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IMPROVING THE ELEMENTS OF CORN GROWING TECHNOLOGY IN THE WESTERN FOREST-STEPPE OF UKRAINE

Moroz V.

*Associate Professor of the Department of Agribiotechnology,
Candidate of Agricultural Sciences*

Shuvar A.

*Head of the Department of Agribiotechnology, Doctor of Agricultural Sciences,
Senior Researcher*

Kozlovsky Yu.

Master of the Department of Agricultural Biotechnology

Solyar S.

Master of the Department of Agricultural Biotechnology

Harhan I.

*Master of the Department of Agricultural Biotechnology
West Ukrainian National University, Ternopil*

ФОРМУВАННЯ ПРОДУКТИВНОСТІ СІВОЗМІНИ ЗАЛЕЖНО ВІД ЧЕРГУВАННЯ СІЛЬСЬКОГОСПОДАРСЬКИХ КУЛЬТУР

Мороз В.В.

доцент кафедри агробіотехнологій, кандидат сільськогосподарських наук

Шувар А.М.

*завідувач кафедри агробіотехнологій, доктор сільськогосподарських наук,
старший науковий співробітник*

Козловський Ю. М.

магістр кафедри агробіотехнологій

Соляр С.М.

магістр кафедри агробіотехнологій

Хархан І.Д.

магістр кафедри агробіотехнологій

Західноукраїнський національний університет, Тернопіль

<https://doi.org/10.5281/zenodo.14235983>

Abstract

The article deals with the improvement of crop rotations by optimizing the structure of sown areas, taking into account natural and climatic conditions, farm needs and economic feasibility. The proposed changes are aimed at reducing the area of industrial and fodder crops in favor of highly profitable cereals, in particular winter wheat. The results of the implementation of improved crop rotations are presented. Improved crop rotation contributes to the preservation of soil fertility, reduction of erosion processes, increase of ecological sustainability of land, as well as profitability of agricultural enterprises in modern market conditions.

Анотація

У статті розглянуто вдосконалення сівозмін шляхом оптимізації структури посівних площ з урахуванням природно-кліматичних умов, потреб господарства та економічної доцільності. Запропоновані зміни спрямовані на зменшення площ технічних і кормових культур на користь високорентабельних зернових, зокрема озимої пшениці. Наведено результати впровадження вдосконалених сівозмін. Вдосконалення сівозмін сприяє збереженню родючості ґрунтів, зменшенню ерозійних процесів, підвищенню екологічної стійкості земель, а також рентабельності агропідприємств у сучасних ринкових умовах.

Keywords: enterprise, crop rotation, cereals, sown areas, fodder crops

Ключові слова: підприємство, сівозміна, зернові, посівні площі, кормові культури

Проектування ефективної системи сівозмін є одним із найважливіших напрямів оптимізації землеробства. Основними етапами роботи є: визначення спеціалізації господарства, враховуючи його ресурси, природно-кліматичні умови та економічні потреби; розробка структури посівних площ, яка

базується на агрономічній доцільності чергування культур; проектування польової сівозміни з урахуванням принципів раціонального використання ґрунтів; розробка плану переходу на нову сівозміну, що забезпечить мінімізацію витрат та

підвищення ефективності; агрономічна оцінка системи сівозмін, спрямована на її подальше вдосконалення [1-3].

Сучасне землеробство є не лише основою аграрного виробництва, а й інструментом забезпечення продовольчої безпеки, відновлення ґрунтових ресурсів та екологічної стійкості. Інтеграція наукових досягнень у галузь, впровадження прогресивних технологій обробітку ґрунту, а також

раціональна організація сівозмін формують базу для сталого розвитку аграрного сектору [4-6].

Дослідження здійснено на базі Приватного агропромислового підприємства (ПАП) «Дзвін» (рис. 1), яке спеціалізується на рослинництві, тваринництві, а також видобутку та обробці каменю. Засноване у 2000 році, підприємство є однією з провідних агрофірм Тернопільщини. Власником і директором ПАП «Дзвін» є Градовий Василь Степанович.



Рис. 1. ПАП «Дзвін»

Головна садиба підприємства розташована в селі Звиняч Чортківського району Тернопільської області, за 50 км від Тернополя та за 21 км від міста Чортків. Господарство обробляє землі в Чортківському та Борщівському районах області.

У парку техніки підприємства є трактори від компаній John Deere та MTZ, сівалки Horsh, а також комбайни Vervalt та Rora.

Основними напрямками діяльності ПАП «Дзвін» є рослинництво, тваринництво, виробництво будівельних матеріалів та зберігання агропродукції. Підприємство обробляє земельний банк площею 10 тис. га, орендуючи землі в селах Звиняч, Скомороше, Косів, Ридодуби, Білий Потік, Семиківці, Білобожниця, Біла, Лосяч, Бурштин, Гуштин, Бурдяківці та інших. Основні культури включають зернові, зернобобові та кормові, а також цукровий буряк.

У 2021 році ПАП «Дзвін» відкрила власну станцію технічного обслуговування для ремонту вантажівок, яка обслуговує як внутрішні потреби, так і зовнішніх клієнтів.

Підприємство активно розвиває молочне скотарство та свинарство. Молочно-товарна ферма в селі Звиняч здійснює повний цикл виробництва молока. На 2023 рік господарство утримує 740 голів великої рогатої худоби української чорно-рябої та голштинської порід, зокрема 270 дійних корів. Щодня на молокозаводи постачається 7300-7400 літрів молока із середньою жирністю 3,7%.

Також підприємство займається виробництвом цегли та видобутком і обробкою пісковиків. Воно має виробничі потужності в селі Косів і родовище пісковиків в урочищі «Перейма».

Для первинної обробки та зберігання продукції в кожному підрозділі ПАП «Дзвін» є необхідне обладнання. Підприємство володіє зерносушильним комплексом, що включає сушарки на дровах та дві газові сушарки Sukar з добовою продуктивністю 250 тонн. У 2017 році розроблено проєкт будівництва елеваторного комплексу поблизу залізниці для прямої доставки зерна в порти. У 2021 році розпочалося будівництво «Білобожницького елеватору» в селі Білобожниця, який введено в експлуатацію в 2022 році. Елеватор має загальну потужність 48 тис. тонн одночасного зберігання в підлогових складах та металевих силосах і обладнаний пунктом завантаження для автомобільного та залізничного транспорту, двома залізничними коліями, зерноочисними блоками та сушаркою STRAHL11000.

ПАП «Дзвін» активно співпрацює з провідними компаніями галузі постачання насіння, зокрема KWS та Syngenta, а також із постачальниками засобів захисту рослин, такими як Bayer, Syngenta та Basf.

На практиці існує кілька основних принципів чергування культур, які використовуються для досягнення високих врожаїв. Наприклад, можливі комбінації включають такі послідовності культур:

- Пшениця – сояшник – пар;
- Кукурудза – овес – люцерна або конюшина – пар або пасовище;
- Морква – пшениця – пирій.

Зимовий цикл: пшениця – пшениця – ріпак – пшениця – пшениця – соя/сояшник на 2 роки;

Літній цикл: кукурудза – соя – сояшник – бавовна – кукурудза – соя – пшениця.

Для українських фермерів доцільним є дотримання наукових рекомендацій з урахуванням географічних зон: оптимальні схеми сівозміни можуть суттєво відрізнитися для Лісостепу та Полісся. Загалом, якщо господарство вирощує значну кількість культур, варто застосовувати багатопільну сівозміну, наприклад, восьмипільну або десятипільну. Якщо ж планується вирощування від двох до чотирьох культур, оптимальними є чотирипільні або п'ятипільні сівозміни з коротким періодом ротації. З урахуванням сучасного попиту на зернові та олійні культури, дослідження показують ефективність чотирипільної сівозміни з чергуванням наступних культур:

1. Багаторічні бобові трави, зернобобові чи кормові культури.
2. Пшениця озима.
3. Сояшник, зернобобові, кукурудза або інші культури, крім зернових стерньових.
4. Ячмінь ярий, пшениця яра, однорічні трави чи однорічні трави з підсівом багаторічних трав.

У цьому прикладі чотирипільної сівозміни перше поле з багаторічними бобовими забезпечує ґрунт азотом, покращує його склад та структуру завдяки розвиненій кореневій системі, що створює сприятливі умови для подальшого вирощування пшениці. Пшениця на другому полі сприяє збагаченню ґрунту органікою та допомагає зменшити щільність бур'янів. На третьому полі доцільно вирощувати олійні культури або культури з високим попитом, як-от зернобобові чи кукурудза. Четверте

поле призначене для зернових з додаванням однорічних трав, які покращують родючість та захищають ґрунт. У разі вирощування зернових культур, солома чи зелена маса може бути використана як корм для тварин або органічне добриво.

Після визначення структури посівних площ з урахуванням економічних та агротехнічних чинників визначають кількісні параметри сівозміни, орієнтуючись на такі принципи:

- кожна культура або група культур, схожих за біологічними та агротехнічними характеристиками, повинна займати цілі поля, мінімізуючи кількість комбінованих посівних площ;
- поля мають бути спроектовані у формі й розмірах, які сприяють виконанню механізованих робіт;
- допустиме відхилення площ між полями складає до 5%, в окремих випадках – до 10%;
- кількість полів визначають шляхом поділу загальної площі сівозміни на середній розмір поля, при цьому забезпечуючи відповідність рекомендованим строкам повернення культур на попередні місця. при вдосконаленні існуючої сівозміни середні розміри поля і кількість полів залишаються незмінними;
- схема чергування культур у сівозміні розробляється на основі наукових принципів;
- при виборі попередників для озимих культур важливо враховувати практичний досвід господарства, а також результати та рекомендації наукових установ.

Основою для розроблення та вдосконалення сівозміни є оптимальна структура посівних площ, яка визначається з урахуванням ґрунтово-кліматичних особливостей регіону, спеціалізації агропідприємства та необхідності забезпечення суміжних галузей сільського господарства [7-10]. Структурний склад посівних площ і розподіл культур за системою сівозміни наведені на рис. 2-4.

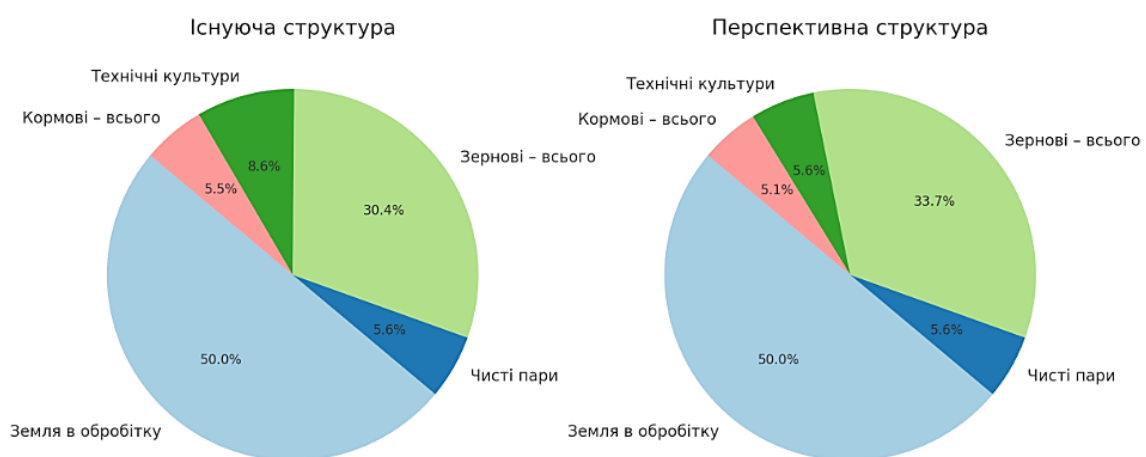


Рис. 2. Розподіл площ по категоріям культур

Ліва діаграма відображає існуючий розподіл площ культур. Основна частка припадає на зернові культури (близько 60,7%), решта розподілена між технічними культурами (17,1%), кормовими культурами (10,9%) та парами (11,2%). Права діаграма

показує перспективний розподіл, де частка зернових культур планується збільшити до 67,3%, а частки технічних та кормових культур зменшити.

Цей графік допомагає зрозуміти, на чому зробити акцент у майбутній структурі сільськогосподарських культур, зокрема на збільшенні зернових за рахунок інших категорій.

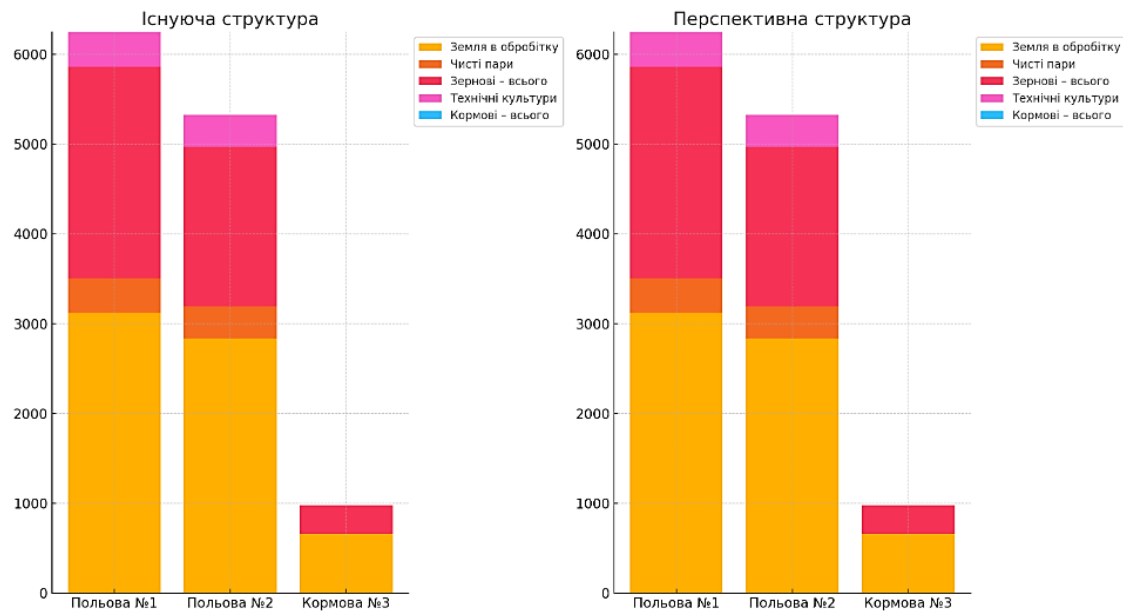


Рис. 3. Розподіл культур за сівозмінами

Лівий графік відображає існуюче розподілення площ культур по трьох структурах сівозмін – польова №1, польова №2 і кормова №3. Зернові в основному займають площу в польових структурах №1 і №2. Правий графік показує перспективну структуру сівозмін для кожної культури, що дозволяє відстежити, як зміни у розподілі культур відобразяться у кожній структурі сівозміни.

Рисунок 3 дає детальний огляд внутрішньої структури розподілу культур і допомагає зауважити конкретні зміни в площах у кожній сівозмінній структурі.

Рисунок 4 порівнює площі для кожної основної категорії культур між існуючою і перспективною структурами. Зауважується значне збільшення площі зернових у перспективній структурі порівняно з існуючою, тоді як площі технічних і кормових культур планується зменшити.

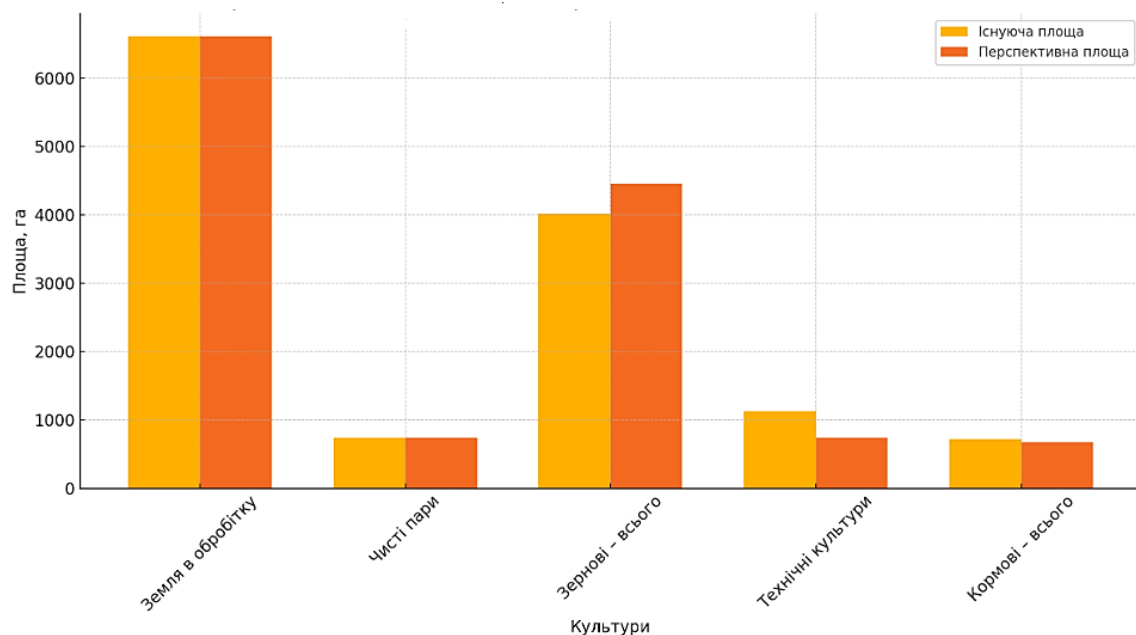


Рис. 4. Порівняння існуючих і перспективних площ по культурам

Гістограма дозволяє легко оцінити загальні тенденції у зміні площ під окремі види культур та ілюструє стратегічні плани щодо їх перерозподілу.

На основі одержаних графіків (рис. 2-4) можна зробити висновок, що перспективна структура сільськогосподарських культур спрямована на збільшення площ під зернові, зокрема пшеницю, з одночасним зменшенням технічних і кормових культур. З урахуванням вимог ринкової економіки, перспективна структура посівних площ спрямована на вирощування високорентабельних культур та оптимізацію сівозміни для підвищення продуктивності і ефективності землекористування [11-14].

У таблиці 1. наведено розподіл посівних площ для існуючої та вдосконаленої сівозмін, які застосовуються в господарстві станом на 2024 рік.

Існуюча сівозміна складається з восьми полів із різними культурами: чорний пар, озима пшениця, цукровий буряк, ярий ячмінь з еспарцетом, еспарцет, кукурудза на зерно та соняшник.

Загальна площа сівозміни становить 3119,0 га із середнім розміром поля 390,2 га.

Чорний пар займає 383,6 га (12,3%), озима пшениця – 393,0 га (12,6%), цукровий буряк та еспарцет – по 389,9 га (12,5%), кукурудза на зерно – 389,9 га (12,5%), а соняшник – 386,7 га (12,4%).

Таблиця 1

Площа кожної культури для обох сівозмін (польова сівозміна №1)

№ поля	Культура	Площа, га	Структура, %
1.	чорний пар	383,6	12,3
2.	озима пшениця	393,0	12,6
3.	цукровий буряк (існуюча) / озима пшениця (вдосконалена)	389,9	12,5
4.	ярий ячмінь з еспарцетом (існуюча) / кукурудза на зерно (вдосконалена)	393,0	12,6
5.	еспарцет (існуюча) / ярий ячмінь (вдосконалена)	389,9	12,5
6.	озима пшениця	393,0	12,6
7.	кукурудза на зерно (існуюча) / соя (вдосконалена)	389,9	12,5
8.	соняшник	386,7	12,4

Вдосконалена сівозміна також складається з восьми полів, але розподіл культур змінений для підвищення ефективності. Культурями залишаються чорний пар, озима пшениця, кукурудза на зерно та соняшник, однак додаються ярий ячмінь та соя, що замінюють цукровий буряк та еспарцет. Загальна площа залишається незмінною – 3119,0 га, із

середнім розміром поля 389,9 га. Розподіл площ за культурами зберігає схожу структуру: чорний пар займає 12,3%, озима пшениця – 12,6% (тепер на трьох полях), кукурудза – 12,6%, а соняшник – 12,4%.

На основі табличних даних побудовано графік порівняння сівозмін (рис. 5)

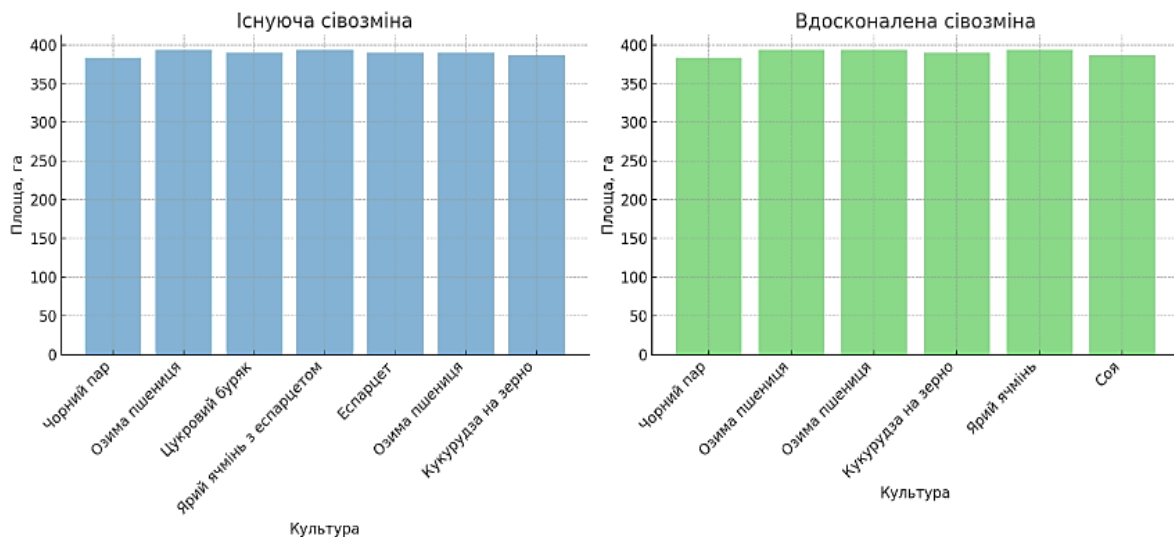


Рис. 5. Порівняння сівозмін існуючої з вдосконаленої (польова сівозміна №1)

Ця таблиця показує, як перерозподіл культур у вдосконаленій сівозміні дозволяє підвищити продуктивність і стійкість посівів, зберігаючи оптимальні показники площ і структури посівних полів.

