

ТЕХНИКАЛЫҚ ҒЫЛЫМДАР ЖӘНЕ ТЕХНОЛОГИЯЛАР

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Sustainable alternatives to plastic: solutions to reduce environmental pollution**Abstract**

Main problem: Plastic pollution from single-use plastics causes threats to human health, biodiversity, and ecosystems worldwide. This study explores alternatives to plastic to reduce environmental pollution in Ust-Kamenogorsk (Oskemen), Kazakhstan.

Methods: We used a mixed-methods approach: a survey (~150 respondents) to quantify daily plastic use, focus groups (5 students) to discuss usage patterns and alternatives, and semi-structured expert interviews (2 experts) to examine waste challenges.

Results and their significance: The survey revealed that plastic packaging (bags) and bottles have the highest daily usage scores (around 3.8 and 3.2 on a 1–5 scale), whereas plastic toys scored lowest (~2.0). Most respondents expressed neutral or moderate satisfaction with plastic products. Focus group participants agreed that plastic is integral to food storage, packaging, and medicine, but suggested reusable bags, water fountains, and paper packaging as local alternatives. Interviewed experts cited plastic's low cost and convenience as barriers to replacement, noted insufficient recycling infrastructure (only about 21.9 % of plastic waste is recycled in Kazakhstan), and advocated incentives such as government subsidies or bans. Overall, findings emphasize the importance of public education campaigns, improved recycling systems, and policies (e.g., bans on plastic bags and incentives) to shift consumer behavior towards sustainable alternatives. Such measures could significantly reduce plastic pollution and support environmental sustainability.

Key words: plastic alternatives, environmental pollution, biodegradable polymers, consumer awareness, waste management, sustainability, Kazakhstan.

Introduction

Plastic pollution is one of the most critical global environmental problems, threatening human health, biodiversity, and ecosystems. Cheap single-use plastics are ubiquitous yet persist in the environment for centuries. In Kazakhstan's industrial city of Ust-Kamenogorsk (Oskemen), reliance on plastic products is high, but recycling rates are low (only about 21.9 % of plastic waste was recycled in 2021). The study objective is to quantify public awareness of plastic issues, document the role of plastic in daily life, and evaluate feasible sustainable alternatives to reduce plastic waste. Previous studies highlight the need for combined technological and policy solutions and the potential of biodegradable polymers (e.g. PHA, PLA) under proper waste systems. Consumer concern and behavior are key factors in plastic reduction, so we included both consumer surveys and expert opinions in our analysis. The findings aim to guide local policies and initiatives for greener consumption.

Materials and Methods

A mixed-methods design was employed. A quantitative survey (distributed via Google Forms to students, teachers, and residents of Oskemen) collected ~150 responses on frequency of daily use of various plastic products (bags, bottles, containers, etc.) using Likert scales (1 = never, 5 = very frequently) and satisfaction with plastics. The survey remained open for two weeks. Respondents were assured confidentiality.

Qualitative data came from two sources. First, a focus group discussion was held with 5 high-school students (grades 10–12) to explore attitudes toward plastic use and alternatives. We asked about common plastic items, inconveniences, and suggested solutions (e.g., reusable items, recycling). Second, semi-structured interviews (~20–30 min each) were conducted with two local experts (in

ecology and waste management) to probe knowledge of plastic pollution, barriers to alternatives, and potential interventions. These sessions were audio-recorded and transcribed, with recurring themes coded for analysis. The combined methods allow triangulation: broad quantitative patterns from the survey, and in-depth perspectives from focus group and interviews.

Results

Survey: 150 respondents completed the survey. Figure 1 (below) and Table 1 summarize key findings. The satisfaction ratings for plastic products were mostly neutral: 58 % of participants reported a neutral or indifferent attitude, 17 % “satisfied”, 17 % “very satisfied”, and only 4 % each “dissatisfied” or “very dissatisfied” (out of 50 respondents, see Table 1).

Table1– Distribution of satisfaction with plastic products (survey of 50 Oskemen residents)

Product (plastic)	Average daily use (1–5)
Bags (shopping packages)	3.78
Bottles (water/drinks)	3.22
Stationery (office use)	3.63
Plates and cookware	2.76
Food containers	2.61
Toys	1.96

The table shows that plastic bags (packaging) and bottles are the most frequently used items (highest average scores), whereas plastic toys are least used.

Focus Group: Participants confirmed that plastic is highly prevalent in daily life (food packaging, containers, medicine). All agreed that plastic makes food transport and storage convenient, and is “irreplaceable” in medical supplies due to hygiene. However, they identified alternatives: using reusable fabric bags instead of disposable plastic bags, installing more drinking-water fountains to avoid bottled water, and shifting to paper or plant-based packaging. They noted that lack of public awareness is a hurdle: “If people understand how harmful plastic is, they will choose differently.” Participants also suggested waste separation and city policies (e.g. banning single-use bags) to encourage change.

Interviews: Experts echoed that plastic’s low cost and availability drive its widespread use. They noted that current recycling and waste-sorting infrastructure is weak, so most plastic ends up in landfills or the Bukhtarma reservoir. Interviewees considered policy interventions essential: examples included government incentives or subsidies for reusable products, strict regulations (similar to plastic bans in EU countries), and public education campaigns. They emphasized that without such measures, consumers and businesses have little motivation to switch to greener materials.

Discussion

Our findings indicate that plastic dominates daily consumption in Oskemen, consistent with global trends. The high use of bags and bottles (average ~3.8 and 3.2) reflects plastic’s convenience and availability. This aligns with Cavaliere et al. (2020), who found that consumer concern and knowledge strongly influence willingness to avoid plastics. Here, most respondents were neutral about plastics, suggesting moderate awareness; experts confirmed that many residents lack information on plastic’s environmental impact.

