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COST-BENEFIT ANALYSIS OF UNIVERSITY CAMPUS FOOD WASTE SORTING

Food waste is recognized as one of the major environmental challenges worldwide, and Kazakhstan is no exception. The article examines the current state of food waste management in higher education institutions of the country and highlights the lack of systematic composting practices.

To evaluate the feasibility of introducing such initiatives, a cost-benefit analysis (CBA) was carried out for a potential composting program at L.N. Gumilyov Eurasian National University based on original data collected in March 2025. In addition, a survey of students' willingness to pay (WTP) was analyzed to determine the level of community engagement and possible financial contributions. The results show that composting at the university level would be economically viable and socially supported.

The findings provide valuable calculations for implementation of composting infrastructure in the university context. The results of the economic assessments may serve as a foundation for informed decision making at both institutions and government levels.

Keywords: *food waste management, composting, cost-benefit analysis, willingness to pay, sustainability, universities, green campus*

Кілт сөздер: *азық-түлік қалдықтарын басқару, компосттау, шығын-пайда талдауы, төлеуге дайындығы, тұрақты даму, университеттер, жасыл кампус*

Ключевые слова: *управление пищевыми отходами, компостирование, анализ затрат и выгод, готовность платить, устойчивое развитие, университеты, зеленый кампус*

Introduction. The issue of food waste is one of the major global problems, that affecs not only environment, but also economy and communities. For example, economically it results in over 1 trillion dollars in wasted food annually, which indicates inefficiencies in the supply chain [1]. And this is at the same time when enormous food waste causes problem of hunger in some countries. From the environmental side, food waste is responsible for 8-10% of global greenhouse emissions. Although food waste is often associated with production sector and households, institutions such as schools and universities also play significant role in the problem. For instance, universities that serve thousands of meals in their canteens daily are usually the subject of overproduction [2, 3]. At the same time, universities may play a key role in shaping behaviour and establishing right moral norms. Previous research states universities that adopt sustainable food waste management systems can reduce waste volumes by 25-40% over the course of a single academic year [4].

Important to mention, the principles of sustainable development are gradually being integrated into the curricula of Kazakhstani universities, in particular in technical universities and departments of environmental sciences, however, there is still a lack of systematic assessments of the volumes, types, causes and practices of food waste management in student canteens and kitchens. Despite the availability of literature on environmental issues and waste sorting [5, 6], the issue of food waste in Kazakhstan remains underexplored, particularly in the context of educational institutions.

Therefore, this paper raises the following research questions:

1. What is the potential for implementing composting programs at Kazakhstani universities?

2. How engaged is the university community, including students, in supporting such initiatives?

Thus, this study aims to assess the economic feasiblity and social acceptability of introducing composting at L.N.Gumilyov Eurasian National University.

The study conducts a cost-benefit analysis (CBA) of a proposed composting system at a large public university. Using primary data collected in March, the authors estimate food waste volumes. In addition,

the level of public support for waste sorting and potential sources of sustainable financing are analyzed using data from a student willingness to pay (WTP) survey. The obtained results allow us to formulate sound business ideas for the implementation of compost infrastructure in the university environment.

Literature review. Universities around the world have recognized their responsibility to the environment and have started implementing sustainable food waste reduction policies. Strategies such as portion control, composting programs and awareness campaigns are proven to be effective on a global scale. For instance, University of Kansas and University of California in the United States implemented composting programs across their campuses that significantly have reduced food waste and are often cited as successful institutional models [7].

The University of Reading (UK) has also implemented a system to measure and reduce food waste, with leftovers sent to composting rather than landfill. At Oregon State University (USA), the Food Recovery Network platform is used to distribute surplus food to local charities. Since 2007, the Australian National University has been running an organic waste recycling program that annually converts 136 tonnes of food and bio-waste into high-quality compost used to enrich student gardens and campus green spaces [8]. As a result, composting programs have emerged as one of the most sustainable solutions to food waste at overseas educational institutions.

Notably, importance of the role of composting programs in raising awareness of waste separation and resource conservation among students and staff is crucial. Researchers report active student partcipation in sustainable practices such as water reduction and energy conservation in universities where composting programs are implemented [9].