У таблиці 2 представлено порівняння культур, площ і структурних часток у польовій сівозміні №2

для існуючої та вдосконаленої версій, що застосовуються у господарстві.

Загальна площа сівозміни однакова для обох варіантів і становить 2831,7 га. Середній розмір поля також не змінюється і дорівнює 354,0 га. Зміни у вдосконаленій сівозміні: на 4-му полі: ярий

ячмінь замінено на сою, що дозволяє більш ефективно використовувати площу для вирощування бобових культур і покращує азотне живлення

ґрунту; на 6-му полі: озима пшениця замінена на кукурудзу на силос. Ця заміна збільшує агротехнічну ефективність і сприяє розширенню кормової бази.

Таблиця 2

Площа кожної культури для обох сівозмін (польова сівозмін №2)

№ поля	Культура	Площа, га	Структура, %
1.	Чорний пар	356,4	12,6
2.	Озима пшениця	353,6	12,5
3.	Кукурудза на зерно	356,4	12,6
4.	Ярий ячмінь (існуюча) / соя (вдосконалена)	350,8	12,4
5.	Соя (існуюча) / озима пшениця (вдосконалена)	353,6	12,5
6.	Озима пшениця(існуюча) / кукурудза на силос (вдосконалена)	356,5	12,6
7.	Озима пшениця	350,8	12,4
8.	Соняшник	353,6	12,5

Розподіл культур: чорний пар залишається на 1-му полі з площею 356,4 га і структурною часткою 12,6% в обох варіантах; озима пшениця займає 2-ге, 6-те і 7-ме поля в існуючій сівозміні, але у вдосконаленій її частка на 6-му полі зменшена через дода-

вання кукурудзи на силос; кукурудза на зерно і соняшник зберігають свої позиції в обох варіантах на 3-му та 8-му полях відповідно, з частками 12,6% та 12,5%. На основі табличних даних побудовано графік порівняння сівозмін (рис. 6)

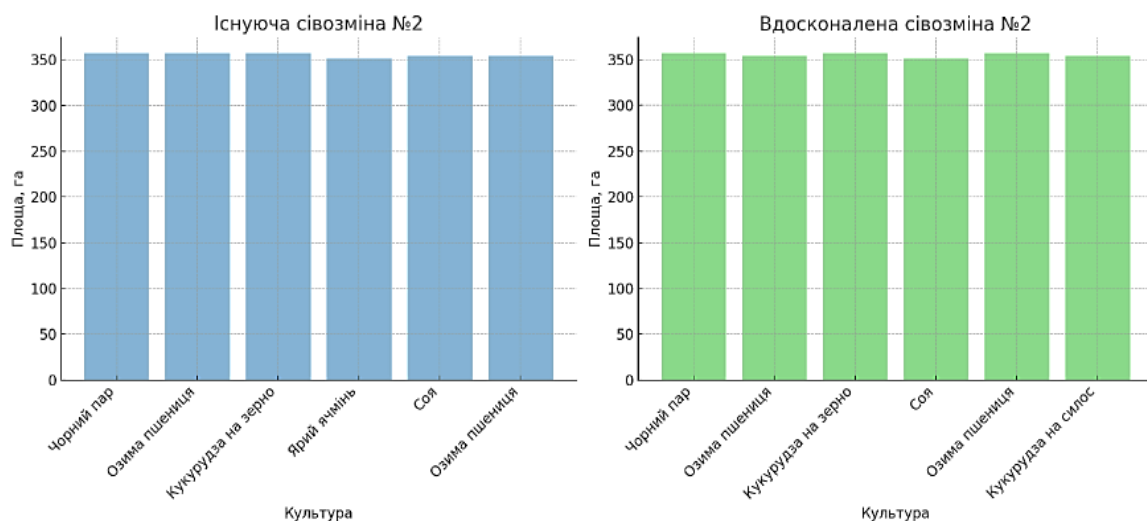


Рис. 6. Порівняння сівозмін існуючої з вдосконаленої (польова сівозмін №2)

Рисунок 6 дозволяє оцінити, як вдосконалена сівозмін більш ефективно використовує наявні площі і відповідає сучасним агротехнічним вимогам, зокрема, за рахунок введення нових культур

(соя та кукурудза на силос), що може сприяти зменшенню ерозійних процесів і підвищенню родючості ґрунтів.

У таблиці 3 представлені дані про площі та структуру культур у польовій сівозміні №3 для існуючої та вдосконаленої версій.

Площа кожної культури для обох сівозмін (польова сівозмінa №3)

№ поля	Культура	Площа, га	Структура, %
1.	Еспарцет	107,8	16,6
2.	Еспарцет	109,7	16,9
3.	Озима пшениця	107,8	16,6
4.	Кукурудза на силос (існуюча) / кормовий буряк (вдосконалена)	106,5	16,4
5.	Озима пшениця (існуюча) / кукурудза на силос (вдосконалена)	109,7	16,9
6.	Ярий ячмінь + еспарцет	107,8	16,6

Загальна площа сівозміни становить 649,3 га, середній розмір поля – 108,2 га.

Еспарцет розміщений на 1-му та 2-му полях з площами 107,8 га та 109,7 га, що становить 16,6% та 16,9% від загальної площі відповідно. Озима пшениця займає 3-тє та 5-тє поля в обох варіантах сівозміни. У вдосконаленій версії вона зміщена на 3-тє поле (16,6%) і не присутня на 5-му, що вивільнило поле для іншої культури.

Зміни у вдосконаленій версії:

- на 4-му полі кукурудза на силос замінена на кормовий буряк;

- на 5-му полі замість озимої пшениці з'являється кукурудза на силос.

Ярий ячмінь з еспарцетом займає 6-тє поле з площею 107,8 га (16,6%) і не змінюється в обох варіантах.

Ці зміни мають на меті оптимізувати використання посівних площ, зокрема, шляхом введення кормових культур, що сприяє покращенню кормової бази. Графік для обох сівозмін рис. 7, щоб візуалізувати площу кожної культури.

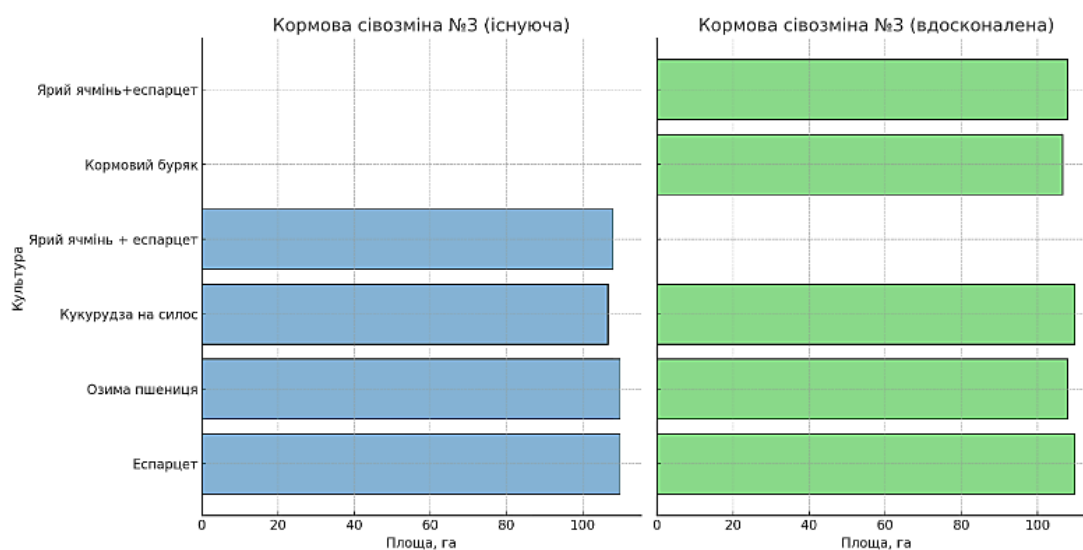


Рис. 7. Порівняння сівозмін існуючої з вдосконаленої (польова сівозмінa №3)

На графіку представлено порівняння площ культур для існуючої та вдосконаленої польової сівозміни №3. Синім кольором позначені культури, що використовуються в існуючій сівозміні, а червоним – у вдосконаленій.

Такі зміни спрямовані на оптимізацію посівів відповідно до потреб господарства, підвищення ефективності сівозміни та збалансованого використання земельних ресурсів.

Висновки. Розробка сівозмін базується на оптимізації структури посівних площ з урахуванням природних і кліматичних умов, потреб господар-

ства та економічної доцільності, що дозволяє зменшити площі технічних і кормових культур на користь високорентабельних зернових.

Перспективна структура посівів передбачає збільшення площ під зернові, зокрема під озиму пшеницю, що сприяє зростанню продуктивності та рентабельності землекористування.

Ефективність вдосконаленої сівозміни №1. У вдосконаленій сівозміні збережено загальну площу 3119,0 га і середній розмір поля 389,9 га, але проведено перерозподіл культур – додано сою та ярий ячмінь, що підвищило ефективність використання площі і зміцнило агротехнічну стабільність.

Вдосконалення сівозмін №2. У сівозміні ячмінь замінено на сою, що підвищує ефективність через покращене азотне живлення ґрунту. Заміна озимої пшениці на кукурудзу на силос забезпечує розширення кормової бази.

Ефективність вдосконаленої сівозміни №3. У сівозміні введено кормовий буряк та кукурудзу на силос, що сприяє підвищенню продуктивності та стійкості посівів і покращує кормову базу господарства.

Вдосконалення сівозмін, зокрема введення бобових і кормових культур, дозволяє зберегти родючість ґрунтів, зменшити ерозійні процеси та підвищити екологічну стійкість земель.

Структурні зміни сівозмін дозволяють ефективно використовувати посівні площі, збільшувати рентабельність агропідприємства та оптимізувати його роботу відповідно до вимог сучасної ринкової економіки.

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Moroz V.*Associate Professor of the Department of Agribiotechnology, Candidate of Agricultural Sciences
West Ukrainian National University, Ternopil***Zhytova O.***Doctor of Biological Sciences, Professor of the Department of Forestry,
Forest Crops and Forest Taxation***Vengel S.***Malinsky Vocational College, teacher-methodologist***Kirikovych I.***Master***Kuznetsova K.***Master**Polissya National University, Zhytomyr2***ТЕХНОЛОГІЯ СТВОРЕННЯ ЛІСОВИХ КУЛЬТУР У ФЛІЛІ «СОСНІВСЬКЕ ЛІСОВЕ
ГОСПОДАРСТВО»****Мороз В.В.***доцент кафедри агробіотехнологій, кандидат сільськогосподарських наук
Західноукраїнський національний університет, Тернопіль***Житова О.П.***доктор біологічних наук, професор кафедри лісівництва,
лісових культур та таксації лісу***Венгель С.М.***Малинський фаховий коледж, викладач-методист***Кирикович І.О.***магістр***Кузнєцова К.М.***магістр*<https://doi.org/10.5281/zenodo.14235985>**Abstract**

The article analyzes the creation of forest crops in different forest vegetation conditions. Based on the analysis, it was found that in the current year in Sosnivske forestry, forest crops were created in the conditions of wet boreal forest - 1.8 hectares, fresh subboreal forest - 4.6 hectares, wet subboreal forest - 18.4 hectares, wet subboreal forest - 1.3 hectares, fresh subgrade - 4.4 hectares, wet subgrade - 1.8 hectares.

It has been determined that four schemes of mixing forest crops are used in the specified forestry: 7rSz3rBp, 4rSz1rDz, 4rSz1rYale, 4rSz1rBp. In wet forest conditions, three planting schemes are used for scots pine and hanging birch, namely 7 rows of pine and 3 rows of birch. In C2 and C3 conditions, 3 planting schemes are used for planting crops, including 4 rows of pine and 1 row of oak, birch or spruce.

In the course of the research, the amount of planting material required per hectare of forest area was determined. Depending on the type of forest and vegetation conditions, it ranges from 3.92 to 4.53 thousand pieces for pine, 0.08-0.60 thousand pieces for spruce, 0.60-0.63 thousand pieces for oak For birch - 0.21-1.67 thousand pieces. The cost of planting one hectare of forest crops is significant, ranging from 11.0 to 29.5 thousand UAH for European pine, from 19.0 to 39.5 thousand UAH for oak, from 16.0 to 34.5 thousand UAH for birch and from 22.0 to 54.5 thousand UAH for spruce.

In addition to the creation of forest crops, the farm provides for natural regeneration in pine stands: a fresh pine forest on an area of 0.7 hectares, a fresh oak-pine subbore on 0.9 hectares, a wet oak-pine subbore on 1.8 hectares, and a wet hornbeam-oak-pine subbore on an area of 0.7 hectares.

Анотація

У статті проаналізовано створення лісових культур у різних лісорослинних умовах. На основі проведеного аналізу, встановлено, що у Соснівському лісництві в поточному році створено лісових культур в умовах вологого бору – 1,8 га, свіжого субору – 4,6 га, вологого субору – 18,4 га, сирого субору – 1,3 га, свіжого сугруду – 4,4 га, вологого сугруду – 1,8 га.

Визначено, що у зазначеному лісництві застосовують чотири схеми змішування лісових культур: 7рСз3рБп, 4рСз1рДз, 4рСз1рЯле, 4рСз1рБп. В умовах вологого бору використовують три схеми розміщення посадкових місць для сосни звичайної та берези повислої, а саме 7 рядів з сосни та 3 ряди берези. В умовах С2 та С3 при посадці культур використовують 3 схеми розміщення, що включає в себе 4 ряди сосни та 1 ряд з дуба, берези або ялини.

В ході проведених досліджень, визначена кількість посадкового матеріалу яке необхідна на гектар лісової площі. Залежно від типу лісорослинних умов вона становить для сосни від 3,92 до 4,53 тис. шт., для ялини – 0,08-0,60 тис. шт., для дуба – 0,60-0,63 тис. шт., для берези – 0,21-1,67 тис. шт. Визначна вартість посадки одного гектара лісових культур, яка становить від 11,0 до 29,5 тис. грн для сосни, від 19,0 до 39,5 тис. грн для дуба, від 16,0 до 34,5 тис. грн для берези та від 22,0 до 54,5 тис. грн для ялини європейської.

Окрім створення лісових культур у господарстві передбачено природне поновлення в соснових деревостанах: свіжий сосновий бір на площі 0,7 га, свіжий дубово-сосновий субір – 0,9 га, вологий дубово-сосновий субір – 1,8 га, а також вологий грабово-дубово-сосновий сугруд на площі 0,7 га.

Keywords: forest type, stand, tree crops, mixing scheme, economic efficiency.

Ключові слова: тип лісу, деревостан, культури дерев, схема змішування, економічна ефективність.

Створення лісових культур є надзвичайно важливим аспектом сучасності, що охоплює різноманітні екологічні, економічні та соціальні питання. Актуальність цього процесу зростає у зв'язку з загрозливими змінами клімату, деградацією лісових екосистем, збільшенням викидів парникових газів та втратою біорізноманіття. Створення лісових культур є важливим кроком у боротьбі з кліматичними змінами, відновленні деградованих територій, збереженні та відновленні біорізноманіття, отриманні економічних вигод, захисті водних ресурсів, а також має соціальний і культурний вплив, допомагає у захисті від природних катастроф і адаптації до кліматичних змін [1-3].

Ліси виконують одну з ключових ролей у пом'якшенні наслідків кліматичних змін, оскільки вони поглинають вуглекислий газ з атмосфери. Висаджування нових лісів і створення лісових культур сприяє зниженню рівня вуглекислого газу в атмосфері, що, в свою чергу, зменшує ефект глобального потепління, а також підтримує кліматичну стабільність, регулюючи температуру і вологість у регіоні [4].

Сільськогосподарська діяльність, вирубка лісів, промислове забруднення та ерозія ґрунтів призводять до деградації земель. Створення лісових культур на таких територіях сприяє відновленню родючості та структури ґрунтів, запобіганню ерозії, а також зменшенню впливу вітрів і злив. Це також покращує водозатримувальну здатність ґрунту, що знижує ризики затоплень і посух. Крім того, лісові культури є важливим засобом для збереження та відновлення біорізноманіття:

ліси слугують притулком для багатьох видів рослин, тварин і мікроорганізмів, які залежать від стабільних лісових екосистем. Відновлення лісових масивів покращує середовище існування для диких тварин, що зменшує ризик їхнього вимирання, а збагачення лісових територій різними видами дерев підвищує екологічну стійкість лісових екосистем [8, 10].

Актуальність дослідження полягає в аналізі ведення господарської діяльності зі створення лісових культур на теренах Соснівського лісництва філії ДП «Соснівське лісове господарство».

Метою досліджень було оцінити створення лісових культур на зрубках у Соснівському лісництві.

Відповідно до поставленої мети передбачається вирішення наступних завдань: оцінити, створення лісових культур за типом лісорослинних умов у Соснівському лісництві; проаналізувати способи створення лісових культур у лісництві; проаналізувати способи розміщення та схеми змішування лісових культур; надати оцінку потреб садивного матеріалу за деревними видами; надати економічну оцінку витрат при створенні культур на одиниці площі [5-7, 9].

Соснівське лісове господарство є складовою Філії «Соснівське лісове господарство». Лісництво розташована у Рівненській області, Березнівський район, селище міського типу Соснове (рис. 1). Загальна кількість майстерський діляниць становить – 6 шт., кількість працівників лісництва – 17 чол.



Рис. 1. Соснівське лісове господарство

Соснівське лісництво загальною площею 5058,0 га входить до складу філії «Соснівське лісове господарство».

Основні показники лісового фонду: 75,1% – соснові насадження I-III бонітету з повнотою 0,63; 13,3% – дубові I-III бонітету з повнотою 0,60; 6,7% – вільхові насадження I-III бонітету з повнотою 0,67; 3,7% березові насадження I-III бонітет з повнотою – 0,67.

Впродовж цього року в Соснівському лісництві було виконано такі види робіт:

- 1) посадка лісових культур на площі 28,0 га;
- 2) поновлення лісових культур – 32,6 га;
- 3) введення нових деревних видів – 9 га;
- 4) догляд за лісовими культурами – 115,7 га;
- 5) підготовка ґрунту під лісові культури на наступний рік – 9,5 га.

Заготівля деревини з рубок головного користування склала 20,2 га (3481,5 м³), рубок освітлення – 12,4 га (77 м³), рубок очищення – 9,1 га (84 м³), рубок проріджування – 4,2 га (38 м³), вибіркових санітарних рубок – 143,4 га (1350 м³), суцільно санітарних рубок – 24,3 га (4515 м³), лісовідновлювальних рубок – 2,8 га (553 м³), вирубок рідин – 2,9 га (273 м³), інших лісгосподарських рубок – 10,8 га (261 м³).

Також облаштовано мінеральні смуги протяжністю 6 км та обслуговані смуги довжиною 111 км. Заготівля шишок хвойних порід склала 770 кг, а збір насіння – 518,1 кг. Загалом реалізовано продукції на суму 4,13 млн грн з ПДВ.

Методика досліджень. Детальніший розгляд методів дослідження технологій створення лісових культур дозволяє глибше зрозуміти процеси, які впливають на ефективність відновлення лісів та підтримку біорізноманіття [11].

За зведеними відомостями проєктів створення лісових культур по Соснівському ЛГ філії «Соснівське лісове господарство» проаналізовано:

- 1) способи створення лісових культур;

- 2) схеми змішування та розміщення лісових культур;

- 3) потреба у садивному та посівному матеріалі за деревними породами;

- 4) типи лісорослинних умов де заплановано створення культур;

- 5) площі створення культур.

Для вивчення вище зазначених завдань у Соснівському лісництві закладено тимчасові пробні площі закладалися у різних типах лісорослинних умов типових для даного лісництва вологій бір (A3), свіжий суббір (B2), вологий суббір (B3), сирий суббір (B4), свіжий сугруд (C2), вологий сугруд (C3). Схема розміщення деревних порід була в умовах A3, B2, B3, B4 була ідентичною – сім рядів сосни і три ряди берези повислої. В умовах C2, C3 – чотири ряди сосни звичайної та один ряд ялини європейської. На всіх ділянках проведено механізований обробіток ґрунту, створення лісових культур відбувалось вручну [2, 3].

Тимчасова пробна площа № 1. Пробна площа розташована у кварталі 30, виділі 2, площа ділянки – 0,5 га. Тип лісорослинних умов – A3 (вологій бір). Схема змішування культур – сім рядів сосни звичайної і три ряди берези повислої. Категорія лісокультурної площі – зруб.

Тимчасова пробна площа № 2. Пробна площа розташована у кварталі 20, виділі 29, площа ділянки – 1,4 га. Тип лісорослинних умов – B2 (свіжий суббір). Схема змішування – культур сім рядів сосни звичайної і три ряди берези повислої. Категорія лісокультурної площі – зруб.

