

*The object of the research is the individual elements of management accounting in the food industry.*

*The study examines the key challenges faced by food industry organizations, which operate under the influence of numerous diverse factors and have their own industry-specific characteristics. This necessitates the use of modern administrative tools and unconventional solutions based on management accounting principles. Exploring the capabilities of the food industry management accounting system, it was found that the final stage can be extended to obtain data that enable cash flow monitoring, net profit assessment, and the identification of key allocation directions.*

*The findings highlight the need to implement the direct costing system in the country's food industry, as it best aligns with the operational specifics of these production sectors. This approach optimizes the tax burden on enterprises by focusing on variable costs, which are particularly significant in the food industry. The adoption of ERP systems, big data analytics, artificial intelligence, and accounting methods such as ABC costing, target costing, and standard costing enables more precise cost allocation, efficient capacity utilization, and real-time resource management. This contributes to increased profitability and competitiveness of food industry enterprises. The industry-specific features of management accounting in the food sector are closely linked to production structure analysis, accounting for seasonal fluctuations, utilization of average annual capacity, and tracking specific costs such as quality control and compliance expenses*

**Keywords:** *accounting, food industry, innovation processes, dataflow automation, cost management*

# IDENTIFYING AREAS FOR IMPROVING MANAGEMENT ACCOUNTING TOOLS IN THE FOOD INDUSTRY

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## 1. Introduction

Innovations in the food industry are primarily aimed at addressing issues such as improving the quality and safety of food products, including socially significant and essential goods. Additionally, one of the key priorities for the food sector is solving the problems of import substitution and resource efficiency. These objectives are mainly achieved through the introduction of new formulations and production technologies or modification of individual technological operations. Patent research indicates a vast number of developments in this field; however, many of them remain unimplemented. A solution to this issue can be a comprehensive approach to innovation, which should be realized through effective interaction between manufacturers and scientific organizations.

Management accounting is a more in-depth method of collecting and transmitting company performance indicators, as it is not limited to financial indicators, which in this case may also be more extensive than in a basic accounting system. Management accounting of the innovation process is a system for monitoring, collecting, recording, processing, and systematizing data about the entities involved in the innovation process and its structural divisions to enable planning, control, and managing the innovation process.

Modern management accounting by responsibility centers and segments utilizes various data collection and analysis methods that define the management accounting approach. American researchers [1] view the innovation process as a combination of two stages: dissemination and implementation of innovations. Accordingly, they define

management accounting of the innovation process as a system for making strategic decisions in the development of innovation programs.

For example, within the structure of Kazakhstan's manufacturing industry, the food sector (including beverage and tobacco production) ranks 2nd after metallurgy, making it one of the most significant economic areas in the country. Efforts to reduce dependence on imported food products and expand the export potential of processing industries necessitate increased efficiency and competitiveness in the domestic food industry. These requirements apply to both domestic and foreign markets, emphasizing the need for modern management and accounting methods in the sector [2].

A key distinction is that financial accounting must be conducted in a certain format, whereas management accounting is a more flexible system that can be adapted to meet the specific needs of management. High financial performance and stock profitability may be linked to the effective use of accounting information systems. Such systems improve data accuracy, enhance financial procedures, and increase overall operational efficiency [3]. Management accounting generates data and analyzes it for internal use or public company reports to strengthen investor confidence [4].

Thus, the role of management accounting is to make financial accounting more adaptable to a company's needs and to enrich it with a broader range of significant indicators to enhance decision-making efficiency. Therefore, research focused on implementing modern management accounting methods based on the search for optimal tools is of scientific importance.

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## 2. Literature review and problem statement

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The paper [5] presents the results of research on selecting an optimal balanced sectoral accounting policy, identifying it as one of the key tools for minimizing risks in the agro-industrial complex. It is shown that food supply chains represent a complex production mechanism, where even relatively low risks at individual stages can lead to significant fluctuations in food inflation. This issue requires a comprehensive approach to price regulation, including price stabilization for raw materials and protecting both producers and consumers from sharp fluctuations. The authors of [6, 7] share the view that the food industry faces high levels of risks, which have a particularly strong impact due to the specifics of the sector. Unresolved issues remain in areas where the industry experiences pronounced seasonal fluctuations in supply and demand, potentially leading to shortages or surpluses of products. This creates risks of price instability and difficulties in production planning.