Another highlight is the financial benefit of composting programs. Universities that successfully implemented them report a notable reduction in disposal costs since reducing landfill-bound waste leads to lower operational expenses. In some cases, composting programs generate additional savings through the use of compost as natural fertilizer on university grounds. Moreover, implementing composting programs enhances a university's reputation as a leader in sustainability.

However, according to a 2023 report on biodegradable waste by the Switch-Asia SCP Foundation in Kazakhstan, the country currently lacks an organized system for sorting and recycling food and biodegradable waste. The report notes that most public and private institutions, including universities, do not have the equipment and systems necessary for composting, food donation, or energy recovery. As a result, edible food ends up in general waste, increasing methane emissions from landfills and missing opportunities to convert waste into useful resources [10].

From a legislative perspective, the Environmental Code of Kazakhstan [11] briefly mentions food waste under the category of "biodegradable waste" (Article 352), but does not require schools or universities to implement waste monitoring or reduction programs. In addition, national food safety and sanitation standards mainly focus on food preparation and with no guidance on consumer waste management [12].

Nevertheless, Nazarbayev University's case demonstrates that 'green' initiatives have great potentaion to receive strong support from the university community. For instance, a paper recycling initiative organised by volonteers of Nazarbayev University collected 13 tons of paper waste in the first year, the profit from was later used for tree planting on campus. As part of the "Green Campus" concept, the university plans to implement a comprehensive waste management program that includes composting of food and plant waste, promoting waste sorting, and monitoring waste disposal practices [8].

Thus, there is a clear deficit in research, infrastructure, and institutional policies in the field of food waste management in the higher education system of Kazakhstan. This complicates the implementation of food waste recycling programs, including composting. Several universities in Kazakhstan, including Satbayev University and Al-Farabi Kazakh National University, have stated their plans to implement composting programs on their campuses. However, following the available data, no university in Kazakhstan has yet implemented composting programs on a regular basis. At the same time, Nazarbayev University's positive experience with paper waste indicates that green initiatives can gain public support.

Due to the active participation of staff and students, the initiative gained wide recognition and contributed to funding for campus greening. This example shows that with community motivation and support, environmental projects can be successful.

Based on this, our study explores the idea that sustainable initiatives such as composting can gain financial and social support. The next section presents a method for estimating the social value of such initiatives using the willingness to pay (WTP) approach.

The main part. L.N. Gumilyov Eurasian National University (ENU), located in Astana, Kazakhstan, is one of the country's leading higher education institutions and a key player in Central Asia's academic landscape. As of recent data, ENU serves a diverse population of approximately 20,000 students and employs about 2,750 academic and administrative staff members. The university operates across a wide campus comprising multiple academic buildings, research centers, and student facilities.

At ENU, meals are prepared in a centralized kitchen facility situated on campus, which serves as the main production hub for all university food services. Once prepared, the food is transported to approximately ten separate canteens located in various academic and administrative buildings.

To assess the patterns and volume of food waste generated within ENU's institutional food services, a simple yet systematic data collection process was developed. Leaflets and log sheets were distributed to kitchen staff at each canteen and food service point across the university. These materials included clear instructions on how to categorize and record food waste, as well as daily log tables for reporting quantities in kilograms. Figure 1 illustrates the three categories of food waste that staff were instructed to use for classification.