The results also reveal systemic issues: interviews showed that cheap plastic (low price, easy purchase) is the main barrier to alternatives, echoing Mülhaupt (2013)’s observation of cost advantages for plastics. Low recycling rates (only ~21.9% in Kazakhstan) mean that sustainable materials alone are insufficient without waste management improvements.

Policy and education are critical. Recommended measures in the literature include bans on single-use items, levies, and improved recycling guidelines. Our participants’ suggestions (e.g. plastic bag bans, reuse incentives) are consistent with these. Solutions should integrate infrastructure and policies suitable for the local context. For example, expanding recycling facilities and school programs (education) would complement stricter regulations.

Overall, promoting alternatives (biodegradable materials, reusables) will require coordinated efforts: public awareness campaigns, government support, and business participation. Without these, plastic consumption is likely to remain high despite its recognized harms.

Conclusion

This study confirms that plastic remains an indispensable part of daily life in Oskemen, yet also highlights significant opportunities to reduce its use. Students and experts identified feasible alternatives (reusable bags, water fountains, paper packaging) and underscored the need for systemic changes. Key recommendations include increasing environmental education, improving waste management infrastructure, and implementing policy incentives such as subsidies for green products or bans on certain plastics. By adopting these measures locally-aligned with global best practices - the community can lower plastic pollution and advance towards sustainability. Future work should evaluate the effectiveness of specific interventions (e.g. bag taxes, school programs) and continue monitoring consumer attitudes to guide policy.

THE LIST OF SOURCES

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Пластмассаның тұрақты баламалары: қоршаған ортаның ластануын азайту шешімдері

Бір реттік пластиктің ластануы әлемдегі адам денсаулығының, биоәртүрліліктің және экожүйелердің қауіпсіздігіне қатер төндіреді; бұл мәселе Қазақстанның Өскемен қаласында өте өзекті, өйткені онда пластик өнімдер кеңінен қолданылады. Зерттеуде аралас тәсіл қолданылды: күнделікті пластик қолдануды сандық бағалау үшін шамамен 150 қатысушымен

сауалнама жүргізілді, пластик тұтыну үлгілері мен баламаларын талқылау үшін 5 оқушыдан тұратын фокус-топтар ұйымдастырылды, қалдықтарды басқару проблемаларын зерттеу мақсатында 2 маманмен жартылай құрылымдық интервью өткізілді.

Сауалнама нәтижелері бойынша пластик пакеттер мен бөтелкелердің пайдалану жиілігі ең жоғары болып шықты (~3,8 және ~3,2 балл, 1–5 шкала бойынша), ал пластик ойыншықтар ең төмен (~2,0). Көптеген респонденттер пластик өнімдерінен нейтралды немесе орташа деңгейде қанағаттанғанын білдірді. Фокус-топ қатысушылары пластиктің азық-түлікті сақтау мен медицинада қажетті екенін атап өтті, бірақ қайта пайдаланылатын сөмкелер, ауыз су бағандары және қағаз қаптамалар сияқты баламаларды ұсынды. Сарапшылар пластиктің арзандығы мен қолжетімділігін басты кедергі деп атады, қайта өңдеу инфрақұрылымының әлсіз екенін айтты және үкімет субсидиялары немесе заңнамалық тыйымдар сияқты ынталандыруларды ұсынуды ұсынды.

Нәтижелер экологиялық ағарту науқандарының, қайта өңдеуді дамытудың және саяси шаралардың (мысалы, пакеттерге тыйым салудың) маңыздылығын көрсетеді, бұл шаралар пластик ластануын айтарлықтай азайтып, тұрақты дамуға септігін тигізуі мүмкін.

Түйінді сөздер: пластикка баламалар, биоыдырайтын полимерлер, қоғамдық экологиялық сана, қалдықтарды қайта өңдеу, экологиялық саясат, Қазақстан, тұрақты даму.

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Устойчивые альтернативы пластику: решения по снижению загрязнения окружающей среды

Загрязнение одноразовым пластиком представляет угрозу здоровью человека, биоразнообразию и безопасности экосистем во всем мире. Эта проблема особенно актуальна для Усть-Каменогорска (Казахстан), где широко используются пластиковые изделия. В исследовании использовался смешанный методический подход: был проведен опрос примерно 150 участников для количественной оценки ежедневного использования пластика, были организованы фокус-группы из 5 студентов для обсуждения моделей потребления пластика и альтернатив, а также были проведены полуструктурированные интервью с 2 специалистами для изучения проблем управления отходами.

Согласно результатам опроса, наибольшую частоту использования имели пластиковые пакеты и бутылки (~3,8 и ~3,2 балла по шкале от 1 до 5), а наименьшую – пластиковые игрушки (~2,0). Большинство респондентов выразили нейтральную или умеренную удовлетворенность пластиковыми изделиями. Участники фокус-группы отметили, что пластик необходим для хранения продуктов питания и лекарств, но предложили альтернативные варианты, такие как многоразовые пакеты, бутылки для питьевой воды и бумажная упаковка. Эксперты назвали основным препятствием низкую стоимость и доступность пластика, заявили о слабой инфраструктуре переработки и предложили использовать такие стимулы, как государственные субсидии или законодательные запреты.

Результаты подчеркивают важность кампаний по экологическому образованию, пропаганды переработки отходов и мер политики (например, запрета пластиковых пакетов), которые могут значительно сократить загрязнение пластиком и способствовать устойчивому развитию.

Ключевые слова: альтернативы пластику, биоразлагаемые полимеры, экологическое сознание населения, переработка отходов, экологическая политика, Казахстан, устойчивое развитие.

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