Тимчасова пробна площа № 3. Пробна площа розташована у кварталі 3, виділі 26, площа ділянки – 1,0 га. Тип лісорослинних умов – B3 (вологій суббір). Схема змішування культур – сім рядів сосни звичайної і три ряди берези повислої. Категорія лісокультурної площі – зруб.

Тимчасова пробна площа № 4. Пробна площа розташована у кварталі 27, виділі 11, площа ділянки

– 1,3 га. Тип лісорослинних умов – В4 (сирий сибір). Схема змішування культур – сім рядів сосни звичайної і три ряди берези повислої. Категорія лісокультурної площі – зруб.

Тимчасова пробна площа № 5. Пробна площа розташована у кварталі 30, виділі 17, площа ділянки – 0,9 га. Тип лісорослинних умов – С2 (свіжий сугруд). Схема змішування культур – чотири ряди сосни звичайної і один ряд ялини європейської. Категорія лісокультурної площі – зруб.

Тимчасова пробна площа № 6. Пробна площа розташована у кварталі 43, виділі 37, площа ділянки

– 0,2 га. Тип лісорослинних умов – С3 (свіжий сугруд). Схема змішування культур – чотири ряди сосни звичайної і один ряд ялини європейської. Категорія лісокультурної площі – зруб.

Результат. Станом на 01.01.2024 р. загальна площа лісового фонду Соснівського лісництва становила 5058,0 га. Відповідно до розподілу площі за категоріями земель насадження природного походження склали 1187,0 га, лісові культури – 2903,1 га, площа лісокультурного розведення – 130,2 га, незімкнуті лісові культури – 325,0 га (рис. 2).

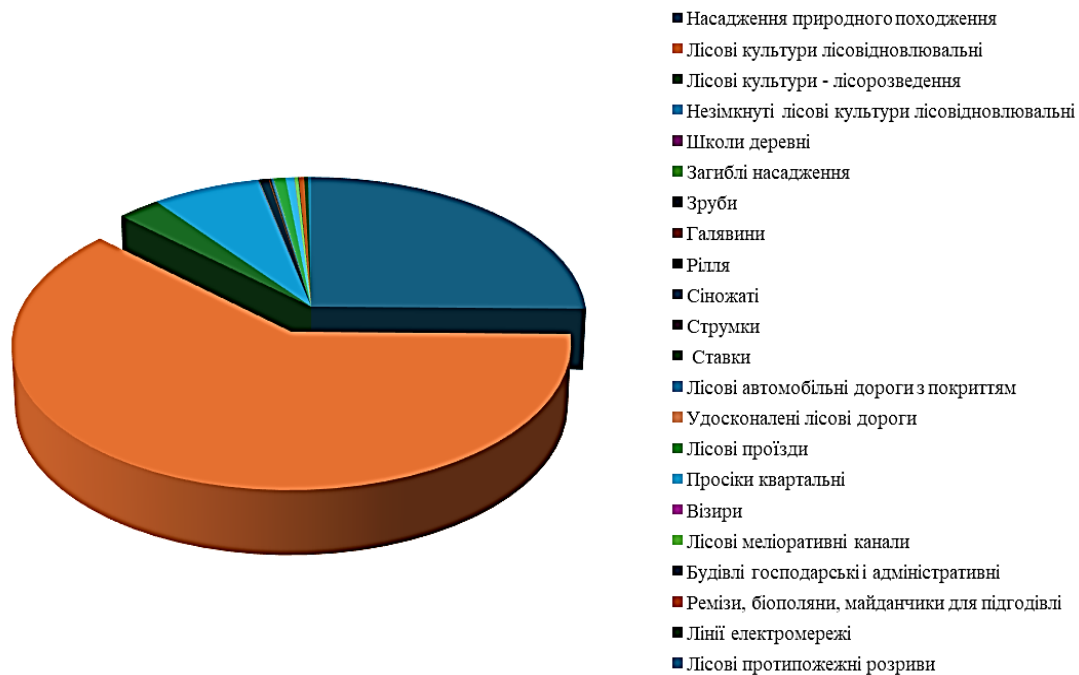


Рис. 2. Розподіл загальної площі за категоріями земель

Площа вкритих лісовою рослинністю лісових ділянок експлуатаційних лісів у Соснівському лісництві становить 4114,9 га, з них лісові культури

займають площу 2956,1 га. Незімкнуті лісові культури займають площу – 321,2 га, а зруби – 27,9 га (рис. 3).



Рис. 3. Розподіл площі вкритих лісовою рослинністю лісових ділянок експлуатаційних лісів, га

Площа земель лісгосподарського призначення захисних лісів у лісництві складає 122,5 га. Серед них площа вкритих лісовою рослинністю лісових ділянок становить – 105,4 га, з них лісові

культури займають площу 77,2 га, незімкнуті лісові культури – 3,8 га, лісові розсадники плантації – 1,9 га (рис. 4).

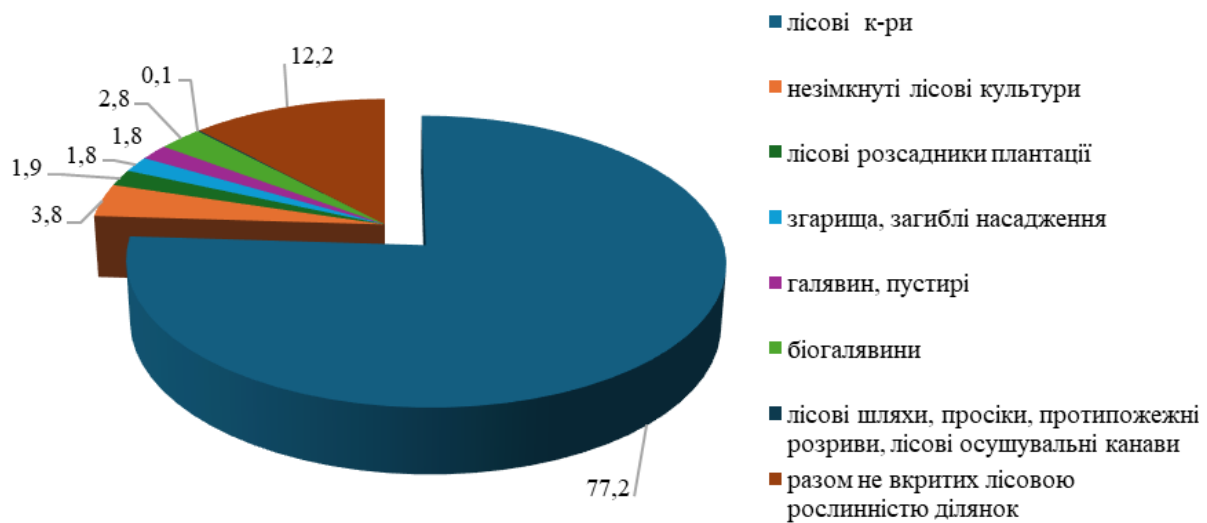


Рис. 4. Розподіл площі вкритих лісовою рослинністю лісових ділянок захисних лісів, га

Серед не лісових земель, сільськогосподарські угіддя займають площу 2,4 га, водні ресурси – 2,0 га, болота – 65,4 га (рис. 5).

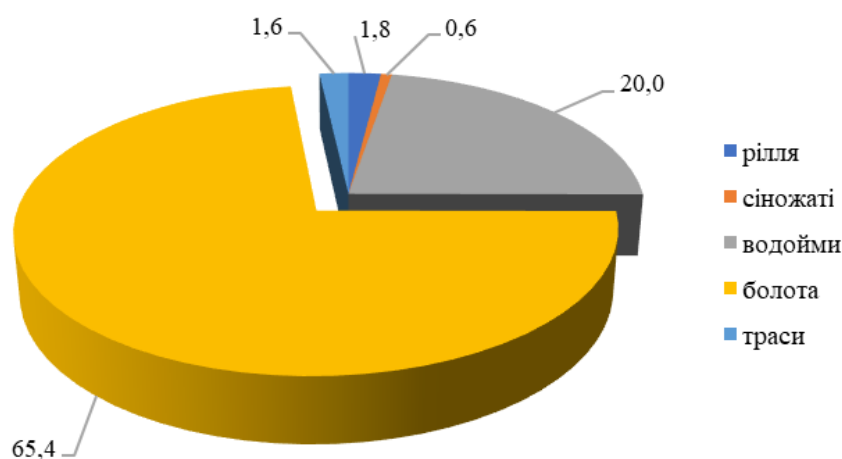


Рис. 5. Розподіл нелісових земель за категоріями, га

Станом на 2024 рік у Соснівському лісництві заплановані рубки освітлення на площі – 92,8 га, рубки очищення – 152,0 га, проріджування – 471,3 га, прохідні рубки на площі – 1580,0 га. Від загальної площі рубок, заплановані рубки догляду у хвойних насадженнях на площі – 2258,9 га, у твер-

долистяних деревних насадженнях – 6,0 га, у м'яко-листяних на площі – 31,5 га. Для відновлення лісових насаджень у лісництві передбачено сприяння природному поновленню у соснових лісах на площі 4,1 га (рис. 6).

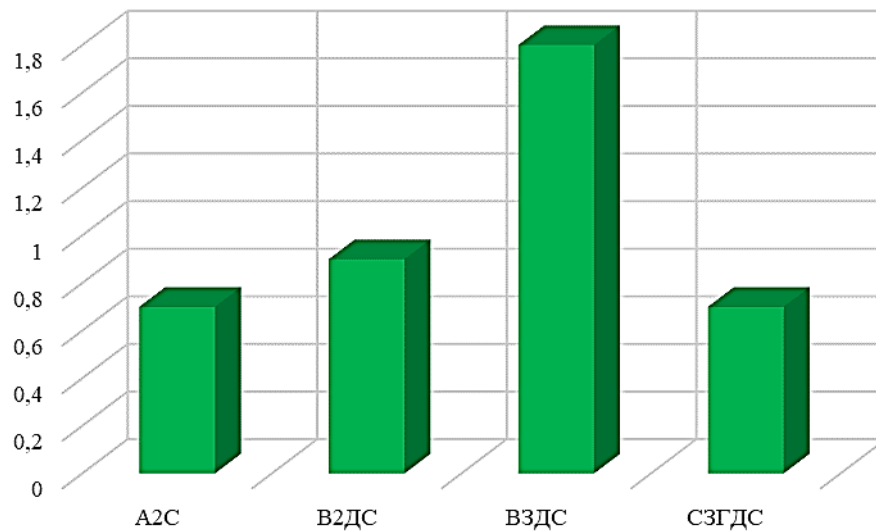


Рис. 6. Природне поновлення в соснових деревостанах, га

Сприяння природному поновленню передбачено в соснових деревостанах у типах лісу свіжий сосновий бір (A2C) на площі – 0,7 га, свіжий дубово-сосновий суббір (B2ДС) – 0,9 га, вологий дубово-сосновий суббір (ВЗДС) – 1,8 га, вологий грабово-дубово-сосновий сугруд (СЗГДС) – 0,7 га.

У Соснівському лісництві станом на 2024 р. створено лісових культур на площі 31,0 га (рис. 7).

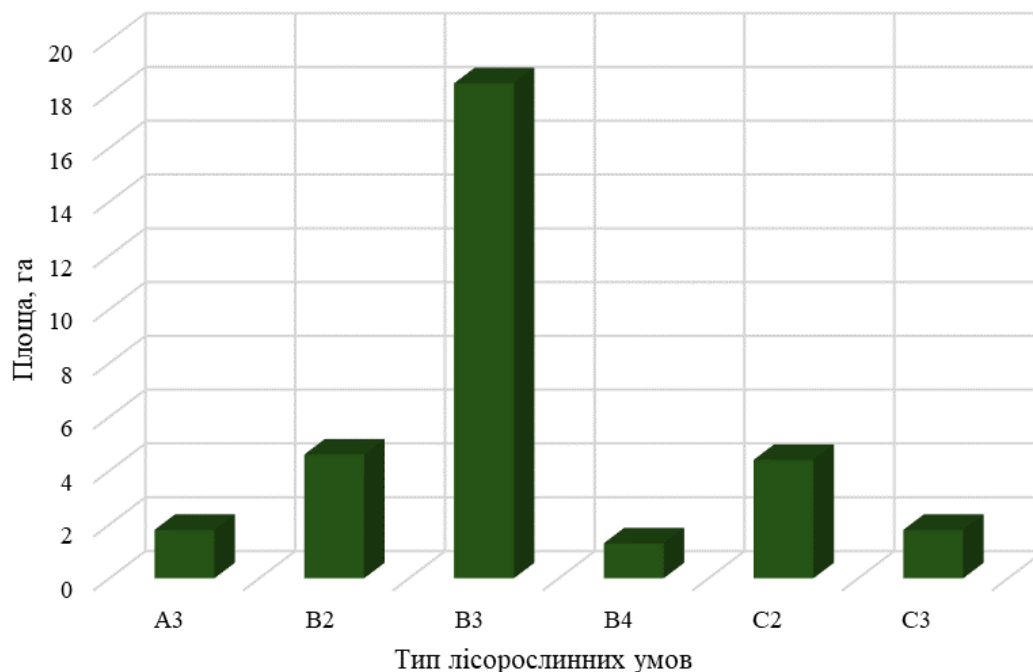


Рис. 7. Створенні лісові культури в соснових деревостанах у Соснівському лісництві

Основна культура це сосна звичайна, її висаджували в лісорослинних умовах: вологий бір (A3) на площі – 1,8 га, свіжий суббір (B2) – 4,6 га, вологий суббір (B3) – 18,4 га, сирий суббір (B4) – 1,3 га, свіжий сугруд (C2) – 4,4 га, вологий сугруд (C3) – 1,8 га. Як видно з рисунка найбільше було висаджено соснових культур в умовах вологого субору.

У Соснівському лісництві переважно використовують 4 схеми змішування лісових культур – 7рСз3рБп, 4рСз1рДз, 4рСз1рЯле, 4рСз1рБп (див. Додаток).

В умовах вологого бору спостерігались 3 схеми розміщення посадкових місць з сосни звичайної і берези повислої, рядів з сосни – 7, з берези – 3. Також три схеми розміщення посадкових місць використовували в умовах свіжого сугруду (C2), вологого сугруду (C3) при посадці культур, які склалися з сосни звичайної, берези повислої, дуба черешчатого та ялини європейської. Схема розміщення 4 ряди сосни та 1 ряд з дуба, берези чи ялини (табл. 1).

Таблиця 1

Схеми розміщення посадкових місць в Соснівському лісництві за типами лісорослинних умов

Тип лісорослинних умов	Схеми розміщення посадкових місць	Схема змішування
A3	Сз2,7×0,6, Бп2,7×1,0 Сз2,5×0,5, Бп2,5×1,0	7рСз3рБп
B2	Сз2,7×0,6, Бп2,7×1,0 Сз2,8×0,6 Бп2,8×1,0	7рСз3рБп
B3	Сз2,7×0,6, Бп2,7×1,0 Сз2,8×0,6 Бп2,8×1,0 Сз3,0×0,5 Бп3,0×1,0	7рСз3рБп
B4	Сз2,7×0,6, Бп2,7×1,0	7рСз3рБп
C2	Сз3,0×0,5 Дз3,0×1,0	4рСз1рДз
	Сз2,7×0,6 Яле2,7×1,0 Сз2,8×0,6 Яле2,8×1,0	4рСз1рЯле
C3	Сз2,8×0,6 Бп2,8×1,2 Сз2,8×0,6 Яле2,8×1,0 Сз2,7×0,6 Яле2,7×1,0	4рСз1рБп 4рСз1рЯле

При таких схемах посадки, потреба с садивному матеріалі на 1 га лісорослинних площ, залежно від типу лісорослинних умов, становила для

сосни від 3,92-4,53 тис. шт., для ялини 0,08-0,60 тис. шт., для дуба 0,60-0,63 тис. шт., для берези 0,21-1,67 тис. шт. (табл. 2).

Таблиця 2

Потреба в садивному матеріалі за деревними породами, на площі 1 га

Тип лісорослинних умов	Деревна порода, тис. шт			
	сосна	ялина	дуб	береза
A3	5,13	–	–	1,67
B2	4,20	–	–	1,50
B3	3,92	–	–	1,51
B4	5,43	–	–	1,43
C2	4,70	0,60	0,60	0,21
C3	4,19	0,08	0,63	0,56

Отже, загальна кількість садивного матеріалу на площі 1 га становила для сосни звичайної – 27,57 тис. шт., для ялини європейської – 0,67 тис. шт., для дуба звичайного – 1,23 тис. шт., для берези повислої – 6,88 тис. шт.

Враховуючі необхідну площу при створенні лісових культур та схем розміщення потреба в садивному матеріалі за деревними породами становила для соснових культур – 128,9 тис. шт., ялинових – 1,71 тис. шт., дубових – 3,76 тис. шт., березових 39,6 тис. шт.

Детальний розрахунок економічних витрат на посадку 1 га лісу з механізованим обробітком ґрунту та ручною посадкою садивного матеріалу складається з кількох етапів. Кожен із них потребує окремих ресурсів, техніки та робочої сили.

1. Підготовка ґрунту (механізований обробіток). Цей етап включає кілька видів робіт для обробки ґрунту: оранка або глибоке розпушування – проводиться для покращення аерації ґрунту та підготовки його до висадки саджанців, вартість робіт близько 2000-3500 грн/га залежно від регіону та техніки (трактори, плуги тощо). Дискування або культивування – використовується для роздрібнення великих шматків ґрунту та вирівнювання поверхні, вартість робіт – 1000-2000 грн/га. Загальна механізована підготовка ґрунту може становити приблизно 3000-5000 грн/га.

2. Садивний матеріал. Вартість саджанців дерев залежить від кількох факторів, таких як вік, розмір, місце придбання, умови вирощування та

регіон. Орієнтовні ціни на саджанці дуба звичайного, сосни звичайної, берези повислої та ялини європейської:

- дуб звичайний (*Quercus robur*). Саджанці віком 1-2 роки: 3-5 грн за один саджанець, саджанці віком 3-5 років або більші екземпляри можуть коштувати 10–25 грн або більше залежно від їхнього розміру та якості;

- сосна звичайна (*Pinus sylvestris*). Саджанці віком 1-2 роки – 1-3 грн за один саджанець, старші саджанці (3-5 років) можуть коштувати 5-10 грн за одиницю або більше залежно від їхнього розміру;

- береза повисла (*Betula pendula*). Вартість саджанців віком 1-2 роки – 3-5 грн за один саджанець, старші саджанці (3-5 років) можуть коштувати 10-25 грн або більше залежно від розміру;

- ялина європейська (*Picea abies*). Саджанці віком 1-2 роки – 5-10 грн за один саджанець, старші саджанці (3-5 років) можуть коштувати 15-40 грн за одиницю, залежно від їхнього розміру.

Ці ціни є орієнтовними і можуть змінюватися залежно від регіону, якості саджанців і постачальника. Якщо потрібно точніші дані для певного регіону або лісорозсадника, можна звернутися до місцевих розсадників або лісових господарств.

Кількість саджанців на 1 гектар (га) залежить від щільності посадки, яка може варіюватися залежно від типу лісу та виду дерев. Зазвичай для стандартного лісонасадження використовують густоту від 3000 до 5000 саджанців на гектар, але для різних порід ці норми можуть трохи відрізнятися.

Орієнтовні показники щільності для різних порід:

- 1) сосна звичайна (*Pinus sylvestris*): 4000-5000 саджанців на 1 га;
- 2) дуб звичайний (*Quercus robur*): 4000-5000 саджанців на 1 га;
- 3) береза повисла (*Betula pendula*): 3000-4000 саджанців на 1 га;
- 4) ялина європейська (*Picea abies*): 3000-4000 саджанців на 1 га.

3. Транспортні витрати. Транспортування техніки, саджанців і робітників до місця висадки може включати: транспорт техніки (трактори, плуги) – від 500 до 2000 грн за день роботи, доставлення саджанців – залежно від відстані та кількості саджанців, орієнтовно 500-1500 грн/га.

4. Ручна посадка саджанців. Для висадки саджанців необхідна робоча сила. Один робітник може висадити приблизно 200-300 саджанців за день. На 1 га потрібно близько 5-10 робітників. Середня денна оплата праці одного робітника – 300-500 грн. Загальна вартість ручної висадки саджанців може становити 3000-6000 грн/га.

5. Додаткові витрати. Додаткові витрати можуть включати: захист саджанців від шкідників – це може бути використання хімічних препаратів

або огорожень від диких тварин, вартість від 500 до 2000 грн/га. Мінеральні добрива – іноді використовують для підвищення приживання саджанців, вартість 500-1000 грн/га.

6. Догляд за насадженнями після посадки (опціонально). Догляд за посадженими лісовими культурами протягом перших кількох років є важливим для забезпечення їх виживання та росту: полив (якщо потрібно): залежить від регіону і кліматичних умов; прополювання та очищення від бур'янів. Вартість робіт може становити від 1000 до 3000 грн/га за сезон.

Розрахунок витрат на 1 га лісу для створення культур із сосни звичайної, дуба звичайного, берези повислої та ялини європейської враховує кілька ключових етапів, включаючи механізований обробіток ґрунту, закупівлю садивного матеріалу, транспортування, ручну посадку та додаткові витрати.

Підготовка ґрунту (механізований обробіток): механізована підготовка ґрунту включає оранку, дискування або культивування. Оранка, дискування та вирівнювання: орієнтовно 3000-5000 грн/га (залежить від складності ґрунту та типу техніки).

Загальні витрати на створення лісових культур на одиницю площі зазначені у табл. 3.