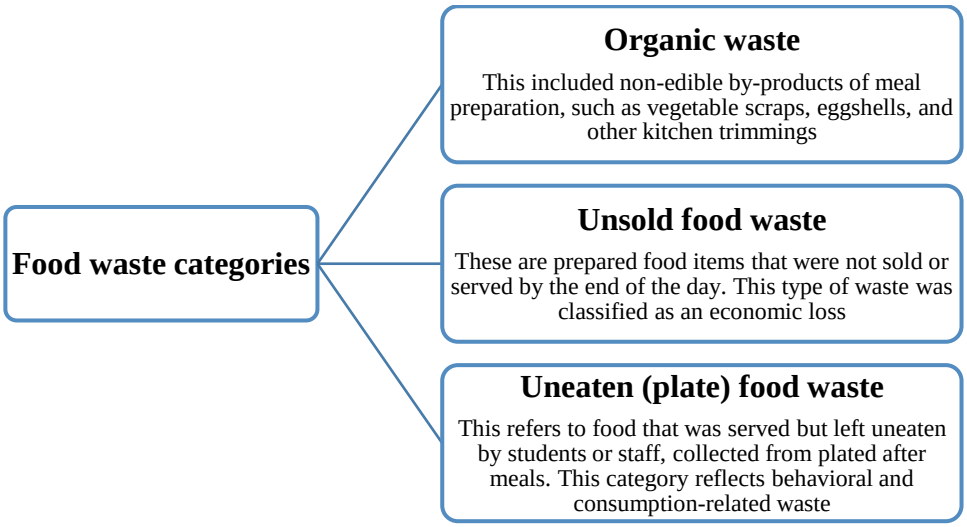

Figure – 1. **Categories of food waste collected at ENU**

**compiled by the authors*

Data collection was conducted between March 1 and 31, 2025. The data were collected from seven food service outlets located on the university's main campuses. According to the monitoring results for March, the average daily volume of food waste was approximately 35 kg of organic waste, 1.2 kg of unsold food, and 10 kg of unused plate scraps. This brings the total volume of food waste to 46.2 kg per day. Taking this into account, the monthly volume of food waste generated on the main campuses alone is 1,386 kg (table 1).

Table – 1

Food waste breakdown at L.N.Gumilyov ENU's main campuses

Waste category	Daily volume, kg	Monthly volume, kg	Yearly volume, tons
Organic waste	35	1 050	12.6
Unsold food	1.2	36	0.43
Uneaten (plate) waste	10	300	3.6
TOTAL	46.2	1 386	16.6

** compiled by the authors*

The adjustment made to account for potential underreporting of food waste (estimated at 20–30%) allows us to project the total monthly volume of food waste generated on campus to range from approximately 1,663.2 kg (1,386 kg × 1.2) to 1,801.8 kg (1,386 kg × 1.3). This corresponds to an annual total of 19.2 to 21.6 tonnes.

Cost-Benefit Analysis (CBA) was utilized to assess the economic feasibility of implementing a composting system in the university area. This method is widely used in applied economics, where all

expected benefits and costs of a proposed project are compared to determine its economic efficiency. In other words, CBA attempts to determine if the benefit of the launch outweighs the costs for its implementation to justify the feasibility of the idea. Elements of the CBA are expressed in monetary terms and include both direct and indirect costs and benefits. The formula is as follows:

$$\text{CBA} = \text{Total Benefits} / \text{Total Costs} \quad (1)$$

where:

Total Benefits is the sum of all economic and ecological benefits;

Total Costs is the sum of all expenses related to the project.

The Contingent Valuation Method (CVM) is one of the tools used to assess non-market or intangible benefits, widely applied in environmental economics. CVM is based on collecting data on the hypothetical willingness to pay (WTP) from the public for the implementation of a specific environmental initiative.

Individual's WTP is typically estimated using a dichotomous choice survey format, in which respondents are presented with one or more yes/no questions regarding their agreement to pay a specified amount. There are two primary types of dichotomous choice formats: single-bounded and double-bounded.

In a single-bounded dichotomous choice, only one bid is presented. The respondent either agrees ("yes") or disagrees ("no") to pay the offered amount. While this approach is simple and less cognitively demanding, it is statistically less efficient and typically requires a larger sample size to obtain precise estimates.

To improve statistical efficiency, the double-bounded dichotomous choice format is widely applied. In this design, respondents are presented with a second bid that depends on their answer to the first one. If the respondent agrees to the first bid ("yes"), a higher follow-up bid is offered; if they decline ("no"), a lower one is presented. This results in four possible response patterns:

Yes – Yes: respondent accepts both the initial and higher second bid

Yes – No: accepts the first, but rejects the higher second bid

No – Yes: rejects the first, but accepts the lower second bid

No – No: rejects both bids

In this study, the double-bounded format was employed to assess participants' WTP. In the first round, respondents received a randomly assigned initial bid. Depending on their answer, the second round presented either a higher or lower amount. This structure allowed for more precise interval estimates of WTP while improving the overall statistical efficiency of the analysis.