The study [8] focuses on global food supply chains and the impact of various aspects, including price volatility in the global market. Effective management of global supply chains requires accurate and timely understanding of the situation at all levels of the chain, from production to consumption. However, issues persist regarding the availability and reliability of data on production volumes, stock levels, and product movements, which complicates decision-making and forecasting.

The paper [9] analyzes the management accounting system with an expanded application of innovative technologies, which enable the automation of management decision-making through the digitalization of variable indicator

datasets and mathematical analysis of input data. However, unresolved questions remain regarding how implementation can be based on statistical data on the effectiveness and feasibility of specific digital solutions. The work [10] examines the impact of artificial intelligence (AI) on the food sector, describing it as part of the Fourth Industrial Revolution. These technologies enhance food production, quality, and nutritional value while simultaneously reducing resource consumption and waste. However, little attention has been given to technology integration across all stages to monitor and improve food quality and safety.

The authors of [11] demonstrate how AI technologies help enterprises improve efficiency, accuracy, and decision-making capabilities, leading to enhanced financial reporting and auditing processes. The research provides a theoretical explanation of AI implementation in accounting and auditing practices within the context of a developing country. Nevertheless, questions remain about the feasibility of integrating AI into the management accounting system of the agricultural sector.

The paper [12] recommends using the heuristic analytic hierarchy process to increase the speed and quality of management decision-making in the country's agro-industrial complex. It also proposes a rational scenario for agricultural production as an example. However, the method described by the author appears too complex for widespread adoption, and the criteria used to assess decision quality are overly dependent on expert opinions. While this mechanism may be useful for large holdings or entire industries, it is redundant for solving everyday sectoral.

Therefore, research aimed at identifying ways to improve management accounting tools in the food industry is crucial, considering the industry's specifics. The focus should be on enhancing management efficiency, minimizing risks, and improving decision-making quality in the face of dynamic market factors.

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## 3. The aim and objectives of the study

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The aim of this study is to identify effective management accounting tools in the food industry. This will help enhance the efficiency and transparency of decision-making in management accounting.

To achieve the aim, the following objectives were set:

- to determine industry-specific features of management accounting in the food industry based on production structure analysis and average annual capacity utilization in the sector;
- to analyze the potential application of modern technologies to improve management accounting in the food industry.

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## 4. Materials and methods

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The object of the study is the individual elements of management accounting in the food industry. The subject of the study includes the functioning of the management accounting system in the food industry, considering its specifics within the context of the modern economic environment.

The research hypothesis suggests that the food industry has unique sectoral characteristics, necessitating their assessment to select the most effective management accounting methods in this area.

Several assumptions were made in the work. First, expenditures on process innovations were classified as overall

management accounting costs. This approach allowed for tracking the funding dynamics of this area over recent years. The second assumption was the generalization of only the main production sectors within the food industry of the Republic of Kazakhstan as a single food complex without considering small sub-sectors. This approach helped highlight key industry-specific features fundamental to the food sector.

The research is based on scientific publications related to the topic. Visualization of research results is achieved through graphical and tabular methods of data presentation.

## 5. Research results on improving management accounting tools

### 5.1. Determining industry-specific features of management accounting in the food industry

In recent years, there has been a trend toward gradual business consolidation in the food industry of the republic. This process is accompanied by an increasing share of products with high added value and a deeper level of processing. From a statistical standpoint, direct measurement of this process is challenging, as it coincides with shifts in the adoption of modern management accounting methods within the economy. However, an indirect assessment can be made by analyzing the dynamics of enterprise expenditures on process innovations, which include the implementation of modern accounting models.

Regarding the rationale for using innovation expenditures as an indicator in the work, statistical data from recent years indicate a lack of qualitative improvements in management procedures within the industry. As shown in Fig. 1 below, expenditures on process-related innovation have been declining since 2016, despite the consistently positive trend in product innovations in recent years.

Fig. 1 demonstrates a decline in overall investments in process innovations, indicating reduced attention to the application of modern management accounting methods and tools in domestic industries. It is important to note that the overall reduction of innovation expenditures significantly contributes to the continued dominance of a resource-export-oriented economic structure in the country.