Таблиця 3

Загальні витрати на створення лісових культур

Культура	Витрати на 1 га, грн					
	Механізований обробіток	Саджанці	Транспорт	Ручна посадка	Додаткові витрати	Загальні витрати
Сосна звичайна	3000–5000	4000–15000	500–1500	3000–6000	500–2000	11000–29500
Дуб звичайний	3000–5000	12000–25000	500–1500	3000–6000	500–2000	19,000–39500
Береза повисла	3000–5000	9000–20000	500–1500	3000–6000	500–2000	16000–34500
Ялина європейська	3000–5000	15000–40000	500–1500	3000–6000	500–2000	22000–54500

Вище зазначені розрахунки є орієнтовними і можуть варіюватися залежно від конкретних умов, типу ґрунту, рельєфу місцевості, якості саджанців та місцевих цін на робочу силу і техніку.

Висновки. Проаналізовано, що у Соснівському лісництві природне поновлення передбачено в соснових насадженнях типів лісу: свіжий сосновий бір (А2С) на площі 0,7 га, свіжий дубово-сосновий субір (В2ДС) – 0,9 га, вологий дубово-сосновий субір (В3ДС) – 1,8 га, а також вологий грабово-дубово-сосновий сугруд (С3ГДС) – 0,7 га.

У Соснівському лісництві станом на 2024 рік було створено лісових культур на площі 31,0 га. Основною культурою є сосна звичайна, яка висаджувалася в різних лісорослинних умовах на площах: вологий бір (А3) – 1,8 га, свіжий субір (В2) – 4,6 га, вологий субір (В3) – 18,4 га, сирий субір (В4) – 1,3 га, свіжий сугруд (С2) – 4,4 га, вологий сугруд (С3) – 1,8 га. Найбільше соснових культур було висаджено в умовах вологого субору.

У лісництві застосовують чотири схеми змішування лісових культур: 7рС3зрБп, 4рС3лрДз,

4рС3лрЯле, 4рС3лрБп. В умовах вологого бору спостерігалися три схеми розміщення посадкових місць для сосни звичайної та берези повислої, з 7 рядами сосни та 3 рядами берези. Також три схеми розміщення використовувалися в умовах С2 та С3 при посадці культур, що склалися з сосни звичайної, берези повислої, дуба черешчатого та ялини європейської. Схема включала 4 ряди сосни та 1 ряд з дуба, берези або ялини.

Потреба в садивному матеріалі на 1 га лісорослинної площі, залежно від типу лісорослинних умов, становила для сосни від 3,92 до 4,53 тис. шт., для ялини – 0,08-0,60 тис. шт., для дуба – 0,60-0,63 тис. шт., для берези – 0,21-1,67 тис. шт.

Розрахунок економічних витрат на посадку 1 га показав, що для створення культур сосни звичайної потрібно від 11,0 до 29,5 тис. грн, для дуба звичайного – від 19,0 до 39,5 тис. грн, для берези повислої – від 16,0 до 34,5 тис. грн, а для ялини європейської – від 22,0 до 54,5 тис. грн.

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ARCHITECTURE

CONSTRUCTION PHASES OF MODULAR HOUSING

Saibulatova A.

*Associate Professor, International Educational Corporation,
Almaty*

Rakhimzhanova A.

Student, International Educational Corporation, Almaty

ЭТАПЫ СТРОИТЕЛЬСТВА МОДУЛЬНОГО ЖИЛИЩА

Сайбулатова А.

*Ассоциированный профессор, Международная
Образовательная Корпорация, Алматы*

Рахимжанова А.

*Студент, Международная Образовательная Корпорация,
Алматы*

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Abstract

This paper explores the foundational principles of modular housing, the evolution of its design and application, key strengths and limitations, and the latest advancements in this construction field. It also includes an evaluation and review of existing implementations.

The primary outcomes of modular construction include a substantial decrease in construction time and expenses, enhanced durability, eco-friendliness, and the ability to meet diverse needs and conditions, such as seismic resilience, climate adaptability, and soil characteristics.

Аннотация

В данной статье исследуются основные принципы модульного строительства, этапы его становления и применения, ключевые преимущества и недостатки, а также современные достижения в данной области. В работе представлен обзор и анализ уже реализованных проектов.

Основными результатами модульного строительства являются существенное сокращение сроков и затрат на строительство, повышение прочности, экологическая устойчивость, а также возможность адаптации под различные требования и условия, включая сейсмическую активность, климатические особенности и свойства грунтов.

Keywords: modular housing, sustainability, regulations, rapid construction, BIM technologies, climate resilience, production, cost efficiency.

Ключевые слова: модульное строительство, устойчивость, нормативы, скорость возведения, BIM технологии, адаптация к климату, производство, экономия затрат.

Введение. Модульное жилищное строительство (MiC) стало революционным решением в современной архитектуре и градостроительстве, позволяющим эффективно справляться с глобальными вызовами, такими как урбанизация, нехватка жилья и необходимость устойчивого развития. Отличаясь процессом предварительного изготовления на производственных площадках и последующей сборки на строительной площадке, модульное строительство предлагает значительные преимущества, включая сокращение сроков возведения, экономию затрат и экологическую устойчивость. Эти особенности делают его особенно востребованным в таких странах, как Норвегия, где строгие строительные нормы, суровые климатические условия и стремление к экологичности задают стандарты отрасли.

Внедрение MiC обусловлено рядом глобальных и региональных тенденций. Рост численности городского населения требует масштабируемых и быстрых решений в строительстве, а увеличение экологической осведомленности требует использования методов с минимальным воздействием на

окружающую среду. Кроме того, технологические достижения, такие как информационное моделирование зданий (BIM), повышают точность и интеграцию модульных проектов, минимизируя отходы и улучшая общую эффективность.

В данной статье представлен всесторонний анализ этапов строительства модульного жилья: от проектирования и изготовления до транспортировки и сборки. Также оценивается роль модульного строительства в решении таких задач, как климатическая устойчивость, адаптация к особенностям грунта и соблюдение местных нормативов. Рассматривая примеры из практики и существующие реализации, работа демонстрирует потенциал модульного жилья в трансформации современных строительных практик и удовлетворении разнообразных общественных и экологических потребностей.

Проектирование и планирование — ключевой этап, определяющий успех модульного жилищного строительства, поскольку именно здесь формируется основа всех последующих процессов. Этот

этап начинается с анализа участка строительства, включающего оценку грунтов, климатических условий и доступности коммуникаций. Правильно выполненное планирование помогает минимизировать риски и оптимизировать ресурсы на этапе реализации.

Одним из главных инструментов, применяемых на этапе проектирования, является моделирование информации о здании (BIM). Эта технология позволяет интегрировать все данные о проекте, начиная от концептуальной разработки модульных блоков до планирования логистики их транспортировки. Использование BIM помогает устранить возможные ошибки при сборке, улучшить координацию между участниками проекта и повысить энергоэффективность зданий, благодаря анализу энергопотребления ещё на стадии проектирования.

Устойчивое строительство требует применения материалов с низким углеродным следом, таких как переработанная древесина, экологически чистый бетон или панели с утеплителем из возобновляемых источников. Внимание к теплоизоляции и герметичности конструкций на этом этапе закладывает основу для повышения энергоэффективности готового здания.

Интеграция возобновляемых источников энергии, таких как солнечные панели или системы рекуперации тепла, должна быть учтена на этапе проектирования. Это позволяет модульным зданиям соответствовать строгим стандартам устойчивости, обеспечивая снижение эксплуатационных расходов и минимизацию углеродного следа.

Таким образом, этап проектирования и планирования не только обеспечивает соответствие требованиям строительных норм, но и задаёт направление для создания инновационных, экологически чистых и эффективных жилых решений.

Этап транспортировки и сборки является одной из ключевых составляющих модульного жилищного строительства, от которого зависит своевременность и качество реализации проекта. Предварительно собранные модульные компоненты изготавливаются на производственных предприятиях и доставляются на строительный участок в готовом виде. Этот процесс требует тщательной организации логистики и учета множества факторов, включая размеры модулей, доступность маршрутов и климатические условия.

Организация транспортировки крупных модульных компонентов сопряжена с рядом сложностей. Необходим учет рельефа местности, таких как горные участки или удаленные районы, где традиционные транспортные средства могут быть ограничены. Планирование маршрутов также включает анализ дорожной инфраструктуры, чтобы избежать повреждений модулей во время транспортировки.

Процесс сборки модульного здания на участке начинается с подготовки фундамента, который должен точно соответствовать спецификациям модулей. Затем модули соединяются в единую конструкцию с использованием кранов и других строительных механизмов.

Модульное строительство обладает большим потенциалом для использования в удаленных или

труднодоступных районах, где традиционное строительство затруднено. Благодаря предварительному производству модулей, процесс строительства становится менее зависимым от местных климатических условий, а быстрая сборка на месте позволяет значительно сократить время проекта. Это делает модульное строительство эффективным решением для регионов с ограниченной строительной инфраструктурой.

Модульные дома обладают значительным потенциалом в области энергоэффективности и устойчивого строительства. Ключевым аспектом энергоэффективности модульных домов является внедрение продвинутых проектных решений. Использование тройных стеклопакетов и материалов с высокими теплоизоляционными свойствами помогает свести к минимуму теплопотери даже в суровых климатических условиях. Также широко применяются стандарты пассивного дома, предполагающие максимальную герметичность конструкции, оптимизацию вентиляции и минимизацию затрат на отопление. Эти меры позволяют создать комфортные условия проживания при снижении энергозатрат.

Модульное строительство предлагает широкие возможности для интеграции возобновляемых источников энергии. Установка солнечных панелей на крыше модульных домов, использование тепловых насосов и системы сбора дождевой воды не только снижают углеродный след зданий, но и обеспечивают долгосрочную экономию для владельцев.

Переход к стандартам почти нулевого энергопотребления (nZEB) является приоритетной задачей для строительной отрасли во всем мире. Модульное строительство демонстрирует высокую эффективность в достижении этих целей благодаря сокращению эксплуатационных расходов и снижению углеродных выбросов. Использование технологий, таких как информационное моделирование зданий (BIM), в сочетании с ранней интеграцией устойчивых решений на этапе проектирования позволяет модульным домам достичь стандартов nZEB быстрее и экономичнее, чем это возможно при использовании традиционных строительных методов.

По всему миру уже реализованы многочисленные примеры энергоэффективных модульных домов, которые соответствуют строгим экологическим стандартам. Например, проекты, спроектированные в соответствии с принципами пассивного дома, продемонстрировали снижение энергопотребления на 30-40% по сравнению с традиционными зданиями. Эти дома включают высокоэффективную изоляцию, герметичность и современные системы вентиляции, что значительно снижает потребности в отоплении и охлаждении. Примером является *Lindner Passive House* в Германии, который демонстрирует модульный подход к устойчивому строительству, а также *The Hive* в Великобритании — модульное здание, спроектированное по стандартам пассивного дома и оснащенное возобновляемыми энергетическими системами, такими как солнечные панели и вентиляция с рекуперацией тепла.



Рис. 1. Lindner Passive House в Германии.



Рис. 2. The Hive, Англия, Вустер.

Эти примеры подчеркивают потенциал модульного строительства в достижении целей по декарбонизации и устойчивому развитию. Модульные здания, благодаря энергоэффективным решениям и адаптируемости к различным климатическим условиям, становятся неотъемлемой частью современной архитектуры, особенно в регионах с высокими требованиями к экологичности и энергоэффективности.

Модульное строительство сталкивается с рядом вызовов, которые ограничивают его более широкое применение и требуют комплексного подхода для их преодоления. Одной из главных проблем является соответствие модульных конструкций строительным нормам и зонированию. В странах с высокими стандартами в этой области процесс согласования проектов может быть затруднен. Строгие требования к энергоэффективности и безопасности часто требуют значительных усилий для адаптации модульных решений к местным нормативам, что может замедлить их внедрение.

Хотя модульное строительство обладает экономическими преимуществами в долгосрочной перспективе, высокие начальные инвестиции остаются значительным препятствием. Производство модульных единиц с использованием качественных материалов, соблюдение экологических

стандартов и внедрение инновационных технологий на этапе проектирования и строительства увеличивают затраты, что может стать барьером для малых и средних застройщиков.

Еще одной проблемой является недостаточная осведомленность и опыт в области модульного строительства среди архитекторов, инженеров и застройщиков. Традиционная строительная отрасль часто относится к новым методам с сомнением, что замедляет внедрение инновационных решений. Кроме того, дефицит специалистов, знакомых с процессом проектирования, производства и сборки модульных зданий, может повлиять на качество реализации проектов.

Несмотря на активное использование современных технологий, таких как моделирование информации о здании (BIM), модульное строительство все еще сталкивается с определенными технологическими ограничениями. Например, логистика транспортировки крупных модулей на удаленные участки может стать проблемой, особенно в регионах с труднодоступной местностью. Постоянное внедрение инноваций для повышения энергоэффективности и адаптации к новым требованиям также остается важной задачей.

Для решения этих проблем необходим комплексный подход, включающий обновление нормативно-правовой базы, субсидирование начальных затрат, проведение образовательных программ для

специалистов и инвестиции в исследования и разработки. Эти меры помогут ускорить внедрение модульного строительства и раскрыть его потенциал в решении задач современного жилищного строительства.

Заключение. Модульное строительство является эффективным решением для устойчивого и энергоэффективного жилья, играя ключевую роль в решении проблем урбанизации и изменения климата. Оно помогает снизить углеродный след, уменьшить эксплуатационные расходы и повысить энергоэффективность зданий. Современные технологии, такие как BIM, 3D-печать и искусственный интеллект, уже вносят значительные улучшения в проектирование и строительство, ускоряя процессы и повышая точность. В ближайшие десятилетия модульное жилье станет более адаптированным к требованиям энергоэффективности, в том числе стандартам nZEB, и интеграции возобновляемых источников энергии. Модульные здания также эффективно решают проблемы климатической адаптивности, обеспечивая жильем людей в экстремальных климатических условиях. Для дальнейшего развития этой технологии необходимы инвестиции в исследования, инновации и реформы строительных норм.

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ARTS

MODERN APPROACHES TO DESIGN IN GRAPHIC DESIGN: INTEGRATION OF AESTHETICS, FUNCTIONALITY AND INNOVATIVE TECHNOLOGIES

Grebeniuk I.

*senior teacher of the design department
King Danylo University
Ivano-Frankivsk, Ukraine*

Basaraba V.

*teacher of the design department
King Danylo University
Ivano-Frankivsk, Ukraine*

СУЧАСНІ ПІДХОДИ ДО ДИЗАЙН-ПРОЄКТУВАННЯ В ГРАФІЧНОМУ ДИЗАЙНІ: ІНТЕГРАЦІЯ ЕСТЕТИКИ, ФУНКЦІОНАЛЬНОСТІ ТА ІННОВАЦІЙНИХ ТЕХНОЛОГІЙ

Гребенюк І.В.

*старший викладач кафедри дизайну
ЗВО «Університет Короля Данила»
м. Івано-Франківськ, Україна*

Басараба В.М.

*викладач кафедри дизайну
ЗВО «Університет Короля Данила»
м. Івано-Франківськ, Україна
<https://doi.org/10.5281/zenodo.14235991>*

Abstract

The article explores current approaches to design in graphic design, which combine aesthetic aspects, functionality and the use of innovative technologies. The main trends in the development of the industry, the role of an interdisciplinary approach and the importance of interactivity in graphic solutions are analyzed. The conclusion is made about the need for a comprehensive approach to design, taking into account changes in the perception of visual information in the digital age.

Анотація

У статті досліджено актуальні підходи до дизайн-проектування в графічному дизайні, які поєднують естетичні аспекти, функціональність та використання інноваційних технологій. Аналізуються основні тенденції розвитку галузі, роль міждисциплінарного підходу та значення інтерактивності у графічних рішеннях. Зроблено висновок про необхідність комплексного підходу до проектування з урахуванням змін у сприйнятті візуальної інформації в цифрову епоху.

Keywords: graphic design, design, aesthetics, functionality, innovative technologies, interactivity.

Ключові слова: графічний дизайн, дизайн-проектування, естетика, функціональність, інноваційні технології, інтерактивність.

Графічний дизайн є одним із ключових напрямів візуального мистецтва, який поєднує креативність із функціональністю. У сучасному світі, де цифрові технології відіграють центральну роль, дизайн-проектування набуває нових вимірів, інтегруючи різноманітні інновації для створення не лише естетично привабливих, а й функціонально ефективних рішень. Є невіддільною частиною нашого повсякденного життя, впливаючи на те, як ми сприймаємо інформацію і взаємодіємо з навколишнім середовищем. Доволі складно сьогодні знайти сферу життя, де б він не був залучений – від вуличних знаків до інтерфейсів мобільних додатків, графічний дизайн робить світ зрозумілішим, яскравішим і більш організованим [3].

Сучасний графічний дизайн прагне балансу між естетичною привабливістю та практичністю. Важливим аспектом є створення дизайну, який відповідає потребам користувачів, забезпечуючи

зручність сприйняття інформації. Наприклад, у веб-дизайні велика увага приділяється простоті навігації, гармонії кольорів та типографії.

Мінімалізм залишається однією з провідних тенденцій. Простота форм, лаконічність композицій та функціональна спрямованість допомагають створювати ефективні візуальні комунікації. Однією з найважливіших складових візуальної комунікації, яка активно розвивається під впливом новітніх технологій є графічний дизайн. Основним інструментом дизайнера протягом останніх десятиліть стали графічні редактори, які дозволяють створювати, редагувати та вдосконалювати зображення. Їх еволюція відображає зміни в потребах дизайну, технологічні прориви та трансформацію методів роботи.

Розвиток графічних редакторів суттєво вплинув на методи роботи дизайнерів, значно розширивши їхній інструментарій. Сучасна цифрова

епоха вимагає від дизайнерів адаптивності, багатофункціональності та здатності до постійного навчання. Сучасні графічні дизайнери використовують різноманітні інструменти такі як Adobe Photoshop, Adobe Illustrator, Blender, Autodesk 3ds Max та інші, які стали стандартом у галузі. Ці програми значно розширили можливості дизайнерів, пропонуючи:

- розширені інструменти редагування растрових та векторних зображень.
- інтеграцію тривимірної графіки та анімації.
- підтримку великих файлів і високої роздільної здатності для друку.
- хмарні функції, що дозволяють працювати над проектами колективно відкриваючи нові горизонти для графічного дизайну.

Вони дозволяють створювати інтерактивні візуальні елементи, які залучають користувачів до взаємодії. Це особливо актуально у сфері реклами, брендингу та освітніх проєктів, зосереджуючи увагу на їх багатогранності та адаптивності до потреб сучасного суспільства.

Розвиток графічних редакторів і впровадження інноваційних технологій суттєво вплинули на інструментарій дизайнерів та трансформацію їхніх професійних ролей. У цифрову епоху дизайнери мають бути не лише творцями естетичного контенту, але й фахівцями, які володіють багато-профільними знаннями та технологічною експертизою. Подальше вдосконалення графічних редакторів і поширення інновацій змінюватиме галузь, роблячи її ще більш гнучкою та інтерактивною.

Дизайнери мають швидко освоювати нові інструменти й технології, адже інновації постійно змінюють професійне середовище. Баланс між творчим мисленням і технічними знаннями є ключовим для успішної кар'єри в дизайні. Сучасний дизайнер повинен розуміти основи програмування, маркетингу та психології, щоб створювати ефективні візуальні рішення.

Графічний дизайн у сучасних умовах є динамічною та багатогранною сферою, яка інтегрує естетику, функціональність та новітні технології. Успішне дизайн-проектування вимагає комплексного підходу, орієнтованого на потреби користувачів та адаптивності до технологічних змін. Перспективи розвитку галузі лежать у подальшій інтеграції цифрових інновацій і міждисциплінарних рішень.

Сучасне суспільство живе в час інноваційних технологій, яке виходить на більш високий рівень розвитку і якості, поступово відходячи від традиційних форм та процесів. Так би мовити, відбувається підміна, витіснення традиційних механізмів і каналів трансляції соціокультурного досвіду і системи цінностей, завдяки чому створюється якісно інше інформаційне середовище [1].

Сучасні світові дизайнерські процеси мають дві основні та протилежні за своєю суттю тенденції розвитку: інтегративний рух до глобалізаційно-орієнтованого дизайну та, навпаки, диференційний рух до регіонально-національного орієнтованого дизайну. Глобалізаційні процеси сприяли створенню єдиних стандартів графічного дизайну, які

передбачали однакові підходи до вирішення проблем комунікації, тотожні засоби та формальні прийоми проектування, але за останні десятиліття простежується активний розвиток графічного дизайну з урахуванням особливостей національної культури. Таким чином, в останнє десятиліття загострилася проблема національного й інтернаціонального у графічному дизайні, що виявляється у суперечності між «звичкою» графічного дизайну підроблятися під загальноприйняту серед лідерів моди і дотримуватися її, та тяжінням до національно зорієнтованого дизайну, спрямованого на врахування національної специфіки споживання, мораль і надбання національної культури. За таких умов з'ясування сутності поняття «сучасний графічний дизайн» є дуже важливим для розуміння тенденцій і перспектив його подальшого розвитку [2].

Творча особистість – це людина, яка глибоко проникає в суть ідей і здатна довести їх до практичних результатів, незважаючи на всі можливі життєві труднощі. При вивченні креативності використовуються різні методи, такі як спостереження, самоаналіз, біографічний аналіз (вивчення біографій видатних особистостей у певних галузях науки, культури, техніки тощо), аналіз продуктів діяльності (особливо творчості учнів), тести, анкетування та експериментальні методи. Слід зазначити, що використання останніх методів пов'язане зі значними труднощами, оскільки кожен творчий процес є унікальним і неповторним і не може бути відтворений ідентично шляхом повторних спостережень [4].

