuring industrial safety, labor protection, and the environment and eliminating duplication of functions of their participants.

The management system is based on the principles set out in international standards [15] and operates in full compliance with the company's organizational structure. **Fig. 1** shows the process model of the environmental management system of the Kogalymenergoneft SC.

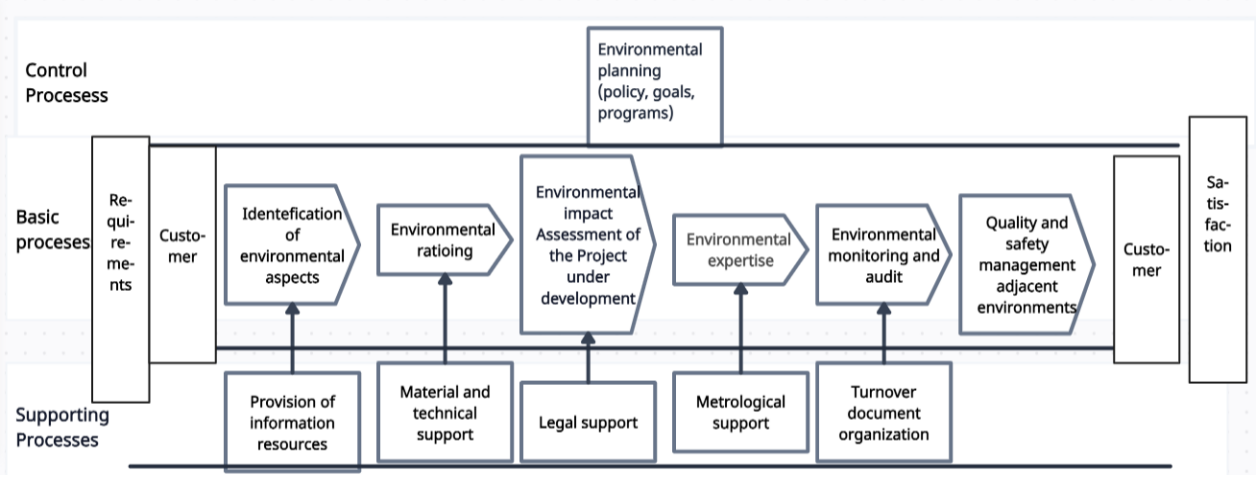


Fig. 1. The process model of the environmental management system of Kogalymenergoneft SC
Рис. 1. Процессная модель системы экологического менеджмента СЦ «Когалымэнергонефть»

Kogalymenergoneft SC defines its environmental aspects (EA) and the environmental impacts associated with them. It determines significant impacts. Therefore, one should consider the enterprise's environmental management system. EA identification was based on data [7].

When assessing the significance of the environmental impacts of an organization's actions, one should consider normal operating conditions and the start and completion of activities, and reasonably anticipated abnormal situations. One should consider past, existing, and future actions.

The requirements of the international standard ISO 14001:2015 is focused on identification of environmental aspects, related to the products of production and the activities of the enterprise, assessing their impact on the environment and developing a system aimed at reducing environmental impact.

Criteria requirements for the effective functioning of EMS are associated with the identification of significant environmental aspects and related environmental impacts, taking into account the prospects of the life cycle, taking into account the identified anomalous and potential emergencies. Therefore, it is assumed that the enterprise considers the identification of environmental aspects in normal production conditions and potentially in emergency conditions. In connection with the above, for many enterprises with existing EMS, a detailed inventory of environmental aspects will be required, especially from the point of view of the life cycle approach, which in turn necessitates the use of life cycle assessment tools for products. The international standard for Life Cycle Assessment ISO 14040:2006 defines life cycle assessment (LCA) how to compile and evaluate input data, output data and the potential impact of technological productions on the environment.

Based on the mentioned provisions, we obtained formula (1).