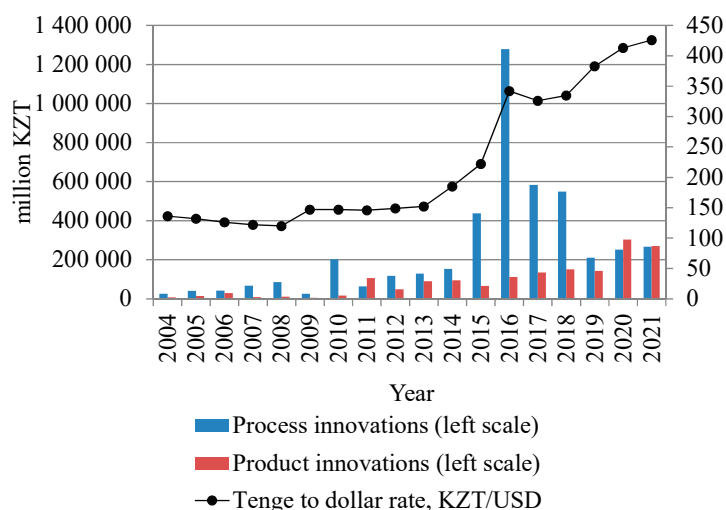


Fig. 1. Expenditures on product and process innovations in the industry of the Republic of Kazakhstan in 2004–2021, million tenge  
Note: Compiled based on [13]

When developing modern process innovation management tools in the agro-industrial complex, it is crucial to consider the specifics of production. Therefore, the implementation of modern management practices should be based on several industry-specific features. The food industry, in particular, is distinguished by the following key characteristics:

- continuous and high-speed production processes, driven by the short shelf life of raw materials, intermediate products, and finished goods;
- limited storage capabilities for raw materials, intermediate products, and finished goods, restricting opportunities for forming intermediate stocks;
- clearly defined segmentation of the production process into distinct stages and steps due to the specific organization of food manufacturing;
- high variability in the assortment, classification and sorting of raw materials, intermediate products, and finished goods, with a rapid turnover in both production and sales.

Thus, management accounting in the food industry should be adapted to the aforementioned production characteristics. It is also worth noting that certain sub-sectors have seen significant development within the food industry. The beverage, meat, dairy, and flour-and-cereals industries collectively accounted for about 60 % of the sector's added value in 2023. These sub-sectors exhibit all of the aforementioned industry-specific aspects of manufacturing (Fig. 2).

It can be observed that the share of beverage and meat production has been steadily increasing, while other sectors have been declining. Over time, the production characteristics of these growing sectors will shape the overall industry landscape. Based on the structure and trends in the share of various segments within Kazakhstan's food industry (Fig. 2), priority should be given to the sector-specific planning and accounting approach described earlier. It should not only serve as an informational database but also enable current data and time series analysis, thereby supporting informed decision-making. Various accounting models serve as the foundation for management accounting. However, not all of them are optimal for the agro-industrial complex. The food industry is characterized by high variability in cost structures, with fixed costs usually being secondary. In such cases, a direct costing system could be a promising approach for organizing accounting, although its adoption remains relatively low in the country [14]. Another defining feature of the food industry is the lack of significant intermediate stocks due to the short shelf life of raw materials, intermediate products, and finished goods.

Additionally, a notable characteristic of food industry enterprises is that their capacity utilization rates are significantly below 100 % (Table 1).

As seen in Table 1, a rather high capacity utilization rate is observed only in the tobacco and confectionery industries. For other sectors, this figure is around 50 % or lower. The instability of capacity utilization is particularly evident in industries with seasonal operations (fruit and vegetable canning, grain processing, etc.), which inherently have a variable capacity utilization rate even within a single year, and that rate is already low. Given this unstable and rather low capacity utilization level, a variable costing model would be appropriate, where indirect costs are allocated based on capacity utilization rates.