Дизайнери дедалі частіше зіштовхуються з викликами, пов'язаними з етикою використання штучного інтелекту, персональних даних і створення маніпулятивного контенту.

Відстеження та розуміння тенденцій дизайну допомагають створювати проєкти, які спілкуються з аудиторією сучасною візуальною мовою. Крім того, тренди часто розвиваються паралельно з розвитком технологій. Дизайнери адаптують свої стилі, щоб використовувати нові інструменти та техніки, а постійне перебування в курсі подій гарантує, що дизайн буде оптимізовано для новітніх платформ і технологій.

По суті, слідування трендам графічного дизайну – це стратегічний спосіб залишатися актуальним, цікавим і технологічно вправним у сфері дизайну, що постійно розвивається [5].

Мінімалізм, позачасовий і стійкий тренд графічного дизайну 2024 року, ймовірно, ніколи не вийде з моди. Філософія «менше – це більше» останнім часом набуває все більшої популярності. За такого підходу кожен елемент у дизайні слугує певній меті, відкидаючи зайве, щоб розкрити суть. Для мінімалістичного дизайну характерні чисті лінії, багато білого простору та лаконічна естетика.

Тренди графічного дизайну поступово переходять у гамму свіжих палітр, інноваційних шрифтів та ностальгії з грайливими акцентами. Йдеться про повернення пікселів, впровадження штучного інтелекту, інклюзивність. Все це стає популярною частиною сучасного дизайну та візуальних ефектів.

Залишатися на крок попереду у 2025 році допоможе інформація, яка розкриває основні тренди, тенденції та напрямки майбутніх років для графічного дизайну.

У сучасному дизайн-проектуванні важливу роль відіграє співпраця фахівців різних галузей: дизайнерів, маркетологів, програмістів, психологів. Це дозволяє створювати графічні рішення, які не лише виглядають привабливо, але й враховують поведінкові особливості аудиторії. Майбутнє візуальної комунікації може призвести до ще більшого посилення співпраці між дизайнерами, технологіями та дослідниками з різних галузей. Цей міждисциплінарний підхід може призвести до інноваційних рішень та нових методологій, які розсувають межі традиційної візуальної комунікації.

Основними викликами є швидкість змін у технологіях, зростання конкуренції та потреба у постійному навчанні. Проте використання інноваційних підходів, таких як інтерактивність, персоналізація та орієнтація на екологічність, відкриває нові можливості для графічного дизайну.

Інноваційні технології не лише оптимізували робочі процеси, а й змінили підходи до створення дизайну. Автоматизовані інструменти допомагають спростувати рутинні завдання, а штучний інтелект відкриває нові можливості для творчості, аналізу даних та адаптації до потреб користувачів. Тут розглядаються основні аспекти інтеграції автоматизації та штучний інтелект у дизайн-проектування, їхній вплив на професію дизайнера та перспективи розвитку галузі.

Широке впровадження всесвітньої павутини та мультимедійних систем у 21 столітті ще більше прискорило еволюцію графічного дизайну. Дизайнери почали використовувати онлайн-платформи для співпраці та натхнення, що призвело до більш різноманітного та інклюзивного дизайнерського середовища.

Автоматизація процесів у графічному дизайні стала можливою завдяки розвитку програмного забезпечення, яке виконує рутинні завдання швидше та точніше, ніж людина. Штучний інтелект у дизайн-проектуванні розширює межі графічного дизайну, пропонуючи інструменти, які аналізують дані, генерують нові ідеї та забезпечують адаптацію до потреб користувачів.

Інструменти на основі штучного інтелекту пропонують креативні рішення та автоматизують редагування. Дозволяють створювати візуальний контент за допомогою генеративних моделей. Штучний інтелект допомагає дизайнерам аналізувати поведінку аудиторії, її уподобання та ефективність візуальних рішень. Це дає можливість створювати таргетовані, персоналізовані дизайни. штучний інтелект може створювати графічні об'єкти або композиції, використовуючи алгоритми генеративного мистецтва. Наприклад, нейромережі, такі як DALL-E чи MidJourney, генерують унікальні ілюстрації на основі текстових описів.

Швидкість виконання рутинних завдань дозволяє дизайнерам зосередитися на творчості та концептуальній роботі. Автоматизація виключає людські помилки в процесах, таких як вирівнювання

елементів або налаштування кольорів. Нові інструменти спрощують створення графіки навіть для нефахівців, що розширює можливості для малого бізнесу та стартапів.

Рутинна залежність від алгоритмів може призвести до стандартизації дизайнів. Дизайнери мають освоювати нові інструменти та технології, що вимагає часу та зусиль. Штучний інтелект в майбутньому може створювати контент, який копіює стиль інших митців, що викликати питання про авторське право.

Інтеграція автоматизації та штучний інтелект у графічний дизайн продовжуватиме зростати. Майбутнє галузі передбачає ще глибше залучення штучного інтелекту для створення персоналізованих дизайнів, удосконалення інструментів віртуальної та доповненої реальності, а також автоматизоване тестування ефективності візуальних рішень.

Автоматизація та штучний інтелект суттєво вплинули на графічний дизайн, зробивши його більш ефективним, доступним та орієнтованим на користувача. Проте ці зміни вимагають від дизайнерів нових навичок, адаптації до інновацій та уваги до етичних аспектів. Інтеграція цих технологій не замінює творчість, але змінює її природу, відкриваючи нові горизонти для візуальної комунікації.

Це свідчить про те, що цифрові технології розширяють творче мислення художніх дизайнерів. Оскільки дизайнери стануть більш вправними у використанні технологій, вони зможуть досліджувати нові ідеї та концепції, виходячи за традиційні межі в художньому дизайні. Створюючи більш захоплюючі та інтерактивні форми мистецтва, дизайнери можуть залучити глядачів способами, які були неможливі традиційними методами. Сучасне дизайнерське мистецтво все більше адаптується до соціальних потреб та уподобань громадськості, що розвиваються. Оскільки цікавість людей до мистецтва продовжує зростати, дизайнерам потрібно буде відповідати на ці вимоги, створюючи роботи, які є не тільки естетично приємними, але й практичними та актуальними для сучасного життя.

Ці прогнозовані тенденції підкреслюють динамічний зв'язок між технологіями та мистецтвом, пропонуючи майбутнє, де цифрові технології відіграють центральну роль у формуванні сучасного мистецтва дизайну.

Еволюція графічних редакторів значно змінила професію графічного дизайнера. З одного боку, вона розширила можливості творчості, зробила дизайн доступнішим і зручнішим для використання. З іншого боку, вона поставила перед дизайнерами нові виклики, такі як необхідність швидко адаптуватися до інновацій, освоювати нові інструменти та працювати в багатозадачному режимі.

Майбутнє графічного дизайну тісно пов'язане з подальшим розвитком графічних редакторів. Інтеграція штучного інтелекту, автоматизація процесів і розширення можливостей програм відкривають нові горизонти для творчості, водночас зберігаючи важливість унікального людського підходу до створення візуального контенту.

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BIOLOGICAL SCIENCES

THE EFFECT OF LETHAL CONCENTRATION HERBICIDES ON FISH BEHAVIOR

Mammadova S.

Ministry of Science and Education of the Republic of Azerbaijan, Baku State University

Ministry of Science and Education of the Republic of Azerbaijan, Institute of Physiology named after A.I.

Garayev

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Abstract

Herbicides were developed to affect the physiological processes of plants, and they are responsible for causing harmful effects on animals. The aquatic environment is a natural reservoir for herbicides, which, after being applied to crops, run off through the soil, reaching rivers, lakes, seas, and oceans. Fish are among the many organisms affected by aquatic pollution caused by herbicides. These animals play an important ecological role and are a major food source for humans. However, few studies have examined the effects of herbicides on fish. In this article, the effects of herbicides on the behavioral responses of fish are studied, using *Cyprinus carpio* as an example. The lethal concentration of Tarkor Super herbicides was determined for fish for the first time. As a result of the research conducted, it was found that they influence the behavioral reactions of fish.

Keywords: herbicides, Tarkor Super, behavior, *Cyprinus carpio*.

Introduction

Herbicides can disperse into the atmosphere and soil, but the aquatic environment is the ultimate reservoir for these compounds, as once applied to fields they can reach rivers, lakes, seas, oceans, and groundwater via leaching, precipitation, or infiltration. Fish are among the many organisms harmed by aquatic herbicide pollution. In developed countries, fish is a valuable source of protein and micronutrients such as omega-3, vitamins A, B, D, iron and zinc. However, due to the increasing discharge of pollutants into water, the maintenance of fish stocks in the wild and the availability of this food source are under threat. Therefore, our research aimed to determine the lethal concentration herbicide Tarkor Super acceptable for fish and how it affects the behavioral reactions of fish.

Material and research methods

The biological object of our research was six-month-old *Cyprinus carpio*, a freshwater fish. We purchased carp from the Khylli fish factory for sturgeon production. To avoid stress, the fish under study were placed in aerated containers and delivered to the aquarium of the A. I. Garayev Institute of Physiology for further research. First of all, lethal concentrations of the studied herbicides were determined using the Dj. Finney method (2). Behavioral reactions such as coughing, yawning, surface swimming, and restless chaotic movement (1) were determined in the norm and after exposure to the herbicide at a lethal concentration. It should be noted that the data obtained were determined after 96 hours of herbicide exposure.

Discussion of the obtained results

Pesticides can affect the behavior of aquatic organisms, leading to species extinction. In addition to target organisms, pesticide exposure also affects non-target organisms, leading to disruption of the food chain and ecological imbalance. Bioaccumulation of pesticide residues in plankton (the food source consumed by many marine organisms) can be transferred to fish and other invertebrates, thereby negatively affecting them directly or indirectly. Some herbicides

with generalized modes of action may also be relevant to fish and other animals. These include substances that interact with metabolic pathways, leading to the formation of reactive oxygen species and other free radicals that damage cells. However, this mode of action is not exclusive to herbicides and will mostly be observed in high-impact scenarios.

Pesticides sold and used in the environment are usually mixed with other substances to facilitate application to target organisms. These substances are known as formulation agents and serve the same purpose as the excipients added to some pharmaceuticals; that is, they help disperse the pesticide in the spray solution or facilitate penetration of the pesticide into the target organism. Since most herbicides must be transported through the xylem and phloem in these cases, surfactants are added to the formula to enhance penetration through the cuticle and into plant tissues (3).

Among the pesticides used in agriculture, herbicides are used in the largest quantities. These substances enter the aquatic environment in various ways, and monitoring studies show their constant presence in natural waters. Herbicides cause changes in many physiological parameters in fish, such as a decrease in the activity of acetylcholinesterase in internal organs, an increase in the activity of liver transaminases, or a violation of the oxidoreductive balance. Changes in hematological parameters are also observed, usually indicating anemia and an inflammatory process. The most frequently observed histological changes include hyperplasia and hypertrophy of the gill epithelium and changes in the microstructure of the liver, such as vacuolization of hepatocytes. Markers of herbicide exposure in fish are usually very sensitive but nonspecific. Analysis of metabolic, hematological, and histological tissue parameters can be useful in determining fish poisoning with herbicides, but they should always be confirmed by monitoring studies (4). In our studies, we looked at behavioral reactions. As a result of the studies, we found that Tarkor Super lethal concentration (17.32 mg/l) has a strong effect on the behavior of fish.

If coughing is normally 3.6 ± 0.67 dw/min, then after the influence of Tarkor Super it was 51.00 ± 3.48 dw/min, yawning is normally 2.6 ± 0.31 dw/min after exposure 21.00 ± 2.77 dw/min, surface swimming 4.8 ± 0.53 dw/min, under the influence of this indicator was 11.70 ± 1.15 dw/min, restless chaotic movement is normally 2.9 ± 0.38 dw/min, under the influence of Tarkor Super lethal concentration (17.32 mg/l) it became 9.10 ± 0.38 dw/min.

Conclusions

1. Lethal concentration of Tarkor Super herbicide for fish determined
2. Behavioural disturbances in fish were detected after exposure to herbicide

3. The studies conducted have proven that Tarkor Super causes disturbances in the nervous system of fish

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ASSOCIATIVE MICROORGANISMS RESIDING IN SOIL AND THEIR BIOTECHNOLOGICAL POTENTIAL**Abdullaeva Sh.***Ph.d., Senior Lecturer**Azerbaijan State Pedagogical University***АССОЦИАТИВНЫЕ МИКРООРГАНИЗМЫ, ОБИТАЮЩИЕ В ПОЧВЕ, И ИХ
БИОТЕХНОЛОГИЧЕСКИЙ ПОТЕНЦИАЛ****Абдуллаева Ш.А.***Доктор философии**Старший преподаватель**Азербайджанский Государственный Педагогический Университет*<https://doi.org/10.5281/zenodo.14235995>**Abstract**

Associative microorganisms residing in soil play a crucial role in maintaining soil fertility and the stability of agroecosystems. These microorganisms, including nitrogen-fixing bacteria, phosphate-solubilizing bacteria, mycorrhizal fungi, and other beneficial microbes, form symbiotic or associative relationships with plants. Their activity enhances nutrient availability, promotes plant growth, increases stress tolerance, and reduces dependence on chemical fertilizers. The biotechnological potential of these microorganisms is widely utilized in agriculture and environmental management. They are employed in the development of biofertilizers, biopesticides, and for the bioremediation of contaminated soils.

Аннотация

Ассоциативные микроорганизмы, обитающие в почве, играют важную роль в поддержании плодородия почвы и устойчивости агро-экосистем. Эти микроорганизмы, включая азотфиксирующие бактерии, фосфатофиксирующие бактерии, микоризные грибы и другие полезные микробы, образуют симбиотические или ассоциативные связи с растениями. Их деятельность способствует улучшению доступности питательных веществ, стимуляции роста растений, повышению устойчивости к стрессам и снижению зависимости от химических удобрений. Биотехнологический потенциал этих микроорганизмов активно используется в сельском хозяйстве и экологии. Они применяются для создания биофертильных препаратов, биопестицидов и биоремедиации загрязнённых почв.

Keywords: nitrogen fixation, associative microorganisms, biotechnological potential, biopesticides, plant growth promotion.

Ключевые слова: азотфиксация, ассоциативные микроорганизмы, биотехнологический потенциал, биопестициды, стимуляция роста растений.

ВВЕДЕНИЕ

Азербайджан, с его разнообразием климатических и почвенных условий, является уникальной территорией для исследования ассоциативных микроорганизмов, обитающих в почвах. Эти микроорганизмы играют важную роль в поддержании экосистемного баланса и могут значительно повысить устойчивость агроэкосистем, улучшая их биологическое состояние. В частности, разнообразие типов почвы, включая серо-коричневые, коричневые и светло-коричневые почвы, способствует образованию различных ассоциативных связей между растениями и микроорганизмами.

Основные группы ассоциативных микроорганизмов в почвах Азербайджана:

1. **Азотфиксирующие бактерии:** Эти микроорганизмы играют ключевую роль в фиксации атмосферного азота, делая его доступным для растений. В Азербайджане они особенно важны для сельского хозяйства, где многие почвы нуждаются в улучшении азотного баланса.

2. **Фосфатсольбилизирующие микроорганизмы:** В Азербайджанских почвах многие формы

фосфора плохо растворимы. Микроорганизмы, которые могут растворять фосфат, значительно улучшают доступность этого важного питательного вещества для растений.

3. **Микоризные грибы:** Эти грибы образуют симбиоз с корнями растений, улучшая их водообеспечение и поглощение минеральных веществ. Микориза является важным элементом в агроэкосистемах, особенно в условиях засушливого климата Азербайджана.

4. **Антагонистические микроорганизмы:** Эти микроорганизмы способны подавлять патогены и вредителей, снижая потребность в химических пестицидах и улучшая здоровье почвы.

Биотехнологический потенциал ассоциативных микроорганизмов в Азербайджане:

1. **Биофертильность:** Использование ассоциативных микроорганизмов для создания биофертилизаторов может улучшить качество почвы и повысить урожайность без вредных экологических последствий. Это особенно важно для сельского хозяйства Азербайджана, где часто используется интенсивное земледелие с применением химических удобрений.

2. Биопестициды: Ассоциативные микроорганизмы могут быть использованы для разработки биопестицидов, которые эффективно защищают растения от заболеваний, уменьшая зависимость от химических пестицидов и минимизируя их воздействие на экосистему.

3. Биоремедиация: В условиях загрязненных земель и водоемов Азербайджана использование ассоциативных микроорганизмов для биоремедиации может сыграть важную роль в восстановлении экосистем. Эти микроорганизмы могут помочь в очистке почв от токсичных веществ, таких как тяжелые металлы, а также разложении органических загрязнителей.

4. Стимуляция роста растений: Ассоциативные микроорганизмы, улучшая доступность питательных веществ и активируя защитные механизмы растений, могут стимулировать их рост и развитие. Это особенно важно в условиях стрессов, таких как засуха или болезни, которые могут снижать урожайность в сельском хозяйстве Азербайджана.

Перспективы дальнейших исследований: Изучение ассоциативных микроорганизмов в Азербайджане и их биотехнологический потенциал открывает широкие возможности для устойчивого сельского хозяйства. Учитывая разнообразие почв и климатических условий, проведение комплексных исследований и использование микробных сообществ для улучшения плодородия почвы, защиты растений и очистки окружающей среды могут стать важными аспектами для развития сельского хозяйства в стране.

Почва – это не физическая или химическая, а прежде всего биологическая и биохимическая система, одним из главных компонентов которой является почвенная микрофлора. Микроорганизмам принадлежит ведущая роль в разложении растительных остатков, синтезе и деструкции гумуса, формировании фитосанитарного состояния почвы, накоплению в ней биологически активных веществ, фиксации атмосферного азота и т.д. Кроме того, почвенные микроорганизмы играют важную роль в формировании плодородия почвы и питании растений. Высшие растения, являясь основным источником питательных веществ для преобладающего числа микроорганизмов, населяющих почву, оказывают существенное влияние на микробные ценозы. Вокруг корней вегетирующих растений образуется особая зона, в которой создаются более благоприятные условия существования как для растений, так и для микроорганизмов. Численность микробов в прикорневой зоне более значительна, чем в остальной массе почвы. Это связано прежде всего с выделениями из корней (экзо-осмосом) органических веществ, синтезированных растениями. Кроме того, в зоне обильного скопления и развития корней улучшаются физические свойства почвы: почвенные частицы оказываются более структурированными, благодаря чему улучшается процесс дыхания корней и микроорганизмов, поддерживается стабильная температура, лучше сохраняется влага благодаря способности корневых систем растений активно изменять влажность окружающей их

среды. Также корни увеличивают кислотность примыкающих к ним микро-слоев почвы (в пределах нескольких миллиметров) за счёт выделения углекислоты и H^+ ионов.

Влияние химико-техногенных аспектов на сельское хозяйство в мире привело к положительным результатам в развитии производственного процесса. Производство продукции расширилось как количественно, так и в плане ассортимента. Тем не менее, интенсивность сельского хозяйства и его развитие на основе более точных интенсивных технологий привели к возникновению проблем, которые следует оценивать с негативной точки зрения. Эти проблемы проявляются в ухудшении качества продукции, усилении деградации земель, сокращении биогенов и других аспектах. Противодействие этим проблемам, развитие сельского хозяйства в соответствии с принципом устойчивого развития, а также поиск более эффективных методов использования земель являются важными задачами для решения.

Как известно, почва играет важную роль как в обеспечении потребностей человека в пище, так и в обитании большинства живых существ на Земле. Поэтому загрязнение и усиление деградации почв является нежелательным явлением, и предотвращение этого является одной из актуальных проблем современных наук, в первую очередь биологии. Следует отметить, что химизация аграрного сектора, интенсификация технологий серьезно влияет на жизнедеятельность существ, обитающих в почве, включая микроорганизмы, что отражается на характере их экологических функций, выполняемых в почве. Поэтому для понимания сущности процессов, происходящих в почве, крайне важно изучение микроорганизмов, которые участвуют в процессах почвообразования, обогащения почвы различными, в том числе биологически активными веществами, регулировании биологического разнообразия. Без их полного изучения невозможно устранить упомянутые отрицательные явления.

Почвы не являются стерильной средой с микробиологической точки зрения, поэтому в них обитают различные микроорганизмы, которые существуют как отдельные группы и выполняют свои экологические функции. Одной из таких групп являются ассоциативные микроорганизмы, обитающие в почве. Эволюция привела к тому, что существующий микробный мир формировался не как отдельные организмы, а как симбиотические единицы, связанные в микро-биому. Открытие новых групп симбиозов растений и то, что растения не являются участниками формирования ранее известных ассоциаций, а наоборот, ассоциации на основе симбиотических отношений являются естественными закономерностями и одной из основных форм существования жизни, служит основанием для таких выводов. Исследование отношений между организмами стало широко развивающейся областью, оказывающей значительное влияние на развитие различных отраслей биологии. Подтверждено, что симбиоз, вызывающий крупные изменения, обусловил возникновение новых жизненных форм, ко-

которые невозможно было бы сформировать в результате эволюции свободноживущих организмов. В классической литературе термин «симбиоз» наиболее часто является синонимом взаимной выгоды, которая формируется между двумя различными организмами.

В последние годы отношение к этому термину изменилось, и его начали рассматривать как многокомпонентную систему, включающую несколько ассоциативных организмов. Точнее, это система, в которой наряду с доминирующим микро-симбионтом присутствуют несколько ассоциативных микро-симбионтов. Поэтому взгляд на организмы, которые ранее считались классическими симбионтами, также изменился. Все это привело к повышенному интересу не только к изучению микроорганизмов с чистыми культурами, но и к исследованию ассоциативных микроорганизмов (микробных сообществ), что продолжает развиваться и по сей день. Ассоциативные микроорганизмы представляют интерес с биотехнологической точки зрения, поскольку они играют важную роль в улучшении плодородия почв. В Азербайджане в микробиологических и микологических исследованиях основной акцент сделан на чистые культуры отдельных микроорганизмов, однако работы, направленные на изучение ассоциативных микроорганизмов, в первую очередь грибов, практически не проводились. Интересно, что исследования, связанные с грибами, в этом контексте также считаются слабо изученными на мировом уровне. Учитывая это, было решено исследовать ассоциативные микроорганизмы, обитающие в почвах с различными экологическими условиями Азербайджана (серо-коричневая, коричневая и светло-коричневая), как по видовому составу, так и по биотехнологическому потенциалу. Для достижения указанной цели было решено выполнить следующие задачи.

ВЫВОДЫ

Ассоциативные микроорганизмы, обитающие в почве, играют важную роль в обеспечении устойчивости агро-экосистем и повышении продуктивности сельского хозяйства. Эти микроорганизмы, включая азотфиксирующие бактерии, фосфато-фиксирующие бактерии, микоризные грибы и другие полезные микробы, формируют ассоциативные или симбиотические связи с растениями, что способствует улучшению доступности питательных веществ, стимуляции роста и повышению устойчивости к стрессовым условиям. Биотехнологический потенциал этих микроорганизмов имеет значительное значение для разработки экологически чистых технологий в сельском хозяйстве. Использование биофертильных препаратов, биопестицидов и методов био-ремедиации позволяет снизить зависимость от химических удобрений и пестицидов, повысить эффективность производства и уменьшить воздействие на окружающую среду.

Перспективы дальнейших исследований в этой области включают оптимизацию применения ассоциативных микроорганизмов для улучшения агрономических свойств почвы, а также разработку новых биотехнологий для устойчивого и экологически безопасного ведения сельского хозяйства.

Ассоциативные микроорганизмы, обитающие в почвах, играют важнейшую роль в поддержании экосистемного баланса и улучшении состояния агро-экосистем. Важность этих микроорганизмов для сельского хозяйства и экологии невозможно переоценить, так как они значительно способствуют улучшению плодородия почвы, стимуляции роста растений, защите от патогенов и снижению зависимости от химических удобрений. Основными группами ассоциативных микроорганизмов, обитающих в почвах, являются азотфиксирующие бактерии, фосфатофиксирующие микроорганизмы, микоризные грибы и антагонистические микроорганизмы. Эти микроорганизмы взаимодействуют с растениями через симбиотические или ассоциативные отношения, что способствует улучшению доступности питательных веществ, усилению устойчивости растений к различным стрессам и повышению общего здоровья почвы. Биотехнологический потенциал ассоциативных микроорганизмов заключается в их применении для создания биофертилизаторов, биопестицидов и в биоремедиации загрязненных почв. Их использование способствует снижению экологического воздействия химических веществ, улучшению здоровья экосистем и обеспечению более устойчивого сельского хозяйства. Применение таких микроорганизмов в сельском хозяйстве Азербайджана, с его разнообразием почв и климатических условий, может сыграть важную роль в устойчивом развитии агроэкосистем и повышении урожайности. Для дальнейшего эффективного использования ассоциативных микроорганизмов в биотехнологии и сельском хозяйстве необходимо продолжать исследования их роли в экосистемах и оптимизировать методы их применения для улучшения состояния почвы и сельскохозяйственного производства.

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CHEMICAL SCIENCES

REMOVAL OF ANILINE DYES FROM AQUEOUS SOLUTIONS

Tereshchenko M.

student,

*Department of Inorganic Substances, Water Purification and General Chemical Technology
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» Kyiv,*

Kostenko E.

student,

*Department of Inorganic Substances, Water Purification and General Chemical Technology
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» Kyiv,*

Obushenko T.

Senior Lecturer

*Department of Inorganic Substances, Water Purification and General Chemical Technology
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» Kyiv,*

Tolstopalova N.

PhD, Associate Professor

*Department of Inorganic Substances, Water Purification and General Chemical Technology
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» Kyiv,*

Sanginova O.

PhD, Associate Professor

*Department of Inorganic Substances, Water Purification and General Chemical Technology
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» Kyiv,*

ВИДАЛЕННЯ АНІЛІНОВИХ БАРВНИКІВ З ВОДНИХ РОЗЧИНІВ

Терещенко М.

студентка,

*Кафедра технології неорганічних речовин, водоочищення
та загальної хімічної технології,*

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського» м. Київ,

Костенко Є.

студент,

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського» м. Київ,

Обушенко Т.

старший викладач,

*Кафедра технології неорганічних речовин, водоочищення
та загальної хімічної технології,*

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського» м. Київ,

Толстопалова Н.

кандидат технічних наук, доцент,

*Кафедра технології неорганічних речовин, водоочищення
та загальної хімічної технології,*

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського» м. Київ,

Сангінова О.

кандидат технічних наук, доцент,

*Кафедра технології неорганічних речовин, водоочищення
та загальної хімічної технології,*

Національний технічний університет України

«Київський політехнічний інститут імені Ігоря Сікорського» м. Київ,

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Abstract

The current state of the problem of wastewater pollution by dyes has been analyzed. Due to the wide variety of dyes, their extraction from wastewater does not have a universal technology, and for some types of dyes such technologies have not been developed at all. Existing methods of extraction and destruction of dyes have been considered. Flotation extraction technology has been proposed, which allows for simultaneous removal and concentration of the pollutant.

The extraction of aniline dyes methyl violet and malachite green has been studied using the example of model aqueous solutions with concentrations of 5-100 mg/dm³, which corresponds to the content of dyes in wastewater.

Rational technological recommendations have been determined, which are advisable to use in the flotation extraction process: collector - sodium dodecyl sulfate (DSN); molar ratio (DSN:D) = (1:1); correction of the pH of the medium is not required (pH 4-5); process duration - 15 minutes.

Анотація

Проведено аналіз сучасного стану проблеми забруднення стічних вод барвниками. Через велике різноманіття барвників, вилучення їх зі стічних вод не має універсальної технології, а для деяких типів барвників такі технології взагалі не розроблялися. Розглянуто існуючі методи вилучення і деструкції барвників. Запропоновано технологію флотоекстракції, що дає змогу забезпечити одночасне видалення і концентрування забрудника.

Досліджено вилучення анілінових барвників метилового фіолетового та малахітового зеленого на прикладі модельних водних розчинів з концентраціями 5-100 мг/дм³, що відповідає вмісту барвників у стічних водах.

Визначено раціональні технологічні рекомендації, які доцільно використовувати в процесі флотоекстракції: збирач – натрію додецилсульфат (ДСН); молярне співвідношення (ДСН:Б) = (1:1); корекція рН середовища не потрібна (рН 4-5); тривалість процесу – 15 хвилин.

Keywords: solvent sublation, dyes, surfactant, extractant, degree of removal.

Ключові слова: флотоекстракція, барвники, ПАВ, екстрагент, ступінь видалення.

Вода становить більшу частину Землі, хоча лише 0,3% придатне для використання людьми та тваринами. Величезні океани, крижані шапки та інші непитні водні ресурси становлять 99,7%. Якість води погіршилася за останні десятиліття через забруднення внаслідок зростання населення, промисловості, незапланованої урбанізації та неадекватного управління водними ресурсами. Забруднення води багато в чому визначається двома основними проблемами: відсутністю безпечної питної води та небезпечним впливом різних хімічних речовин та патогенів, виявлених у забрудненій воді та харчовому ланцюгу [1]. Забруднення води характеризується надлишком шкідливих речовин у водоймах, що виникає як у результаті природних явищ, так і в результаті діяльності людини [2]. Текстильна промисловість відома тим, що виробляє стічні води, які містять значну кількість барвників та хімікатів, які дуже шкідливі для водного середовища та життя в ньому [3]. Повідомлялося, що з обробки 1 кг текстильного виробу необхідно близько 100–200 дм³ води, залежно від типу процесу [4]. Неадекватне очищення та подальший викид цієї великої кількості води, насиченої небезпечними хімічними речовинами, можуть призвести до серйозного забруднення водного середовища, що впливає на водні екосистеми і, отже, на здоров'я людини [5]. Тому ефективне очищення стічних вод текстильної промисловості є пріоритетним завданням для спеціалістів з водних ресурсів та екологів, щоб забезпечити стійку роботу текстильної промисловості та уникнути загрози для природи.

В останні роки забруднення природних вод органічними та неорганічними поллютантами стало проблемою для багатьох країн. Стічні води текстильної промисловості містять безліч шкідливих ксенобіотиків, які є у великих кількостях і небезпечні для довкілля та здоров'я населення. Оскільки текстильні фабрики по всьому світу регулярно викидають мільйони тон забруднених стічних вод, стічні води, що містять токсичні барвники, є серйозною проблемою. Забаврлені стоки, поєднуючись з природними джерелами води, покривають верхній

поверхневий шар водойм, що знижує інтенсивність проникнення світла у воду, що безпосередньо впливає на біомеханізм гідробіонтів [6].

Існує кілька визнаних та нових методів очищення стічних вод, що містять барвники. Фізичні та хімічні методи, як правило, ефективні при очищенні стічних вод, що містять барвники. Широко використовують фізичні методи, такі як мембранна фільтрація, опромінення, іонний обмін та адсорбційні методи. Основним недоліком мембранних процесів є те, що вони мають короткий термін служби до початку забруднення мембрани, тому при будь-якому дослідженні економічної доцільності необхідно враховувати витрати на періодичну заміну. Процедури хімічного окислення включають окислювачі (озон), фотохімічні методи, коагуляцію або флокуляцію та використання хімічних реагентів. Ці хімічні процедури іноді є дорогими, і хоча барвники видаляються, накопичення концентрованого осаду викликає проблеми з утилізацією. Існує також небезпека вторинного забруднення внаслідок надмірного використання хімікатів. Однак ці методи спричиняють дорогі експлуатаційні витрати та небажані наслідки. У порівнянні з фізичними та хімічними підходами очищення стічних вод, що містять барвники, біологічний підхід є більш економічним, екологічно безпечним та загальноприйнятим. Зокрема, фіторе mediaція менш затратна, проста у реалізації та має довгострокове рішення [7].

Нанотехнології в даний час є найбільш ефективною і перспективною стратегією деградації барвників. Поєднання фізичних та біологічних методів з нанотехнологіями на сьогоднішній день є найбільш ефективним підходом. Фотокаталітична деградація та адсорбція з використанням зелених синтезованих наночастинок є екологічно чистими та високоефективними [7].

Необхідні подальші дослідження для розробки безвідходного методу та зниження ризиків для довкілля та здоров'я населення під час переходу від лабораторії до пілотного масштабу. На додаток до цього, дуже небагато досліджень вивчали вартість

очищення, і визначення найкращої доступної технології без надмірних витрат. У майбутньому дослідники повинні зосередитись на аналізі вартості процедур очищення.

Недосконалість існуючих технологій очищення стічних вод, забруднених барвниками, зумовлює необхідність пошуку альтернативних методів. Перспективним варіантом є технологія флотоекстракції [8], яка володіє наступними перевагами:

- можливість роботи з великими об'ємами водних об'єктів, концентрування яких може легко перевищити співвідношення 100:1;
- активна речовина виноситься бульбашками газу і надходить у верхній шар гідрофобної рідини без змішування фаз.
- процес флотоекстракції не є рівноважним процесом і не лімітується константою розподілу. В наслідок цього, вилучення незначних кількостей елементів може теоретично досягати 100 %;
- через відсутність змішування фаз, можливість утворення емульсій в процесі флотоекстракції зводиться нанівець;

- ступінь вилучення в процесі флотоекстракції не залежить від відношення об'ємів водної та органічної фаз.

Мета статті – дослідити флотоекстракційний процес та обрати умови для ефективного вилучення анілінових барвників (на прикладі метиленового фіолетового та малахітового зеленого).

Метиловий фіолетовий або основний фіолетовий ($C_{24}H_{28}N_3Cl$) відноситься до класу анілінових барвників. Він є кислотно-основним індикатором, і саме тому найчастіше використовується в аналітичній хімії. Крім того його використовують і в мікробіології – для забарвлення патогенних організмів і їх виявлення. В промисловості використовується для забарвлення стрічок пишучих машинок, як складова чорнил, та обмежено – для окраснення тканин та шерсті. Метилфіолет є мутагенною і мітотичною отрутою, а також кластогеном, тому він представляє велику небезпеку для екології.

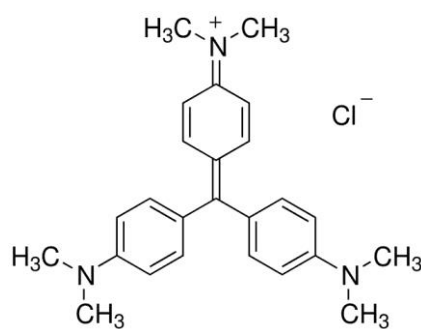


Рисунок 1. Структурна формула барвника метиленового фіолетового

Сполуки, що містять у одного атому вуглецю три фенольних кільця, представляють собою широку групу трифенілметанових барвників. Їх отримують конденсацією ароматичних альдегідів з ароматичними амінами. До цієї групи відносяться такі барвники як малахітовий зелений, фуксин, кристалічний фіолетовий. В їх структурах можна виділити хіноїдний фрагмент і є можливість для делокалізації заряду.

Малахітовий зелений (тетраетил-4,4'-діаміно-трифенілметан, $[C_{25}H_{30}N_4Cl]Cl$) – це синтетичний барвник. Це темно-зелені кристали з металічним блиском, що добре розчиняються у воді та етанолі. Малахітовий зелений є кислотно-основним індикатором: у водних розчинах у сильно кислотному середовищі він має жовтий колір, а при рН

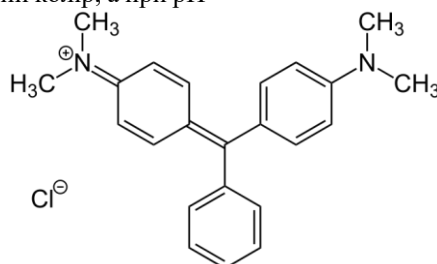


Рисунок 2. Структурна формула малахітового зеленого

вище 11,6 знебарвлюється через приєднання гідроксилу з утворенням трифенілкабінолу.

Малахітовий зелений має різноманітне використання, хоча традиційно використовується як барвник. З цією метою щорічно виробляються мільйони кілограмів малахітового зеленого та пов'язаних триарилметанових барвників. У мікроскопії його використовують для забарвлення клітинних ядер, еритроцитів, яєць аскарид. Також він використовується як лікарський засіб у ветеринарії – наприклад при лікуванні акваріумних риб від інфекційних захворювань. Крім того малахітовий зелений можна використовувати як реагент для фотометричного визначення Титану(IV), визначення Фосфору, Вольфраму, сульфідів.

Методика проведення дослідження флотоекстракційного очищення неодноразово описана в

наших попередніх роботах [9-11]. Тому тут ми наведемо тільки результати вилучення анілінових

барвників (на прикладі метиленового фіолетового та малахітового зеленого).

Оскільки анілінові барвники (Б) є катіонними сполуками, то ПАР було підібрано аніонні. Як ПАР використовували додецил (лаурил) сульфат натрію, каприлат натрію та лаурат натрію з концентрацією 0,05 моль/дм³.

ПАР разом з барвником утворює гідрофобний комплекс, що в свою чергу вступає в поверхневу

взаємодію з бульбашками газу (повітря) і підіймається до межі розподілу фаз «вода-органічна сполука» де відбувається поглинання органічною фазою. На рисунку 3 наведено результати вибору збирача для флотоекстракційного видалення. Процес проводили за наступних умов: рН 5, вихідна концентрація барвника 10 мг/дм³, тривалість процесу 20 хв. Найкраща ефективність при використанні додецил (лаурил) сульфат натрію (ДСН)

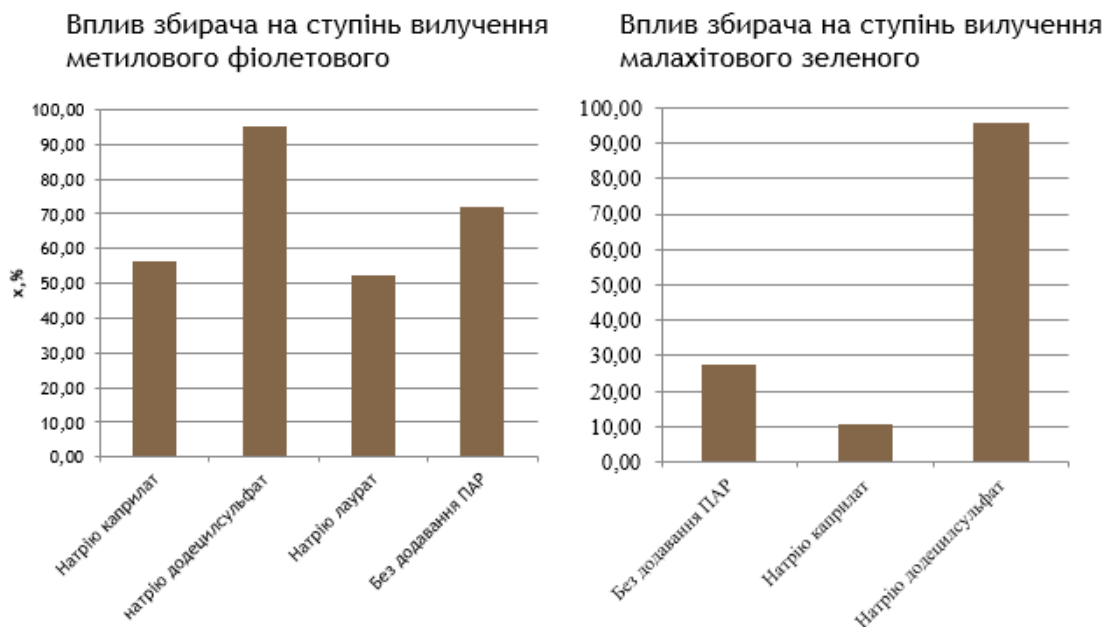


Рисунок 3. Вибір збирача для видалення барвників

Досліджували ефективність флотоекстракції в залежності від природи екстрагентів, які відрізнялись між собою за довжиною карбонового ланцюга та його структурою – нормальною чи розгалуженою, в присутності ПАР або без них. В якості екстрагентів використовувались наступні спирти: н-аміловий спирт, ізоаміловий спирт, октанол, ізооктанол, бутанол, ізобутанол, бутилацетат, гексанол, гептанол, ундеканол. Час експерименту складав 20 хв., ПАР - натрій додецил (лаурил) сульфат з концентрацією 0,05 моль/дм³ що подається у розчин за молярним співвідношенням 1:1.

Отримані експериментальні результати представлено на рисунку 4 та вони свідчать, що оптимальним екстрагентом є н-аміловий спирт (1-пентанол). Це можна пояснити тим, що дана сполука є

найбільш спорідненою до утвореного сублату. Крім того розчинність н-амілового спирту невисока ($S_{\text{н-аміл.}} = 3 \text{ г/100 см}^3 \text{ H}_2\text{O}$). Можна припустити, що бутанол та ізобутанол не є задовільними для екстрагування сублату за рахунок короткої структури карбонового ланцюга, що зумовлює важче утримання ними порівняно великої молекули йонного асоціату. До того ж, дані спирти досить добре розчиняються у воді ($S_{\text{бут.}} = 7,9 \text{ г/100 см}^3 \text{ H}_2\text{O}$; $S_{\text{ізобут.}} = 8,5 \text{ г/100 см}^3 \text{ H}_2\text{O}$) за рахунок достатньо сильної поляризації їхніх молекул, зумовленої наявністю ОН-групи. Це робить їх не придатними для використання в якості екстрагентів при очищенні стічних вод.

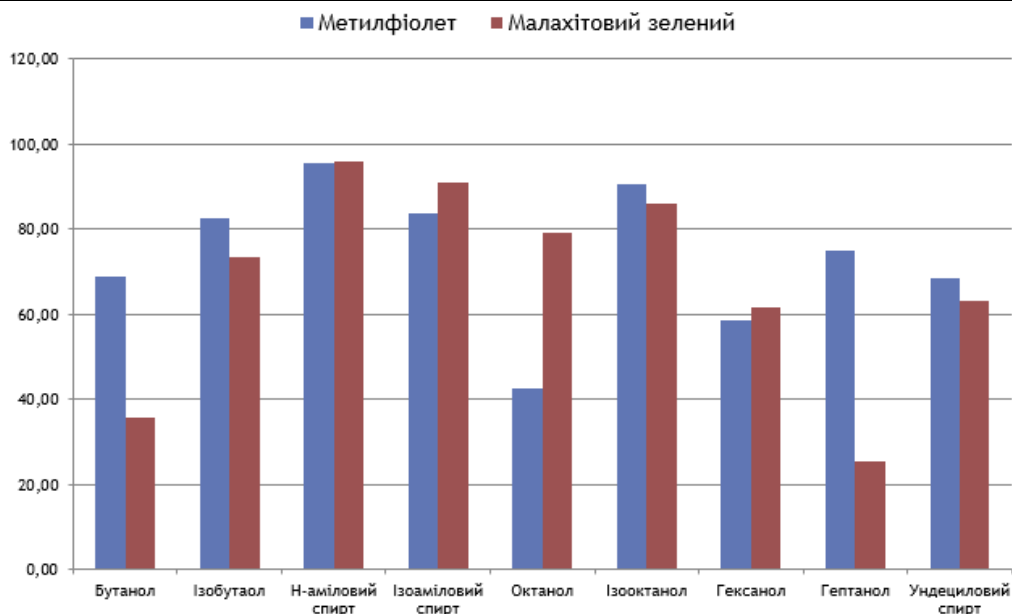


Рисунок 4. Вибір збирача екстрагенту для видалення барвників

При зростанні довжини карбонового ланцюга вплив гідроксильної групи послаблюється і розчинність вищих спиртів у воді різко знижується ($S_{\text{гекс.}} = 5,9 \text{ г/дм}^3$; $S_{\text{окт.}} = 0,46 \text{ г/дм}^3$), причому настільки, що, наприклад, ундеканол можна вважати практично нерозчинними у воді. Проте водночас, як показують отримані результати, такі спирти як ундеканол, гексанол, гептанол гірше розчиняють комплекс ДСН:Б. Це можна пояснити тим, що сублат є йонною сполукою, а вона є практично не розчинною у слабополярних екстрагентах. До того ж при використанні ундецилового спирту спостерігалось інтенсивне піноутворення, оскільки він володіє властивостями поверхнево-активних речовин. При флотоекстракції утворення піни не є бажаним процесом, оскільки через свою нестійкість піна поступово руйнується, при цьому вода стінок пухирців

утворює дрібні краплі, які коалесціюють і під дією сили тяжіння спускається через органічний шар до водної фази, повертаючи назад екстрагований раніше сублат [8].