As part of this study, a survey was conducted among students (n = 637), who were presented with a realistic scenario of implementing a food waste sorting and composting system in the university cafeteria. In the first round, respondents were asked: *"Are you willing to pay 100 KZT to support green initiatives at your university?"* This served as the initial bid. Based on the response, the second-round bid was adjusted accordingly:

- If the answer was *yes*, the bid increased to 150 KZT; if *yes* again, it further increased to 180 KZT.
- If the initial answer was *no*, the bid decreased to 50 KZT; if *no* again, it further dropped to 20 KZT.
- If the second bid was 50 KZT and the answer was *yes*, it then increased to 80 KZT.
- If the second bid was 150 KZT and the answer was *no*, it then decreased to 130 KZT.

After the data collection, the analysis was performed using Tobit regression in Stata 18, and the average WTP value was calculated. This value was then extrapolated to the total number of students at the university (~20,000 people). As a result, a quantitative estimate of the social support for the project and potential internal funding was obtained.

Composting technologies are well-documented in both domestic and international scientific literature. Therefore, the engineering and technical parameters of the composting system, including waste volumes, loading frequency, carbon-to-nitrogen ratio, as well as covering and aeration methods, were gathered from the following sources:

- Domestic sources: state standards, and regulations, including the Environmental Code of the Republic of Kazakhstan;
- International sources: campus composting practices in leading universities worldwide, as well as GOST R 57001–2016, GOST 33985–2016, and others.

These sources provided the necessary data to adapt the engineering and regulatory calculations to the specific conditions of a Kazakhstani university.

The compost output was calculated according to the source [10], which states that 100 kg of waste equals 63 kg of compost.

By studying theoretical and practical materials on composting, we can identify several methods that can be used in educational institutions for effective food waste management (Figure 2).