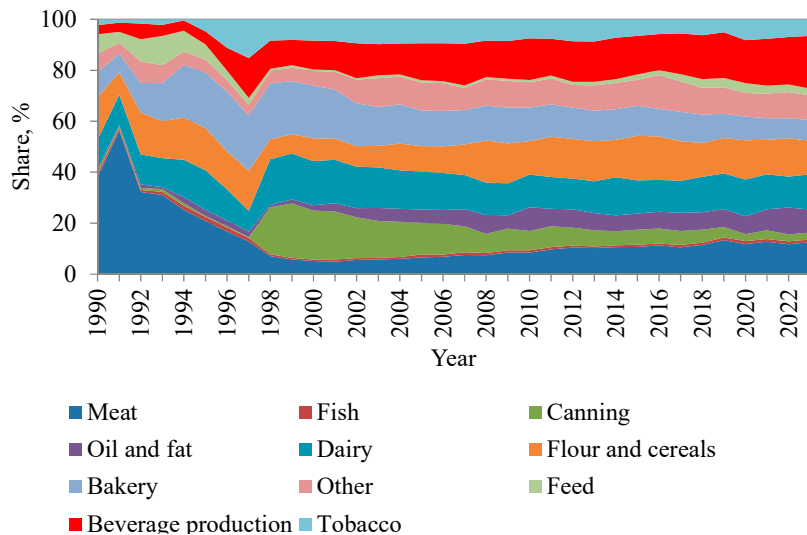


Fig. 2. Structure of industrial production in the food industry of the Republic of Kazakhstan for 1990–2023, %

Note: Compiled based on [13]

Table 1

Average annual capacity utilization by food industry enterprises of the Republic of Kazakhstan in 2023, %

Category	%
Cigarettes	88.0
Chocolate	70.7
Sugar	59.2
Fresh or chilled poultry meat	56.4
Sausages and similar products	53.0
Vodka	51.5
Dairy products	49.9
Butter and spreads	44.6
Frozen poultry meat	43.0
Fresh or chilled meat (excluding poultry)	40.4
Bread	37.9
Mineral and carbonated water	37.9
Cheese and cottage cheese	37.8
Processed liquid milk and cream	37.7
Animal feed	37.2
Vegetable oil	35.1
Flour	33.8
Fish and seafood products	31.3
Processed and canned vegetables	19.9
Groats	14.8
Fruit juices	7.2
Vegetable juices	7.1
Grape wine	12.7

Note: compiled based on [13].

The direct costing model is relatively more complex compared to the traditional absorption costing method, so its limited adoption in the domestic economy is justified by this factor. Its application is mostly restricted to certain branches of the food industry with a high raw-material-to-finished-product turnover rate, such as the meat and dairy sectors. In contrast, industries like beverage production or the tobacco sector do not require significant structural changes in accounting practices.

Target costing is not widely applicable to the food industry due to the need for pre-determined product pricing and large production volumes. This makes the system more suitable for mechanical engineering and related industries when assessing the feasibility of launching new models. In the food industry, however, there is significant volatility in selling prices and an extensive range of relatively simple end products. Nevertheless, in some cases, this model may be justified for the introduction of new innovative products. For product innovations, it is considered the most appropriate management accounting system [15]. Thus, in the course of solving the second research objective, factors influencing the third area of our study were identified, namely: the search for the most optimal management accounting method in the food industry. The following industry-specific features were revealed:

- the predominant development in the Republic has been observed in the beverage, meat, dairy, and flour-and-cereals sectors, as illustrated in the flow diagram (Fig. 2);
- these industries are characterized by a relatively low capacity utilization rate, significantly below 100 %, primarily due to production seasonality (Table 1). As a result, this leads to variability in both cost magnitude and structure.

Summarizing the observed industry-specific features, it can be concluded that since the key food industry sectors in Kazakhstan, which have seen the greatest development in recent years, exhibit significant cost variability due to seasonality and, consequently, far-from-100 % capacity utilization rate, fixed costs generally play a secondary role. This highlights the need to implement the direct costing system in the country's food industry, as it best aligns with the operational characteristics of these production sectors. It optimizes the tax burden on enterprises by focusing on variable costs, which are particularly significant in the food industry. Given the current structure of national production with a focus on beverage, meat, dairy, and flour-and-cereals sectors, this approach is universally applicable to the Republic's food industry as a whole.

## 5. 2. Analysis of the potential application of modern technologies to improve management accounting in the food industry

Improving management accounting tools in the food industry is a crucial task for enhancing management efficiency, reducing costs and improving the financial performance of enterprises. Given the industry's specifics where product quality control and cost management at all stages of the life cycle are essential, accounting tools should focus on innovative approaches, process automation, and the integration of new technologies. The key areas for improving management accounting tools in the food industry can be considered as follows:

1. Integration of modern information technologies. One of the main directions is the implementation and development of information technologies in the management accounting system:

- business process management (BPM) tools;
- laboratory information management systems (LIMS);
- enterprise asset management (EAM) tools;
- customer relationship management (CRM) tools;



- manufacturing execution systems (MES);
- warehouse management systems and supply chain management (WMS, SCM) tools;
- corporate/enterprise performance management (CPM/EPM) tools;
- financial, asset and human resources management (ERP) tools;
- electronic document management systems (EDMS).