Таким чином, найбільш доцільним екстрагентом йонного асоціату ДСН:Б є н-аміловий спирт.

Досліджено залежність ступеня вилучення барвників від рН середовища. Умови проведення експерименту: вихідна концентрація барвників 10 мг/дм^3 , тривалість процесу 20 хв., співвідношення Б:ДСН 1:1, органічна фаза н-аміловий спирт.

Як видно з графіку залежності (рисунок 5) в сильнокислому середовищі ступені видалення помітно менший у порівнянні із стандартними умовами ($\text{pH}=6$). В діапазоні рН 6-9 процес перебігає значно краще, однак особливого впливу на процес зміна рН не має.

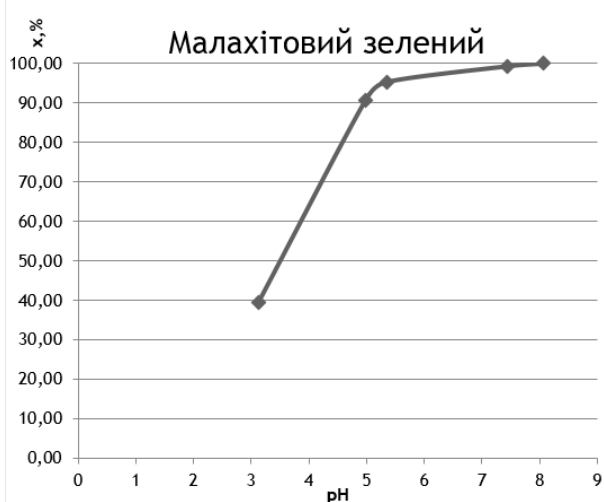
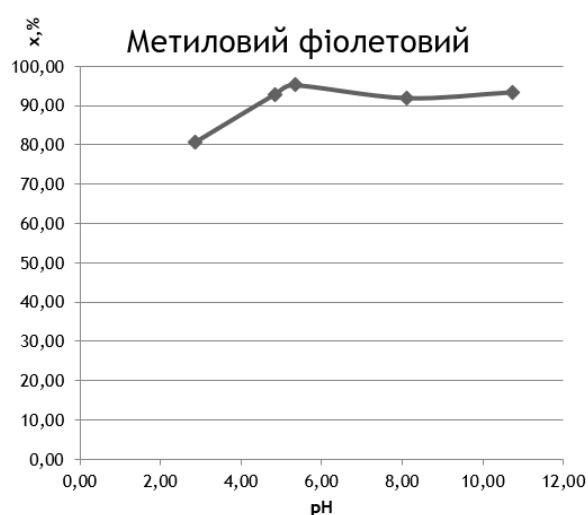


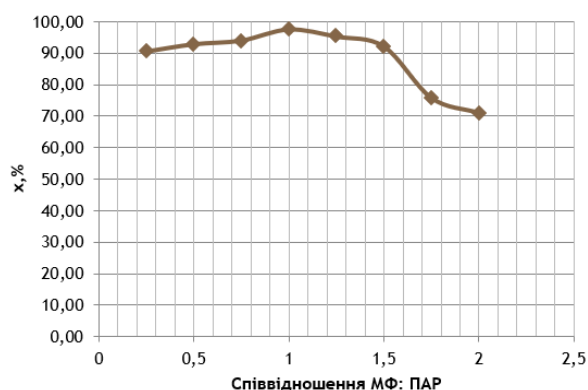
Рисунок 5. Вплив рН середовища на ступінь видалення барвників

На рисунку 6 надано залежність ступеня вилучення барвників від молярного співвідношення Б:ДСН. Метою цієї серії дослідів було визначення оптимального співвідношення Б:ПАР. Для обох

барвників ступені вилучення зменшуються після співвідношення 1:1.25. Найефективнішим співвідношенням обрано 1:1.

Згідно рисунка 6 в діапазоні молярних співвідношень (Б:ПАР) від 0,25:1 до 0,75:1 ступінь вилучення фактично однаково високий. Значення вільної поверхневої енергії і поверхневого натягу при даних співвідношеннях мінімальні, що відповідає максимальному насиченню молекулами

Метиловий фіолетовий



Малахітовий зелений

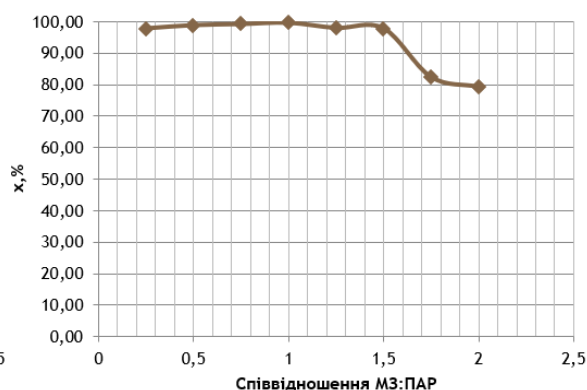


Рисунок 6. Залежність ступеня вилучення барвників від молярного співвідношення Б:ДСН

Досліджено залежність ступеня вилучення від вихідної концентрації розчину барвника (рисунок 7). При зменшенні вихідної концентрації ступінь вилучення, зазвичай, зменшується, оскільки чим

менша кількість забруднювача, тим важче він видаляється. Отримані результати знаходяться в межах похибки дослідів.

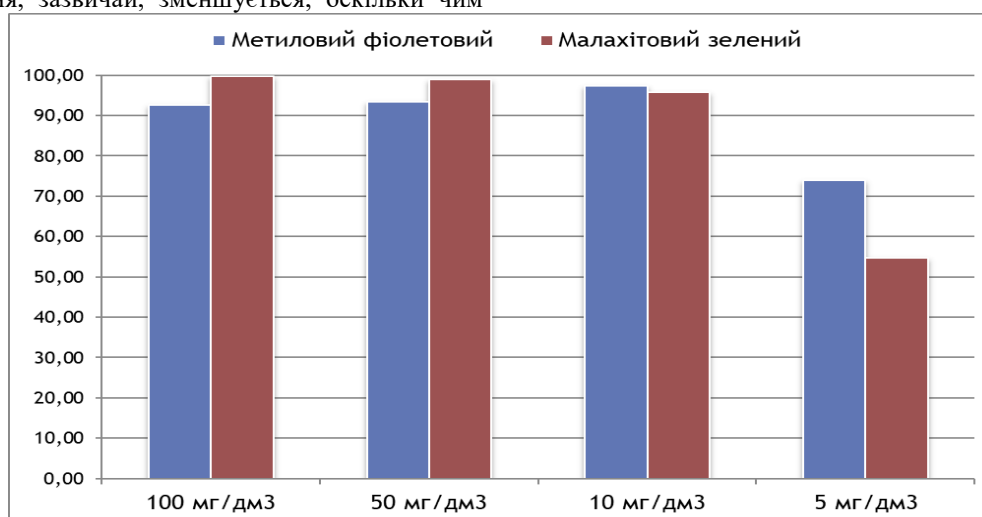


Рисунок 6 – Вплив вихідної концентрації розчину на ступінь вилучення барвників

Результати дослідів вказують на те, що при зменшенні концентрації вихідного розчину спостерігається зменшення ступеня вилучення барвника. Так, при концентрації 5 мг/дм³ досягнуто найменший ступінь вилучення, адже чим менша вихідна концентрація забрудника, тим складніше його видалення. При більших концентраціях помітний вплив на ступінь вилучення не спостерігається.

Висновки. Проведено аналіз сучасного стану проблеми забруднення стічних вод барвниками. Через велике різноманіття барвників, вилучення їх зі стічних вод не має універсальної технології, а для деяких типів барвників такі технології взагалі не розроблялися. Розглянуто існуючі методи вилучення і деструкції барвників. Запропоновано технологію флотоекстракції, що дає змогу забезпечити одночасне видалення і концентрування забрудника.

Досліджено вилучення анілінових барвників метилового фіолетового та малахітового зеленого на прикладі модельних водних розчинів з концентраціями 5-100 мг/дм³, що відповідає вмісту барвників у стічних водах.

Визначено раціональні технологічні рекомендації, які доцільно використовувати в процесі флотоекстракції: збирач – натрію додецилсульфат (ДСН); молярне співвідношення (ДСН:Б) = (1:1); корекція рН середовища не потрібна (рН 4-5); тривалість процесу – 15 хвилин.

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ECONOMIC SCIENCES

DEVELOPMENT OF THE CIRCULAR ECONOMY IN DEVELOPED COUNTRIES USING THE EXAMPLE OF THE USA: IMPACT ON SUSTAINABLE DEVELOPMENT STRATEGIES

Abdullina L.

master's degree, Bauman Moscow State Technical University

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Abstract

The article examines the development of the circular economy (CE) in the USA and its impact on sustainable development (SD) strategies. It explores the transition from a linear to a circular model aimed at reducing waste, minimizing resource use, and lowering emissions. The paper analyzes examples of successful initiatives in waste recycling, renewable energy, and sustainable construction, supported at both governmental and corporate levels. It discusses obstacles and challenges to the full implementation of circular practices, including economic, regulatory, and cultural aspects. The author makes a conclusion of the necessity for a comprehensive approach and coordinated efforts to achieve SD.

Keywords: circular economy (CE), sustainable development (SD), waste recycling, renewable energy, sustainable construction, economic strategies, environmental initiatives.

Introduction

The circular economy (CE) is an innovative model of economic development focused on minimizing waste and maximizing the efficient use of resources. Unlike the traditional linear model, based on the principles of «production – consumption – disposal», the CE is built on closed production-consumption cycles, where materials and products retain their value for as long as possible. The transition to a CE is becoming increasingly relevant in the context of global environmental and economic challenges, including the depletion of natural resources, environmental pollution, and climate change.

Developed countries, particularly the USA, play a significant role in promoting CE principles. As one of the world's largest economies, the USA has substantial resources and technological potential. In recent decades, the country has actively implemented initiatives aimed at developing the CE, including measures for waste recycling, carbon dioxide emission reduction, and the creation of sustainable production chains. These efforts are aimed at integrating circular principles into sustainable development (SD) strategies, which seek to balance economic growth, social well-being, and environmental protection.

The aim of this article is to analyze the processes of implementing the CE in the USA and their impact on SD strategies. The paper will discuss the main principles of CE, examine successful practices of USA companies, and identify the barriers and challenges the country faces on its path to SD.

Main part. Theoretical aspects of the CE

The concept of the CE began to take shape in the 1970s when ecologist John Bennington and economist Walter R. Stahl proposed ideas aimed at closing production cycles and reusing resources. During this period, theories such as «closed ecosystems» and the «materials loop» also emerged, advocating for a shift away from the linear economic model towards a system where the waste of one process becomes a resource for

another. These ideas formed the foundation of the modern CE where the primary goal is the sustainable use of resources.

In the following decades, with the strengthening of the environmental agenda, the CE came to be seen as one of the key tools for SD. According to the OECD, by 2022, more than 30 countries, including the USA and the European Union, had adopted strategies for transitioning to a CE. Projections indicate that the transition to the CE by 2030 could generate economic growth of \$4,5 trillion and save up to \$700 billion worldwide [1].

In the USA, the origin of the CE idea can be traced back to environmental activism and laws during the 1970s in response to the growing awareness of environmental issues like pollution and resource depletion. Waste management programs were implemented and the Environmental Protection Agency (EPA) was founded in this era to promote principles of sustainable development and resource conservation.

In the modern era, government support is crucial for the development of the CE. This support includes tax incentives, subsidies, grants for the implementation of environmentally friendly technologies, and waste recycling programs, all of which contribute to a faster transition of enterprises to sustainable production and consumption models. For example, the «Solid Waste Infrastructure for Recycling» grant program allocates \$55 million annually from 2022 to 2026 [2].

The CE principles focus on developing a sustainable and efficient production and consumption system that reduces waste and maximizes resource utilization. For example, waste minimization principle aims to decrease waste amounts by practicing recycling, reusing, and recovering materials. The waste recycling rate in the USA was 44 in 2024, higher than Canada's rate of 24,4 [3].

Another rule of CE involves prolonging the longevity of products and materials by repairing, upgrading, and reusing them. In 2022, Fortune calculated that the worldwide automotive repair and refurbishment industry was worth \$60,78 billion. It is forecasted that the

amount will rise from \$65,49 billion in 2023 to \$126,42 billion by 2030, showing an annual growth rate of 9,9% [4].

The «product cycle» concept is a key component of the CE, covering all stages of a product's life, from creation and manufacturing to usage and disposal. In contrast to the linear model, the CE strives to maximize the lifespan of products and materials in circulation. This is achieved by designing products with recycling and repair in mind. For example, according to Precedence, the green electronics manufacturing market size was \$16,93 billion in 2023. The growth rate is projected to be 26,13%, with the market size reaching \$155,89 billion by 2032 [5].

Thus, the CE is an essential tool for transitioning to SD models, especially in developed countries like the USA [6]. Integrating circular principles and technologies into various economic sectors requires not only government initiatives but also the active involvement of businesses and society as a whole.

Circular economy in the USA

As per a 2021 Executive Order by the USA President, the federal government pledged to generate and

sustain employment by advancing clean energy and sustainable infrastructure. By the year 2030, federal agencies must purchase electricity that is completely free of carbon, and by 2035, all light-duty vehicles must not produce any emissions.

These initiatives strive to decrease greenhouse gas emissions by 65% from 2008 levels while also boosting employment opportunities in clean technology and sustainable energy industries. In 2023, the number of clean energy jobs increased significantly, surpassing the growth rate in other sectors by more than double (4,9% compared to 2%), resulting in the creation of 149,000 new positions. This growth is due to increased federal and private investments in constructing solar and wind power plants and expanding recycling infrastructure [7]. Latino and Hispanic workers made up nearly one-third of new energy positions, increasing by 79,000 from 2022. This supports Sustainable Development Goal (SDG) 8 «Decent work and economic growth» and SDG 10 «Reduced inequalities». According to the USA Department of Energy report, the highest number of clean energy positions is in California (fig. 1).

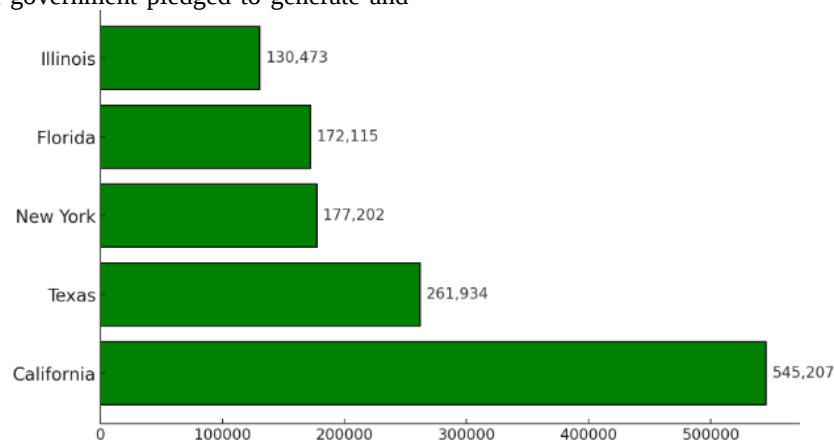


Figure 1. Number of clean energy positions across states in 2023

The new jobs created within the framework of the CE require employees to have high qualifications in technical and engineering fields related to the operation and maintenance of recycling equipment, management of renewable energy facilities, and skills in implementing environmentally sustainable technologies. These positions often demand specialized education or additional professional training covering competencies such as operating recycling and waste management systems, maintaining solar and wind energy installations, and using data management for resource optimization. At the same time, a significant portion of these positions is available at an entry level, enabling the inclusion of vulnerable populations by providing them with

access to economic opportunities and prospects for professional growth in the field of sustainable development.

An example of the CE's growth in the USA is the development of electric vehicle (EV) infrastructure, supported by the 2021 Infrastructure Investment and Jobs Act and the 2022 Inflation Reduction Act. As of February 2024, there were over 61,000 public EV charging stations in the USA, with 31% located in California [8]. Studies show that 64% of Americans live within 2 miles (3,2 km) of a public charging station (fig. 2).

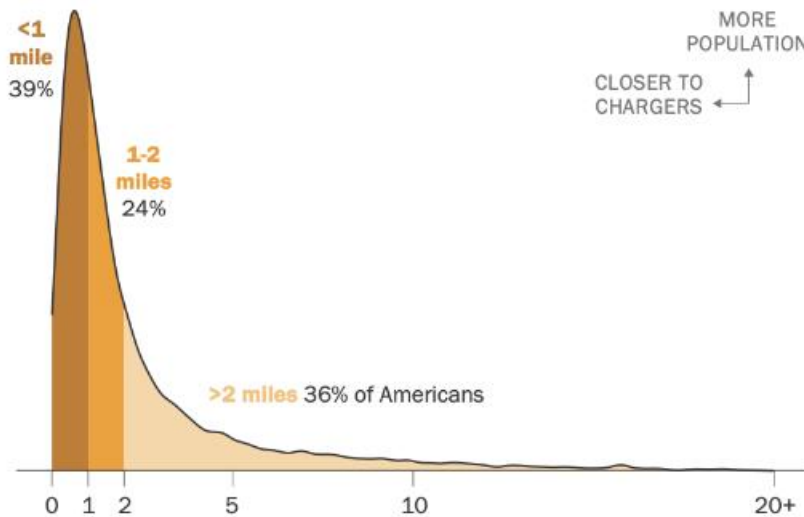


Figure 2. Distance to nearest EV charging station, miles

Federal sustainable building programs, like the «Assisting Federal Facilities with Energy Conservation Technologies» (AFFECT), plan to construct and upgrade over 200 million square meters of zero-emission buildings by 2030, fostering sustainable communities and reducing energy consumption. In 2024, \$104 million was allocated to energy-saving and clean energy projects across 31 federal sites.

The USA circular economy demonstrates a comprehensive approach to SD, integrating economic, social, and environmental initiatives. Through government support and private investment, the country actively develops clean energy, EV transport, and sustainable building infrastructure [9]. Implementing such programs strengthens the economy, reduces social and environmental risks, and highlights how the CE can be a key driver of change towards a more sustainable and equitable society.

Impact of the USA circular economy on SD strategies

The USA' SD strategies aim to achieve environmental, social, and economic sustainability by reducing pollution, enhancing energy efficiency, and developing green technologies. The USA is particularly vulnerable to significant climate risks and is situated in a zone of «climate hazards», which includes frequent extreme weather events such as hurricanes, wildfires, floods, droughts, and extreme temperatures. The application of circular principles not only helps manage the consequences of such climate disasters but also prevents them by reducing carbon footprints and slowing global warming. For example, using recycled materials in manufacturing instead of extracting new resources reduces emissions and minimizes the destructive impact on ecosystems [10].

As part of the strategy to achieve net-zero carbon emissions by 2050, the EPA aims to increase the recycling rate of household and industrial waste to 50% by 2030, focusing on plastics, paper, and electronics recycling. The Department of Energy (DOE) manages the Circular Economy Initiative, which funds innovative technologies for the reuse of critical materials such as

rare earth elements and batteries. This helps reduce dependence on imports and supports the creation of sustainable supply chains.

At the state and city levels, circular strategies are actively implemented. In California, Senate Bill SB 1383 was enacted to reduce methane emissions from organic waste by 40% by 2030, involving the development of composting and food waste recycling infrastructure. New York City's «Zero Waste» program aims to achieve zero waste levels by 2030. This initiative involves investments in recycling construction materials and textiles, as well as educational programs to raise public awareness.

Corporations in the USA are also actively promoting the CE. **Apple**, for instance, adopts circular principles in its business strategies, utilizing recycled materials in production and establishing closed loops for battery recycling, in turn diminishing its environmental impact and decreasing the use of fresh resources. Approximately 20% of the materials used in Apple products in 2022 were sourced from recycled or renewable sources, with features like 100% recycled aluminum in device enclosures and 73% recycled rare earth elements in magnets for products such as iPhones and MacBooks [11]. In the retail industry, companies such as **Patagonia** have created initiatives for reusing and repairing products to prolong their lifespan and decrease waste. In 2023, Patagonia fixed more than 60,000 clothes through its Worn Wear initiative at the repair center located in Reno, Nevada.

As we can see, the CE in the USA is a crucial component of the country's SD plan, involving collaboration among the federal government, states, and private industry to establish a CE that reduces waste, generates employment opportunities, and boosts economic progress.

Challenges in implementing CE principles in the USA

The implementation of the CE in the USA faces several challenges and difficulties associated with the diversity of economic, regulatory, and natural conditions. Despite active efforts from the government and businesses, there are numerous barriers that limit the

development of circular models and hinder the full transition to sustainable practices (table 1).

Table 1.

Features of Implementing the CE in the USA		
Challenge	Description	Examples
Diversity and Fragmentation of Legislation	In the USA, CE initiatives are often regulated at the state and city levels, leading to inconsistencies in rules and standards. This complicates coordination and the application of unified approaches across the country, as different regions may have their own priorities and limitations.	In California, SB 1383 aims to reduce methane emissions from organic waste, while central states like Oklahoma and Texas have fewer CE measures, creating a national imbalance in efforts.
High Initial Investments and Lack of Infrastructure	The implementation of recycling technologies and sustainable production processes requires significant investment. In some regions, particularly in rural and less developed areas, recycling and reuse infrastructure is weak.	In Midwestern states like Nebraska and Iowa, there is insufficient capacity for recycling plastic and organic waste. This leads to a dependence on transporting materials to other regions, increasing costs and carbon footprint.
Lack of Cultural and Consumer Awareness	Some Americans do not recognize the importance of recycling and sustainable consumption, which complicates the transition to a CE. Cultural and educational barriers prevent the implementation of new sustainable practices.	In rural areas and small towns, such as those in Mississippi or Alabama, the lack of secondary recycling facilities and information campaigns limits the development of a CE.

The implementation of the CE in the USA is complicated by several barriers, including the diversity of the legislative framework, high costs associated with developing infrastructure, and cultural differences that slow the transition to more sustainable practices. Efforts to raise public awareness and increase funding for infrastructure modernization can help eliminate these obstacles and ensure the successful development of the CE in the country.

Conclusion

The development of the CE in the USA contributes to the integration of environmental, economic, and social aspects into sustainable development strategies. One of the most important outcomes of implementing circular principles has been the creation of new jobs in areas such as waste recycling, renewable energy, and sustainable construction. As noted in the article, investments in solar and wind energy and the expansion of recycling infrastructure led to the creation of approximately 149,000 new jobs in the clean energy sector in 2023 alone. This supports both economic stability and the achievement of SDG 8, which focuses on promoting decent work and economic growth.

The implementation of CE involves specific skill requirements for employees, particularly in technology and recycling. These requirements include specialized technical training and the development of skills needed to work with innovative technologies. Since some of these positions require entry- and mid-level qualifications, they are accessible to vulnerable populations, including ethnic minorities and socially disadvantaged groups.

Thus, the CE in the USA not only reduces the carbon footprint and conserves natural resources but also creates a substantial economic contribution by expanding employment opportunities. The effective imple-

mentation of circular models requires coordinated efforts at all levels – from federal to local – and aims to build a more sustainable and equitable society.

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INTERNATIONAL EXPERIENCE OF DIGITALIZATION OF ACCOUNTING AND AUDITING IN COMMUNICATION ENTERPRISES

Pashayeva D.

ORCID: 0000-0001-9087-5844

Place of work: Baku Business University. Azerbaijan, Baku. Hasan Zardabi 88a

Position: Lecturer, Finance Department

Academic degree: PhD candidate in economics

<https://doi.org/10.5281/zenodo.14236001>

Abstract

This article explores the digitalization of accounting and auditing in telecommunications companies. It highlights the benefits of this trend, including increased efficiency, enhanced accuracy, improved transparency, and reduced costs. The article also examines the factors influencing the pace of adoption across different countries, such as technological infrastructure, regulatory environment, workforce skills, and implementation costs. It then dives into the legal framework surrounding digital accounting and auditing, emphasizing electronic records, data privacy, and audit trails. The impact of digitalization on telecommunication companies is analyzed, showcasing benefits like improved financial reporting and risk management. Challenges such as data security, integration, change management, and regulatory uncertainty are also addressed. Finally, the article explores future considerations including emerging technologies, standardization, and continuous learning.

Keywords: digitalization, accounting, auditing, telecommunications, efficiency, risk management, technology, future

Introduction

The telecommunications industry is a dynamic sector that thrives on innovation and efficiency. As technology continues to evolve, so too do the accounting and auditing practices within these enterprises. The digitalization of accounting and auditing has emerged as a critical trend, transforming how financial data is recorded, analyzed, and verified. This article delves into the international experience of this phenomenon, exploring the approaches taken by various countries and the impact on telecommunications companies.

The digitalization of accounting and auditing encompasses various technologies, including cloud computing, big data analytics, blockchain, and robotic process automation (RPA). These technologies offer numerous benefits for telecommunications companies, including:

- **Increased Efficiency:** Automation streamlines manual tasks, freeing up human resources for higher-level analysis and strategic thinking (Gerritsen et al., 2020).
- **Enhanced Accuracy:** Digital systems minimize human error and ensure data consistency (Alles et al., 2019).
- **Improved Transparency:** Real-time access to financial information facilitates better decision-making and accountability (Al-Shami et al., 2021).
- **Reduced Costs:** Automation can significantly decrease processing times and labor costs associated with accounting and auditing functions (Knechel et al., 2017).
- **Stronger Risk Management:** Advanced analytics capabilities enable proactive identification and mitigation of financial risks (KPMG, 2023).

This article aims to provide a comprehensive overview of the international experience with digitalization

in telecommunications accounting and auditing. It will explore:

- The pace of digitalization adoption across different countries.
- Specific standards and regulations implemented for digital accounting and auditing.
- The legal framework governing digital accounting and auditing practices.

By examining these aspects, the article will provide valuable insights for telecommunications companies and policymakers seeking to leverage the advantages of digitalization.

International Landscape of Digitalization

The pace of digitalization adoption in telecommunications accounting and auditing varies significantly across countries.

- **Developed Economies:** Countries like the United States, the United Kingdom, and Canada have been at the forefront of implementing digital solutions. These regions boast a mature technological infrastructure and a strong regulatory environment that facilitates the adoption of new technologies (European Commission, 2020). Telecommunications companies in these countries have been actively adopting cloud-based accounting systems, big data analytics for financial reporting, and RPA for automating routine tasks.

- **Emerging Economies:** Countries like India, China, and Brazil are demonstrating a growing commitment to digitalization. While they might face challenges related to infrastructure and regulatory clarity, these nations are making significant strides in digital adoption. Telecommunications companies in these regions are increasingly using cloud-based solutions and exploring the potential of blockchain technology for secure financial transactions (KPMG, 2022).

Table 1.

Tables of Countries with Digital Accounting Standards and Auditing Regulations

Country	Pace of Digitalization Adoption	Standards Implemented	Laws/Regulations Related to Digital Accounting/Auditing
United States	High	US GAAP (Generally Accepted Accounting Principles) with industry-specific pronouncements (AICPA, 2024)	Sarbanes-Oxley Act of 2002 (SOX) (PCAOB, 2023)
United Kingdom	High	Financial Reporting Council (FRC) standards (FRC, 2024)	Digital Accounting and Auditing Regulations 2014
Canada	High	Canadian Institute of Chartered Accountants (CICA) Handbook (CICA, 2022)	Assurance Engagements Standard (AES) 3150 - Identification and Assessment of Risks in an Audit (CICA, 2022)
India	Moderate	Indian Accounting Standards (Ind AS) (Institute of Chartered Accountants of India [ICAI], 2023)	Information Technology Act, 2000 (amended in 2008)
China	Moderate	Chinese Accounting Standards (CAS) (Ministry of Finance of the People's Republic of China [MOF], 2023)	Accounting Information Disclosure Rules by the Ministry of Finance (MOF)
Brazil	Moderate	International Financial Reporting Standards (IFRS) (IASB, 2023)	Law No. 11,638/2007 (regulates electronic documents and digital signatures)

Resurse: Prepared by the author.

Factors Influencing Pace of Adoption:

Several factors influence the pace of digitalization adoption in different countries:

- **Technological Infrastructure:** The availability of reliable and high-speed internet connectivity is crucial for cloud-based accounting systems and big data analytics (Gerritsen et al., 2020).
- **Regulatory Environment:** Clear and supportive regulations are essential for encouraging companies to embrace new technologies (European Commission, 2020)
- **Skillset of Workforce:** The workforce needs training and upskilling to effectively utilize and manage digital accounting and auditing tools (Knechel, et al., 2017)
- **Cost of Implementation:** The initial investment required for implementing digital solutions can be a barrier for some companies (Alles, et al 2019)

Legal Framework for Digital Accounting and Auditing

The legal framework surrounding digital accounting and auditing plays a critical role in shaping the adoption and application of these technologies within the telecommunications sector. Here's a closer look at some key aspects:

- **Electronic Records and Digital Signatures:** Many countries have enacted legislation that recognizes the validity of electronic records and digital signatures. This legal recognition is essential for ensuring the authenticity and reliability of digital financial data (European Union, 2019).
- **Data Privacy and Security:** Data privacy regulations are becoming increasingly important as more financial information is stored and transmitted

electronically. These regulations aim to protect sensitive data from unauthorized access, use, or disclosure. Telecommunications companies need to ensure compliance with relevant data privacy laws when implementing digital accounting and auditing solutions (KPMG, 2023).

- **Audit Trail Requirements:** Auditing standards often require companies to maintain a comprehensive audit trail that allows auditors to reconstruct financial transactions. Digital accounting systems should be designed to capture a complete and tamper-proof audit trail for all financial activities (International Federation of Accountants [IFAC], 2022).

Examples of Legal Frameworks:

- **Sarbanes-Oxley Act of 2002 (SOX) (US):** SOX is a US law that enhances corporate governance and financial reporting. It imposes stricter requirements on internal controls and auditor independence, impacting how telecommunications companies conduct their financial audits in a digital environment (PCAOB, 2023).

- **Digital Accounting and Auditing Regulations 2014 (UK):** These regulations in the UK outline specific requirements for the use of digital accounting systems and electronic audit files. They ensure that digital records meet the needs of auditors and provide a framework for conducting effective audits in a digital landscape (FRC, 2024).

- **Information Technology Act, 2000 (India):** This act, amended in 2008, recognizes the legal validity of electronic records and digital signatures in India. This legal framework facilitates the adoption of digital accounting solutions for telecommunications companies operating in the country (Institute of Chartered Accountants of India [ICAI], 2023).

Impact of Digitalization on Telecommunications Companies

The digitalization of accounting and auditing has a significant impact on telecommunications companies in several ways:

- **Improved Financial Reporting:** Digital solutions can streamline the financial reporting process, ensuring timely and accurate reporting of financial performance. This enhances transparency and facilitates better decision-making by management and stakeholders (Alles et al., 2019).

- **Enhanced Risk Management:** Advanced analytics capabilities of digital tools enable telecommunications companies to identify and assess financial risks more effectively. Proactive risk management allows for early intervention and mitigation strategies (KPMG, 2023).

- **Increased Efficiency and Cost Savings:** Automation of routine accounting tasks frees up valuable human resources for higher-value activities. Additionally, digital solutions can significantly reduce manual processing costs associated with accounting and auditing functions (Knechel et al., 2017).

- **Strengthened Internal Controls:** Digital systems can improve internal controls by providing real-time access to financial data and facilitating automated reconciliations. This strengthens the overall financial governance of telecommunications companies (Al-Shami et al., 2021).

Challenges and Considerations

Despite the numerous benefits, digitalization also presents some challenges for telecommunications companies:

- **Data Security Concerns:** The security of sensitive financial data is a primary concern in a digital environment. Companies need to implement robust cybersecurity measures to protect against cyberattacks and data breaches (KPMG, 2023).

- **Integration Challenges:** Integrating new digital accounting and auditing systems with existing legacy systems can be complex and time-consuming. Careful planning and implementation strategies are necessary to ensure a smooth transition (Gerritsen et al., 2020).

- **Change Management:** The shift to digital accounting and auditing requires changes in organizational culture and employee skillsets. Companies need to invest in training programs to equip their workforce with the necessary skills to effectively utilize these technologies (Alles et al., 2019).

- **Regulatory Uncertainty:** The legal frameworks governing digital accounting and auditing are still evolving in some countries. Companies need to stay informed about regulatory updates to ensure compliance (European Commission, 2020).

The digitalization of accounting and auditing operations is transforming the telecommunications industry worldwide. This trend leads to increased efficiency, faster financial reporting, and potentially lower audit fees. Here's a detailed analysis of these trends across eight countries:

Table 2.

International Digitalization Trends in Accounting and Auditing for Telecommunication Enterprises

Countries	Companies adopting digital accounting (%)	Companies adopting digital auditing (%)	Average time for closing financial statements (days)	Reduction in audit fees (%)	Analysis
USA	85	72	5	20	The US telecommunications sector shows strong digital adoption, leading to faster financial statement closing and potentially reduced audit costs.
UK	78	68	6	15	The UK follows a similar trend to the US, with a high adoption rate for digital accounting and auditing, resulting in efficiency gains.
Germany	92	85	4	25	Germany emerges as a leader in digitalization, with the highest adoption rate for both accounting and auditing, leading to significant efficiency improvements.
France	80	75	7	18	France demonstrates a solid commitment to digitalization, with positive impacts on closing times and potentially reduced audit fees.
China	95	88	3	30	China stands out as the frontrunner in digitalization, achieving the fastest closing times and the highest reduction in audit fees, likely due to widespread adoption of digital solutions.

India	65	50	10	12	India shows lower adoption rates compared to developed countries, resulting in longer closing times. However, there's still potential for digitalization to improve efficiency.
Canada	80	70	6	18	Canada aligns with France in terms of digital adoption for both accounting and auditing, achieving efficiency gains in closing times.
Brazil	72	60	8	15	Brazil exhibits the lowest adoption rate among the listed countries, leading to longer closing times. Further digitalization efforts could be beneficial.

Resurce: Prepared by the author.

This table reveals a clear correlation between the level of digital adoption and the efficiency of accounting and auditing processes. Countries with higher adoption rates experience faster financial statement closing times and potentially lower audit fees. China stands as a prime example, highlighting the significant benefits of digitalization in this sector. However, countries like India and Brazil have room for improvement by embracing digital solutions more extensively.

Conclusion

The digitalization of accounting and auditing is transforming the financial landscape of the telecommunications industry. By embracing these technologies, telecommunications companies can gain a competitive edge through improved efficiency, enhanced risk management, and strengthened financial governance. However, it is crucial to address the challenges associated with data security, integration, change management, and regulatory uncertainty. As countries continue to develop and refine their legal frameworks for digital accounting and auditing, the international landscape will continue to evolve. Telecommunications companies that proactively adapt to these changes will be well-positioned to capitalize on the benefits of digitalization and achieve sustainable financial success. In addition, research in machine learning and artificial intelligence is enabling advanced data analytics for audit purposes. These techniques can automate mundane tasks, identify anomalies, and improve audit quality.

Future Considerations:

The digitalization of accounting and auditing in telecommunications is an ongoing process with constant advancements on the horizon. Here are some key considerations for the future:

- **Emerging Technologies:** The integration of new technologies such as artificial intelligence (AI) and machine learning (ML) holds immense potential for further automating accounting and auditing tasks. Exploring these possibilities can increase efficiency and accuracy even further (Knechel et al., 2017).
- **Standardization and Harmonization:** As the international landscape of digital accounting and auditing evolves, the need for greater standardization and harmonization across countries will become increasingly important. Consistent standards will facilitate international business operations and enhance

transparency in global financial markets (International Federation of Accountants [IFAC], 2022).

- **Continuous Learning and Upskilling:** The pace of technological change necessitates a continuous learning culture within telecommunications companies. Investing in training programs will ensure that employees possess the necessary skills to navigate the evolving digital landscape of accounting and auditing (Alles et al., 2019).

In conclusion, the digitalization of accounting and auditing offers telecommunications companies a path towards improved financial management, enhanced risk mitigation, and greater operational efficiency. As technology continues to develop and adapt legal frameworks, telecommunications companies that embrace these changes and invest in their workforce will be well-positioned to thrive in the ever-evolving competitive landscape. From a cybernetic perspective, digitalization presents both opportunities and challenges. On the one hand, it enables real-time financial monitoring, improved audit trails, and enhanced data integrity. On the other hand, it necessitates robust cybersecurity measures to safeguard sensitive financial data and mitigate cyberattacks.

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GLOBAL ECONOMIC AND LEGAL PROBLEMS OF INTRODUCING THE CIRCULAR ECONOMY AND GEORGIA

Pavliashvili S.

Member of the National Academy of Sciences of Georgia, Doctor of Economics, Professor, Tbilisi, Georgia

Tokmazishvili M.

Doctor of Economics, Professor, Alte University, Tbilisi, Georgia

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Abstract

The study discusses the international economic and political obstacles to the transition of the circular economy, finance, the exploitation of economies of scale by businesses, consumer behavior and market demand, supply chain and infrastructural problems, legal assistance, and policy remedies.

Georgia's shift to a circular economy is described, along with its general goals. When deciding on the proper state policy emphases and establishing multifaceted parameters for the transition to the circular economy, the research helps to organize and prioritize issues.

Keywords: circular economy, value chain, circular models, circular practices and policies

Introduction

It is well recognized that the circular economy's implementation aims to reduce waste, save resources, and advance sustainability across a range of industries. In the process of putting it into practice, many nations face varying degrees of economic, social, legal, infrastructural, technical, and other issues.

The legal and economic aspects are the subject of the paper. The literature review makes a distinction between supply chain difficulties, economic issues, and inconsistent regulations and policies. Setting goals involves identifying and categorizing the global barriers to the circular economy, which should be essential in selecting the appropriate state policy goals and complex planning specifications. The study used empirical methods, such as expert and entrepreneur interviews, observational data, and comparison tools, because there is a lack of statistical data on the circular economy.

1. Economic challenges

Transition to a circular economy necessitates large investments in infrastructure, introducing of waste management systems, and new technology. Economic barriers are a significant obstacle to the implementation of the circular economy. The scientific literature has extensively examined these problems (1, 2, 3). Several hurdles are identified from an economic perspective:

Although circular models are a long-term approach, many companies put immediate financial gain ahead of sustainability over the long run. Making the shift to a circular economy requires coordination, planning, and effort. One major obstacle to the adoption of a circular economy is the size of economic operations, the scope of the output and associated expenses (4). Many entrepreneurs are hesitant to invest in new systems and technologies that might not provide immediate financial rewards since the initial expenses of switching to a circular model are significant for businesses. Installing infrastructure for the recycling or reuse of materials, training employees, developing items for recycling, and investing in new technology necessitates a large upfront cost. Businesses that manufacture plastic items, for instance, face higher expenses when attempting to build appropriate recycling equipment or transition to more sustainable, recyclable materials.

The price of creating circular supply networks, which involve gathering, classifying, and recycling discarded goods, is also added. When it comes to changing procedures and obtaining new technology, this process is particularly difficult for small and medium-sized business owners. They have a small production scale and small brands, and scarce financial resources. Due to their creative character and modest market reach, startups and small and medium-sized firms that concentrate on implementing the circular economy—such as waste-to-energy technology or biodegradable packaging—are high-risk businesses. They struggle to pay for these expenses, which disadvantages them in comparison to businesses with linear supply chains. Linear business models are not the same as the circular business notion. Traditional linear production models, on the other hand, have low unit costs and enjoy economies of scale in the consumer products sector.

Moreover, investments in novel recycling technologies are necessary for the circular economy, but their research and use are expensive. The absence of infrastructure for extensive circular operations exacerbates this, raising expenses and creating logistical difficulties for companies looking to adopt circular practices. Without a cohesive strategy or industry norms, fragmented circular economy initiatives are expensive and ineffectual. Changes to product designs come with increased expenses, which is another deterrent for businesses.

Traditional automakers with a traditional linear model and a focus on producing new cars have higher short-term profit margins than businesses that make cars that are meant to be easily disassembled and recycled in a number of countries. Even though it is more costly for the environment (in terms of emissions and noise) than buying new automobiles, recycling, auto repair, and auto renewal are highly popular in less developed countries.

The environmental costs of extraction, pollution, and waste processing are frequently overlooked when determining the price of raw resources. Environmental expenses are not reflected in market pricing. New materials may thus be less expensive than recycled ones. For instance, although recycled materials are better for

the environment, their usage is less appealing commercially in the building sector since freshly mined sand for concrete is less expensive than recovered aggregates.

The market's low demand for circular products is a significant obstacle that might prevent businesses from growing their circular product lines. When putting circular models into practice, consumer behavior matters. It is costly to provide incentives for customers to return unwanted goods for recycling or refurbishment. To collect and handle used goods, businesses must spend money on marketing efforts, incentives, or logistics infrastructure. If customers are not accustomed to returning old goods, it might be expensive for a firm that manufactures reusable packaging materials to set up a system for gathering, cleaning, and reusing packaging materials. As a result, the market for recycled goods is small. enterprises could not be motivated to invest in circular enterprises if there isn't a high demand for these goods.

The expense of conducting research to make circular judgments is considerable. This is particularly true in nations like Japan, the United States, Europe, and others that are seen as engines of innovation and progress. A substantial investment in research and development (R&D) is necessary to create new kinds of biodegradable polymers that can take the place of traditional plastics. Businesses may spend money on these breakthroughs, but the rewards are unknown and unexpected, and the expenses are considerable.

These financial obstacles demonstrate the necessity of encouraging laws, financial incentives, and other support systems to assist companies in overcoming the difficulties involved in making the shift to a circular economy. To overcome these obstacles, enabling legislation, technology advancements, and investment are needed to provide economies of scale in the use of circular models.

2. