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ENERGY MANAGEMENT IN NETWORK TRADING COMPANIES: CURRENT CHALLENGES AND SOLUTIONS

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Abstract. This study is devoted to the review of modern tools of energy saving management in retail outlets of chain trading companies that provide direct offline sales of products. The research topic is highly relevant due to the digitalization of retail, development of ESG- and eco-friendly approaches to enterprise management. Throughout the research, the authors define the role of energy monitoring in energy management and saving in retail. The main directions of energy monitoring in retail outlets have been identified and characterized. The most widespread monitoring tools in the modern retail market are also distinguished and specified. As a result, the authors define major disadvantages of their application and develop the range of promising solutions.

Keywords: energy management, energy saving, online retail, offline sales, monitoring tools, automation

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УПРАВЛЕНИЕ ЭНЕРГОСБЕРЕЖЕНИЕМ СЕТЕВЫХ ТОРГОВЫХ КОМПАНИЙ: СОВРЕМЕННЫЕ ПРОБЛЕМЫ И ПУТИ РЕШЕНИЯ

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Аннотация. Данное исследование посвящено обзору современных инструментов управления энергосбережением розничных точек продаж сетевых торговых компаний, обеспечивающих непосредственную офлайн-продажу продукции. Актуальность темы исследования определена цифровизацией ритейла, развитием ESG- и экологичного и подходов к управлению предприятиями. В процессе исследования авторами была определена роль энергетического мониторинга в области управления энергопотребления и энергосбережением в ритейле. Определены и охарактеризованы основные направления энергетического мониторинга розничных точек продаж ритейла. Идентифицированы и проанализированы наиболее распространенные в современном ритейле-рынке инструменты мониторинга. Определены ключные недостатки их применения, предложено их системное решение.

Ключевые слова: логистика, цифровая трансформация, цифровой двойник, архитектура информационных систем, моделирование

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Introduction

With the development of retail, the spread of environmental agendas, and the popularization of ESG policies, the functional area of energy-saving management is becoming more and more important for chain retailers. Society and environment oriented approaches to energy consumption are currently becoming highly relevant. In this regard, the research proposes a review of modern energy monitoring tools in retail (providing the functioning of the digital twin of the retail point of sale) in order to identify and solve the main functional and economic problems of their application.

Materials and Methods

This research is carried out on the grounds of existing research on the topic and author's conclusions on energy saving management perspectives. Theoretical basis for the research is shaped by the international standards on energy and environmental management, as well as studies on digitalization and automation (Kapustina et al., 2019; Barykin et al., 2021; Voronova, 2024; 2019; Krymov, 2016). Another important facet under consideration is development of green and ESG policies in retail (Bakharev, 2020; Kalinina, 2019; Niyazbekova, 2022). The methodology of this paper includes a system of theoretical (analysis, synthesis, classification, deduction, and induction) and practical (description) research. Application of the above

mentioned methods allows assessing the theoretical framework and business practice related to energy monitoring in retail. In its turn, the descriptive method ensured the presentation of intermediate and final results of the research.

Results and Discussion

According to the international standard ISO 50001:2018 for energy management systems, energy management rests on the "Energy Performance Based Approach". It implies that energy consumption and management technologies should be based on energy consumption indicators (GOST R ISO). In this case, ISO 14001:2015 states that environmental management systems are obligatory requirements. The application of a systematic approach to energy-saving management as part of environmental management will allow the company to achieve positive dynamics of financial and operational performance as a result of the implementation of environmentally significant solutions (Karakece, 2021; Sizova, 2021). Traditionally, the following directions of energy resource use and energy consumption monitoring are distinguished in retail (Table 1).

Table 1. Characteristics of energy monitoring in retail outlets, FMCG-retail (designed by the authors)

Direction of energy use	Power supply				Central heating	Water supply
Feature	Refrigeration equipment	Lighting	Air-conditioning	Electric heating		
Facilities to be managed and monitored	Cooling chests; Refrigerated displays; Refrigeration units	Lighting units	Industrial air conditioning units	Autonomous heating from electric boilers	Central heating equipment	Sanitary equipment; piping
Facility management tools	Temperature controllers; Lighting controllers (relays)	Switches	Switches	Temperature controllers	Temperature controllers	Water head controllers
Built-in monitoring tools	Temperature sensors Opening sensors (relay); Emergency alarms	–	–	Temperature sensors; Emergency alarms	Heat meters; Alarms	Water meters; Alarms
Additional monitoring tools	Network cards; Smart energy utilization spots; Multi-channel energy meters; Universal energy meters				Pressure sensors; Leak sensors; Temperature sensors	
Monitoring indicators	Electricity consumption; Maintained temperature; Operating mode; Operation failure	Electricity consumption; Operating mode; Operation failure	Electricity consumption; Maintained temperature; Operating mode; Operation failure	Electricity consumption; Maintained temperature; Operating mode; Operation failure	Heat consumption; Maintained temperature; Operating mode; Operating failure	Water consumption; Operation failure (leaks)

According to the table, energy consumption in retail outlets includes a system of tools for monitoring the indicators and mode of operation of engineering equipment (Hasan, 2021; Strielkowski, 2021). Against the background of digitalization of retail, the modern market of IT solutions in management and monitoring of equipment in retail outlets provides business with the possibility of obtaining a unified information system to manage their operational processes and collecting data via the formation of a digital twin (Liu, 2022; Kappertz, 2023). Figure 1 depicts the essence of the digital twin.

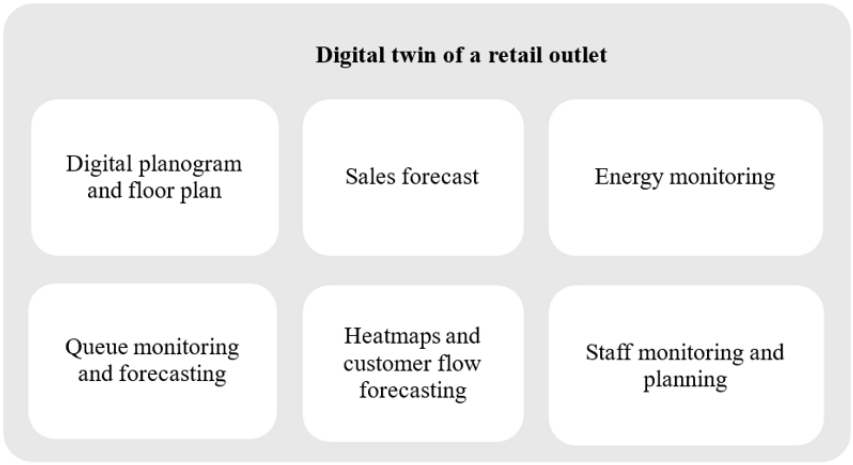

Fig. 1. Digital twin of a retail outlet (developed by the authors)

As already mentioned, the source of data for the digital twin is infrastructure tools, which are part of the engineering complex of retail facilities, as well as retailers' databases. Based on this, the digital twin tools can be generalized as a set of the following three innovative technologies (Fig. 2).

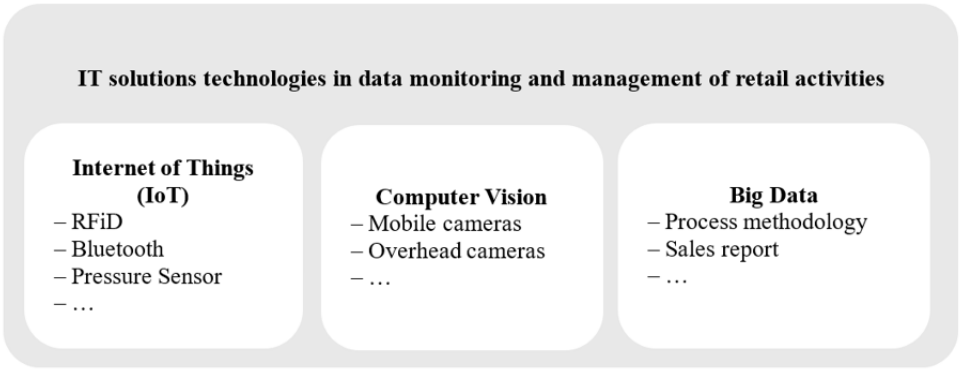

Fig. 1. Typization of modern IT technologies formation and provision of a digital twin

The most common tools for monitoring the activities of retail outlets in chain trading companies include the following:

Sensors. At present days factory sensors and equipment alarms are used in electrical equipment.Vender sensors with the ability to transmit data to a single server (“smart sensors”), installed on individual equipment, areas of the sales floor, or electrical panels. At the same time, in conditions of disparate technological levels of equipment used in retail outlets, network cards

based on IoT technology are being actively implemented.

Application of these tools in combination with modern software provides:

1. Regular monitoring of energy consumption indicators of all retail point-of-sale equipment, including those that do not have built-in sensors and meters.
2. Management (including zonal) of equipment and its automation.
3. Visualization of energy consumption data.
4. Automation of energy savings at the retail outlet.

However, in the conditions of mass introduction of such technologies, retail will need a large funds. It is likely to turn out as an uneasy mission due to increasing IT support costs, price index, and dynamic purchase flow.

Cameras. Today, photo and video cameras for retail outlets can have different locations (ceiling cameras, wall cameras, and mobile cameras) depending on the purpose of use and layout solutions. A heat map of the retail outlet can be generated by integrating the camera data collection server with specialized software equipped with computer vision technology and possessing data on the layout.

Heat maps are a tool for visualization (presentation tool) of data on the intensity of customer flows obtained as a result of computer vision technology application. Technically, the heat map is shaped as a result of the identification of buyers and tracking their movement in accordance with the algorithm processing from cameras by specialized software. In addition, computer vision technology accumulates such statistical information as the number of visitors during the day, their average turnover per hour, as well as peak hours.

From a traditional point of view, heat map technology can be used as a tool for evaluating the effectiveness of merchandising, since it contributes to the key indicators of a given operational area of a retailer, including:

- Main routes of shoppers.
- Demand for specific goods.
- Efficiency of promotion campaigns.
- Ergonomics of the planogram.

At the same time, it is important to note that a number of the obtained data in conjunction with the register of retail equipment can be applied by retailers in order to find sources of increasing energy-saving indicators.

Electronic Shelf Labeling. These are e-ink screens equipped with RFID tags, which allow to automatically update the prices of products presented at the retail outlet according to the planogram by synchronizing the price data from the central server. Based on the description, the following key functions of Electronic Shelf Labeling are evident:

Automation of the price update.

Formation of a digital planogram of the retail outlet.

Thereby, introduction of this tool enables retailers to acquire an instrument for managing and monitoring the display of goods in real time in the digital planogram (Osheyor Gidiagba, 2023; Madsen, 2003). It is also important to note the strategic role of this tool for retail companies because the effectiveness of offline sales management depends on the fulfillment of its principles.

Conclusion

Overall, in order to effectively manage energy in chain retail companies, IT tools for monitoring energy consumption indicators should be used only with an integrated approach in association with the technologies of heat maps and Electronic Shelf Labeling. This approach will allow making informed management decisions based on the dynamics of energy consumption

indicators, taking into account the data of planograms and the intensity of customer flows in dynamics.

In order to form an effective integrated solution of energy-saving management, the authors suggest structuring the main elements of optimization in energy consumption (Table 2).

Table 2. Elements of optimization of energy consumption management (designed by the authors)

Direction of energy use / Feature	Digital planogram	Heat map	Monitoring module of power consumption	Remote control module
Implementation tool	Electronic shelf labels	Cameras	Sensors, network cards	Network cards
Technology behind IT solutions	IoT	Computer vision	IoT	IoT
Objectives of IT solutions	Price management; Planogram management; Assessment of intensity of customer interaction with products; Evaluation of merchandising effectiveness; Targeted advertising placement	Analyzing traffic intensity; Tracking demand for products; Detecting flaws in design and/or organization of merchandise in the store; Defining key points of the customer's routes	Monitoring energy utilization rates; Automation of data collection on equipment operation	Automation of engineering equipment management
Results of using IT solutions	Digital planogram of the outlet	Data on customer traffic intensity	Energy consumption indicators	Function of remote (including zone) control of equipment
Business process	Energy management in retail outlet			

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