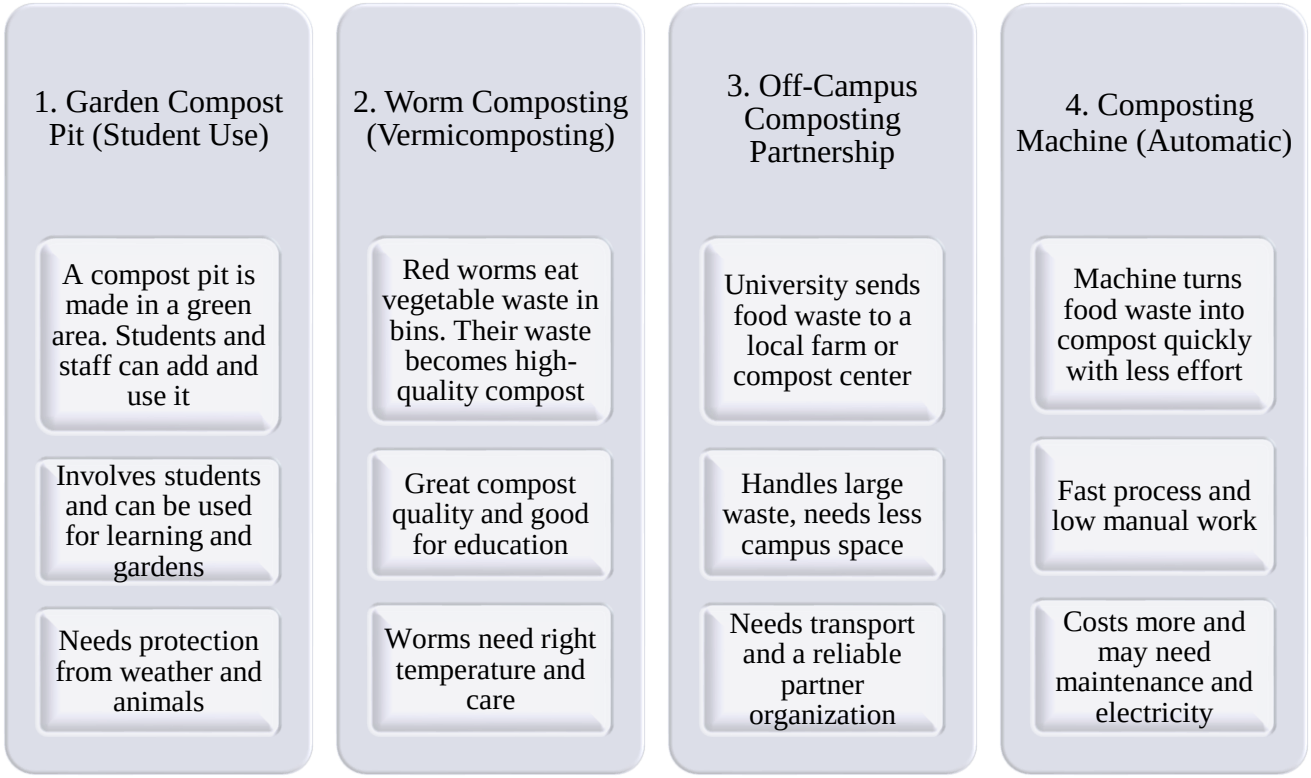

Figure – 2. **Composting techniques in educational institutions**

** compiled by the authors*

As can be seen from Figure 2, each composting method has its own characteristics, advantages, and disadvantages. The choice of method depends on the available resources, the scale of the problem, and the educational goals. Within this study, a garden compost pit was taken as an example.

The volume of the compost pit was calculated using the formula:

$$\text{Volume (m}^3\text{)} = \text{Length (m)} \times \text{Width (m)} \times \text{Depth (m)} \quad (2)$$

The volume of one pit will be: 2.5 m × 1.2 m × 0.5 m = 1.5 m³

To determine the mass of organic waste, the following formula was used:

$$\text{Waste mass (kg)} = \text{Pit volume (m}^3\text{)} \times \text{Waste density (kg/m}^3 \quad (3)$$

For a pit volume of 1.5 m³:

- At a density of 350 kg/m³: 1.5 × 350 = 525 kg
- At a density of 600 kg/m³: 1.5 × 600 = 900 kg

Thus, a compost pit with a volume of 1.5 m³ can hold from 525 to 900 kg of food waste, depending on its density. According to data from March 2025, the average volume of organic waste was from 30 to 35 kg per day. Therefore, the filling time for one pit is from 15 to 30 days depending on the waste density and its daily volume. Considering the volumes of food waste and the dimensions of the composting pit, the following costs and benefits have been calculated (table 2 and 3).

Table – 2

Cost components of CBA (Horizon – 5 Years)

Category	Quantity	Unit Cost (KZT)	Frequency	Total Amount (KZT)
Digging compost pits (12 units)	12	15,000	one-time	180,000
Covering film (1 roll)	1	70,000	annually (as needed)	350,000 (5 years)
Delivery and purchase of base materials	1	30,000	one-time	30,000
Labour payment (2 workers)	2	100,000	monthly (5 years)	2 × 100,000 × 12 × 5 = 12,000,000
Seasonal maintenance (spring)	—	50,000	annually	250,000
TOTAL (for 5 years)	—	—	—	12,810,000 KZT

** compiled by the authors*

Assuming an average WTP of 219 KZT per student and a student population of approximately 20,000, the estimated annual benefit amounts to around 4.4 million KZT (table 3). Over a five-year period, this translates into a projected benefit of approximately 22 million KZT, which exceeds the estimated implementation costs of 12.81 million KZT. The cost-to-benefit ratio is 1.71, which means that for every tenge invested, the project returns 1.71 tenge in benefits. This indicates that the project is economically viable.

Table – 3

Benefits (Economic and Environmental)

Benefit Category	Economic or Environmental Effect
Reduction in mixed waste disposal costs	~30,000–50,000 KZT per month (360,000–600,000 KZT per year)
Compost production for landscaping	Savings on fertilizer purchases, especially during the spring season
Improved ESG rating and sustainable university image	Alignment with sustainability principles, reputational benefit
Educational component (student involvement)	Increased environmental literacy, development of behavioral norms
Willingness of students to pay for sorting (WTP)	Based on survey results: ~219 KZT × 20,000 students = 4.4 million KZT per year (hypothetical maximum)

** compiled by the authors*

Given the demonstrated support for social and environmental initiatives within the university community, it is reasonable to conclude that the proposed composting system has a strong potential for successful adoption and long-term sustainability.

Conclusion. This study assessed the economic feasibility and social acceptability of introducing composting at L.N. Gumilyov Eurasian National University. The cost-benefit analysis based on local data showed that composting would generate 1.71 KZT in value for each KZT invested. The willingness-to-pay survey (n = 637) revealed that, on average, each student is ready to contribute 219 KZT annually to support a composting program. With a student population of about 20,000, the projected contribution amounts to 4.4 million KZT per year and around 22 million KZT over five years, which is almost twice the projected costs of approximately 12 million KZT. These results confirm that composting in the university context is not only environmentally and socially beneficial but also economically viable.

The novelty of this research lies in studying the possibility of introducing a food waste sorting and composting program in the context of a Kazakhstani university.

The findings directly address the research questions by demonstrating the potential of composting programs in higher education institutions, confirming students' willingness to provide financial support, and identifying the conditions for scaling such initiatives to other universities in the country. It is recommended to initiate composting programs at universities in ways that ensure active student involvement. Student contributions can serve as an additional financing mechanism to support such initiatives. Furthermore, targeted awareness campaigns should be implemented to strengthen community engagement.

Future research will focus on analyzing the factors influencing students' decisions to participate in sustainability initiatives, with the aim of developing clear guidelines for increasing engagement. In addition, extended data collection on food waste volumes at the university is needed, since seasonal fluctuations may affect the accuracy of the assessments. In this regard, work on continuous data collection is ongoing.

Thus, the successful implementation of composting programs at university campuses requires the development of infrastructure and a deeper analysis on the motivation of the university community to engage in such initiatives.

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Калиева С.С., Азылканова С.А., Байжолова Р.А., Сурош Д.

УНИВЕРСИТЕТ КАМПУСЫНДАҒЫ ТАМАҚ ҚАЛДЫҚТАРЫН СҰРЫПТАУДЫҢ ШЫҒЫН-ПАЙДА ТАЛДАУЫ

Аңдатпа

Азық-түлік қалдықтары бүкіл әлемде негізгі экологиялық проблемалардың бірі ретінде танылған, және Қазақстан да бұл мәселеден тыс қалған жоқ. Мақалада елдегі жоғары оқу орындарында азық-түлік қалдықтарын басқарудың қазіргі жағдайы қарастырылып, жүйелі компост жасау тәжірибесінің жоқтығы атап өтіледі.

Осындай бастамаларды енгізудің мүмкіндігін бағалау үшін 2025 жылдың наурыз айында жиналған бастапқы деректер негізінде Л.Н. Гумилёв атындағы Еуразия ұлттық университетінде ықтимал компосттау бағдарламасына шығын–тиімділік талдауы (CBA) жүргізілді. Сонымен қатар, университет қауымдастығының қатысу деңгейін және ықтимал қаржылық үлестерді айқындау мақсатында студенттердің төлеуге дайындық (WTP) сауалнамасы талданды. Нәтижелер көрсеткендей, университет деңгейінде компосттау экономикалық тұрғыдан тиімді әрі әлеуметтік қолдау табатын бастама бола алады.

Зерттеу нәтижелері университеттік ортада компосттау инфрақұрылымын енгізу үшін құнды есептеулерді ұсынады. Экономикалық бағалаулардың қорытындылары негізделген шешімдер қабылдауда білім беру ұйымдары мен мемлекеттік деңгей үшін тірек бола алады.

Калиева С.С., Азылканова С.А., Байжолова Р.А., Сурош Д.

АНАЛИЗ ЗАТРАТ И ВЫГОД СОРТИРОВКИ ПИЩЕВЫХ ОТХОДОВ В УНИВЕРСИТЕТСКОМ КАМПУСЕ

Аннотация

Пищевые отходы признаны одной из серьёзных экологических проблем во всём мире, и Казахстан не является исключением. В статье рассматривается текущее состояние управления пищевыми отходами в высших учебных заведениях страны и подчёркивается отсутствие системных практик компостирования.

Для оценки возможности внедрения таких инициатив был проведён анализ «затраты–выгоды» (CBA) потенциальной программы компостирования в Евразийском национальном университете имени Л.Н. Гумилёва на основе оригинальных данных, собранных в марте 2025 года. Кроме того, был проанализирован опрос студентов о готовности платить (WTP) с целью определения уровня вовлечённости университетского сообщества и возможных финансовых вкладов. Результаты показали, что компостирование на университетском уровне может быть экономически целесообразным и социально поддерживаемым.

Полученные выводы представляют ценные расчёты для внедрения инфраструктуры компостирования в университетской среде. Результаты экономической оценки могут служить основой для принятия обоснованных решений как на институциональном, так и на государственном уровнях.