Modern systems that integrate all business processes, including costing, inventory management, procurement, and production, significantly enhance accounting accuracy and decision-making efficiency. The use of such technologies helps speed up reporting processes, reduce errors, and improve accounting transparency.

2. Costing automation. To improve management accounting, it is essential to automate product costing processes. Implementing automated costing systems allows for a more accurate allocation of overhead costs, taking into account the specifics and complexity of different production operations. This approach helps eliminate distortions that may arise from traditional costing methods and improves cost control at each stage of the production process.

There is a wide range of costing methods that can be effectively applied in the food industry as an innovative approach in management accounting (Table 2).

The costing methods listed in Table 2 are applicable to the life cycle of food products. It is advisable to start costing using “Strategic management accounting methods”, implementing them from the preliminary stages of food production. For example, effective approaches include: lifecycle costing, which considers expenses over the entire product lifecycle; value chain analysis, which accounts for product-specific characteristics at all stages of its lifecycle. Another valuable tool, suitable for both strategic and operational management, is the balanced scorecard. “Life-cycle costing” enables businesses to estimate costs and assess results from cultivation to food product sales. This method accounts for production-stage costs, as well as pre-production and post-production expenses, which traditional management accounting often misclassifies as period costs, failing to associate them with specific products.

The “Balanced scorecard” concept aligns employees’ daily activities at all management levels with the company’s strategic goals, ensuring effective strategy implementation. It links financial indicators with operational metrics, such as customer satisfaction, internal business processes, innovation activity, and financial performance. While implementing this system offers significant advantages, it also involves significant costs. Simply developing performance indicators as part of implementing the “Balanced scorecard” concept is not enough; successful adoption requires integration into all management processes, necessitating a fundamental transformation of the company’s overall strategy.

A comparison between target costing and traditional methods highlights the greater efficiency of the former. Organizations using traditional costing systems tend to incur higher expenses during the production process. This is because total production costs can only be determined after manufacturing is complete. If these costs exceed the market price, additional research is necessary.

Table 2

Traditional and innovative costing methods recommended for use in the food industry

Accounting feature	Traditional methods	Innovative methods
Completeness	Traditional costing (full costing method)	Direct costing
Object	Methods: job order, contract, combined	–
Segmentation by operations and functions	Value analysis	Just-in-time (JIT). ABC costing
Target cost efficiency	–	Target costing. Kaizen costing
Accounting and controlling	Actual costing	Standard costing
Strategic planning accounting	–	Strategic management methodology. Strategic business unit concept. Balanced scorecard. Life-cycle costing. Value chain analysis

Successful implementation of target costing is possible only if most of food industry enterprises operate in close cooperation.

An effective cost control approach during the investment and production stages is order costing (ABC costing). This method allocates expenses by identifying multiple functional cost centers (cost pools) based on operations (tasks, work types). ABC costing can be compared to the job order costing method, but its key differences are as follows:

- overhead costs are not allocated to orders based on direct labor as the primary cost driver;
- overhead costs are treated as a collective set of categories with different allocation bases.

Each cost category has a particular allocation basis, typically using process intensity ratios that are not directly linked to production volume. The goal is to allocate costs to specific orders for a more precise determination of initial costs. Furthermore, the method provides greater accuracy compared to the standard costing method.

Although ABC can be used by companies in planning their activities, in practice, it is often difficult to implement. Its application in management accounting and for substituting traditional cost grouping methods must be economically and methodologically justified.

At the investment stage, it is advisable to use kaizen costing, which is applied in almost all areas of food industry production in combination with other cost management methods. This approach focuses on continuous productivity optimization. It aims at ongoing improvement, constant optimization, and gradual yet stable cost reduction within company departments by utilizing internal reserves. It is worth noting that the application of kaizen costing helps ensure the required cost level of goods and reduce expenses to a predetermined level while simultaneously improving product quality through modifications to production processes and enhancements in their efficiency.

The standard costing system in question is a normative costing method. While there are some differences, both methods share a strict approach to cost regulation. They implement the initial establishment of regulatory costing based on accepted resource spending standards, and conduct separate accounting and control of expenses, taking into account norms and deviations from them.

### 3. Forecasting and data analytics.

An important area of focus is the implementation of analytical tools for cost forecasting and assessing the efficiency of production processes. The use of big data analysis methods and artificial intelligence to predict changes in the cost of raw materials, labor, and other factors allows for rapid responses to changes in the external environment. This facilitates more accurate planning and cost management while also improving profit and financial performance forecasting.

The use of artificial intelligence in the food industry is particularly relevant for collecting and analyzing data on raw material and component supplies, as well as in managing finished product sales. Digital solutions ensure the accuracy and timeliness of transmitted data regarding the movement of material resources. The features of digital products are in high demand within the retail sector. Accordingly, food industry enterprises can also effectively utilize artificial intelligence and the Internet of Things together in procurement and sales departments. The application of digital solutions in the food industry and the results of a survey conducted on enterprises in 2022 are demonstrated through examples from the food industry in Table 3.

Table 3

Responses of enterprises evaluating the application of digital technologies in 2022 in the “food production” sector, %

Category	Positive	No impact	Negative
<b>Big data collection, processing, and analysis technologies</b>			
Financial activities	3.3	68.4	28.3
Employee safety	15.9	75.2	9.0
Production of goods with new characteristics	3.0	73.7	23.3
Internal process efficiency	3.1	66.5	30.4
Cooperation efficiency	3.2	65.5	31.3
Environmental impact	3.4	82.7	13.9
<b>Artificial intelligence</b>			
Financial activities	2.7	87.0	10.3
Employee safety	2.8	88.2	9.0
Production of goods with new characteristics	2.6	87.7	9.7
Internal process efficiency	2.5	83.9	13.6
Cooperation efficiency	2.8	85.8	11.4
Environmental impact	2.7	90.2	7.1
<b>Internet of Things</b>			
Financial activities	2.7	76.2	21.1
Employee safety	2.6	79.5	17.9
Production of goods with new characteristics	2.5	78.3	19.2
Internal process efficiency	2.5	72.8	24.7
Cooperation efficiency	2.6	73.4	24.0
Environmental impact	2.4	85.6	12.0
<b>Other digital technologies</b>			
Financial activities	2.0	65.5	32.5
Employee safety	1.7	75.4	22.9
Production of goods with new characteristics	1.5	74.5	24.0
Internal process efficiency	1.6	61.9	36.6
Cooperation efficiency	1.5	60.4	38.1
Environmental impact	1.7	84.3	14.0

Note: calculated by the author (s) based on [21].

As seen in Table 3, the use of digital technologies, including artificial intelligence and the Internet of Things, in the food industry was positively assessed by almost 15.9 % of companies.

Thus, in the area of “internal process efficiency”, which primarily includes key management accounting tools, the use of Big Data technologies had a positive impact in only 3.1 % of cases. Artificial intelligence showed a positive effect in 2.5 % of cases, as did the Internet of Things. Other digital technologies accounted for 1.6 %, respectively. In all other instances, the impact was either negative or nonexistent. This means that the positive impact of digital solutions, regardless of the area of application, was actually within the margin of statistical error.

The use of artificial intelligence for expense forecasting and cost optimization is becoming an increasingly popular tool in management accounting. AI systems can analyze historical data and predict future cost trends, allowing businesses to take proactive optimization measures. This is particularly important in the food industry, where variable factors such as raw material costs can strongly affect overall expenses. Additionally, artificial intelligence can be useful in conducting comprehensive statistical analyses of a company’s financial performance, particularly its financial stability.

Overall, the use of modern tools in management accounting for the food industry can significantly improve accounting processes, enhance data accuracy, speed up decision-making and reduce costs. However, for the effective implementation of these technologies, proper training and adaptation of business processes to new tools are essential.

## 6. Discussion of research results on improving management accounting tools

Management accounting in the food industry has several specific features due to the unique nature of food production, storage, and sale processes. These characteristics influence costing methods, financial flow management, and both operational and strategic decision-making. The decline in total investments in process innovations (Fig. 1) reflects reduced attention to the use of management accounting tools in the industry. The overall reduction in innovation expenditures significantly contributes to the continued dominance of a resource-export-oriented economic structure.

Addressing this issue requires diversifying production structures and enhancing the competitiveness of Kazakhstan’s products in both domestic and international markets. Therefore, increasing expenditures on process innovations appears to be a reasonable approach. In recent years, this area has remained significantly underfunded compared to earlier periods, even without accounting for inflation. One of the promising process innovation approaches is the improvement of effective management accounting tools.

The structure of industrial production in the food industry is diverse, encompassing several key segments, each playing a crucial role in the country’s economy. In the Republic of Kazakhstan, the beverage, meat, dairy, and flour-and-cereals sectors have seen the most development, as illustrated in the flow diagram (Fig. 2). Based on the structure and trends in the share of various segments within the food industry, priority should be given to sectoral planning and accounting. This system should not only serve as an informational database

but also enable current data analysis, thereby supporting informed decision-making. Since the food industry is characterized by significant variability in cost structures, fixed costs generally play a secondary role.

Table 1 highlights the high capacity utilization rate in the tobacco and confectionery industries. For other sectors, this figure is around 50 % or lower. Given this unstable and rather low capacity utilization level, a variable costing model would be appropriate, where indirect costs are allocated based on capacity utilization rates. A wide range of costing methods as an innovative approach in management accounting is presented in Table 2. It contrasts traditional methods such as full costing (absorption costing) and innovative approaches like direct costing, ABC costing, target costing, and others. Traditional methods often distort product cost information by distributing costs across all production stages without considering their specifics. ABC costing and target costing provide a more accurate picture of actual costs at each stage of a product's lifecycle, helping to avoid unnecessary expenses. For example, target costing allows for the early determination of a product's target cost, while ABC costing enables a more precise allocation of overhead costs across functional centers, making it a more effective cost control tool. The simultaneous use of multiple resource-intensive tools in enterprise operations reflects the complexity of their activities and the extensive scope of tasks handled by the management accounting system.

The application of digital solutions in the food industry and the results of a survey conducted on enterprises in 2022 are demonstrated through examples from the food industry in Table 3. According to the survey, the use of digital technologies, including artificial intelligence and the Internet of Things, in the food industry was positively assessed by companies.

One of the main drawbacks of research in improving management accounting tools is the lack of universal solutions that would suit all organizations, especially across different industries. Tools that may be effective in one company may not always be applicable in another due to differences in business processes, scale, resources, and corporate culture. For example, implementing costing methods such as target costing or ABC costing may be highly effective in one organization, but in another company with fewer resources and different processes, their implementation might not lead to the desired results. Research often overlooks the real cost and resources needed to implement new management accounting tools. Implementing innovative methods such as process automation using ERP systems, big data analysis, or artificial intelligence requires significant capital investments, as well as personnel training. Many studies focus on the theoretical benefits of implementing such technologies, without addressing the real challenges and costs associated with their practical application.

Research limitations are related to various factors, including theoretical uncertainty, high implementation costs, the lack of consideration for industry specifics, and practical application issues. These limitations underscore the importance of a comprehensive approach to improving tools and the need for a deeper exploration of the actual conditions and industry-specific features of management accounting in the food industry.

The potential development and enhancement of management accounting tools are linked to the introduction of innovative technologies, refinement of existing methods, and

accounting for changes in the economic, social, and technological environment. In line with current trends and business needs, the improvement of costing tools may include further development of more flexible approaches, such as ABC costing (Activity-Based Costing), which allows for a more precise cost allocation across specific business operations and processes. With the development of artificial intelligence and big data processing technologies, management accounting is becoming more accurate and predictive.

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## 7. Conclusions

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1. The use of average annual capacity in the industry shows that many enterprises operate with underutilized capacity during the off-season. Effective management accounting should include capacity planning and reallocation mechanisms to ensure optimal capacity utilization and minimize production costs. Fixed costs are a secondary factor, as the capacity utilization rate is less than 100 %. This highlights the need to implement the direct costing system in the food industry, as it best aligns with the operational characteristics of these production sectors. It optimizes the tax burden on enterprises by focusing on variable costs, which are particularly significant in the food industry. Given the current structure of national production with a focus on beverage, meat, dairy, and flour-and-cereals sectors, this approach is universally applicable to the food industry as a whole.

2. Modern technologies provide ample opportunities for improving management accounting in the food industry, allowing for more accurate calculations, faster data processing, and improved decision-making processes. The adoption of ERP systems, big data analytics, artificial intelligence, and accounting methods such as ABC costing or target costing contributes not only to cost optimization but also to ensuring management flexibility and adaptability. In the context of a rapidly changing external environment and sustainable development, such approaches are essential for maintaining competitiveness and resilience in enterprises.

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## Conflict of interest

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The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, or otherwise, that could affect the results described in the current paper.

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## Financing

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The study was performed without financial support.

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## Data availability

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All data are available in the main text of the manuscript.

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## Use of artificial intelligence

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The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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