To determine the EA significance, we calculated the total impact on the environment using the formula:

$$T_i = S_i \cdot I_i \cdot P_i \cdot D_i, \quad (1)$$

where S_i is the impact scale of EA; I_e is the intensity (severity) of EA impact; P_i is the probability of EA impact; D_i is the duration of EA impact (**Table 1**).

We attribute to significant EA the indicators equal to or more than 36. The assessment of the sustainability of the development of an industrial enterprise should be carried out in the aspects of external and internal sustainability.

T a b l e 1. The EA significance rating scale [1]
Таблица 1. Шкала оценок значимости ЭА [1]

Impact factors	**Values, in points**
Impact scale of EA (S_i) within:	
Places of work	1
Object as a whole	2
Nearby territory	3
District and more	4
the intensity (severity) of EA impact (I_i):	
Impact within the limits of permissible legally-established norms	1
Exceeding the maximum permissible, legally established norms with minor consequences for the environment	2
Exceeding the maximum permissible legally-established norms with significant consequences for the environment	3
Probability of EA impact (P_i):	
Random rare events (small)	1
Recurring events (average)	2
Frequent recurring events or constant exposure (high)	3
Duration of impact on EA (D_i):	
Within a few hours	1
Within days	2
For a long time or permanently	3

The basis for the proposed scale of assessments (see **Table 1**) is an expert assessment of four interrelated variables with equal weight: (1) economic, (2) social, (3) risk tolerance and (4) environmental [12]. The experts were the leading specialists at the enterprise for the development and maintenance of the environmental management system. The experts were asked to choose the value that best describes the marked variables in the enterprise on a scale from one to four points. The first variable is the scale of the impact of environmental aspects, which ultimately determines the economic costs associated with ensuring environmental protection. The second variable reflects the intensity of the impact of the environmental aspect in the context of the social well–being of the population living next to the production enterprise under consideration. The third variable is determined by the probability of environmental impact, which determines the sustainability of the environmental management system to negative risks, and finally, the fourth variable characterizes the duration of the environmental impact, thereby assessing the anthropogenic impact on environmental conditions.

Environmental sustainability is the relationship between the economy of the enterprise and its environmental safety, minimizing the harmful impact of the production and economic activities of the enterprise on the environment. **Table 2** shows the criteria for the analysis of environmental sustainability.

Table 2. Environmental sustainability of the resource-extracting enterprise
Таблица 2. Экологическая устойчивость ресурсодобывающего предприятия

Analysis criteria	Indicators
Environmental safety	Coefficient of resource-saving technologies
	Coefficient of environmental protection measures
Impact of activities on the environment	Environmental pollution coefficient
	Coefficient of environmental intensity

We calculated the environmental sustainability indicator using the formula [5]:

$$S_e = \sqrt[4]{C_{rt} \cdot C_{ep} \cdot C_e \cdot E_i}, \quad (2)$$

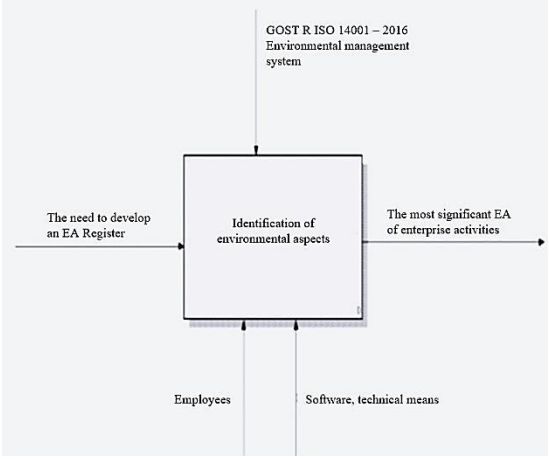
where C_{rt} is Coefficient of resource-saving technologies; C_{ep} is Environmental pollution coefficient; C_e is the coefficient of environmental protection measures; E_i is the coefficient of environmental intensity.

The characteristic of the state of the environmental sustainability indicator at the enterprise is carried out using data [5].

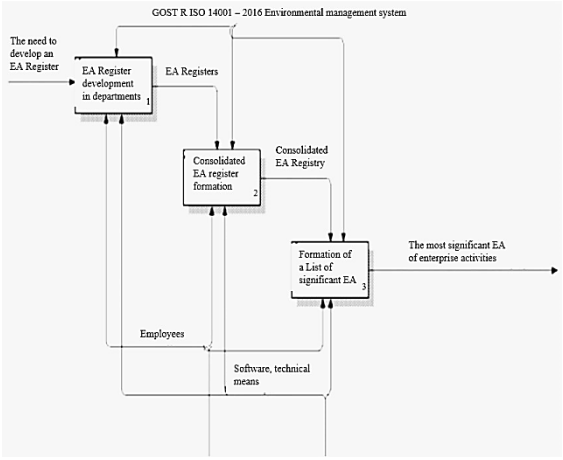
The results obtained serve as a basis for the development of further recommendations to improve environmental sustainability.

Results and discussion

We developed the process of EA identification for the organization, and the decomposition of this process was carried out. **Fig. 2** shows the result.



a



b

Fig. 2. The process of EA identification (a) and its decomposition (b) (compiled by the authors)
Рис. 2. Процесс идентификации ЭА (a) и декомпозиция процесса идентификации ЭА (b) (составлено авторами)

The output of the EA identification process is a register of the most significant EA. **Table 3** shows the EA register.

To determine the EA significance, we calculated the total environmental impact using the formula (1). **Table 4** shows the results of calculating the EA significance.

Furthermore, we calculated the integral indicator of environmental sustainability by taking the average $C_{rt} = 0.87$.

$$S_e = \sqrt[4]{0.87 \cdot 0.37 \cdot 0.8 \cdot 0.7} = 0.65.$$

Based on the data in **Table 4**, we can conclude that the highest value has such an environmental aspect as "emissions of pollutants into the hydrosphere" caused by a pollutant, iron oxide.

Table 3. EA register
Таблица 3. Реестр ЭА

Environmental aspect	Polluting substance	Environmental impact	Environmental aspect significance
Emissions of pollutants into the hydrosphere	Iron oxide	Water pollution	High
Emissions of pollutants into the hydrosphere	Manganese and its inorganic compounds	Water pollution	Average
Wastewater discharges into water bodies	Iron	Water pollution	Average
Wastewater discharges into water bodies	Oil products	Water pollution	Average

Table 4. EA significance calculation
Таблица 4. Расчет значимости ЭА

Environmental aspect	Polluting substance	S_i	I_i	P_i	D_i	T_s
Emissions of pollutants into the hydrosphere	Iron oxide	3	2	3	3	54
Emissions of pollutants into the hydrosphere	Manganese and its inorganic compounds	2	1	2	3	12
Wastewater discharges into water bodies	Iron	3	1	1	2	6
Wastewater discharges into water bodies	Oil products	3	2	2	2	24

According to the chosen classification (see **Table 4**), we can define the enterprise as the enterprise with medium sustainable development. The obtained results served as the basis for the development of a methodology for assessing the role of resource-saving technologies in improving environmental sustainability and the development of measures to improve the sustainability of the environmental management system, namely:

- To identify and evaluate significant EA.
- To evaluate the role of resource-saving technologies.

To adapt the methodology for assessing the role of resource-saving technologies in improving environmental sustainability.

Conclusions

We analyzed the activities of the enterprise Kogalymenergoneft SC, which is the largest service center in the West Siberian Federal District.

We analyzed the standards in the field of environmental management GOST R ISO 14001-2016.

In addition, we analyzed the methods of assessing the contribution of resource-saving technologies in improving the sustainability of the environmental management system.

We developed the methodology for assessing the role of resource-saving technologies in improving environmental sustainability.

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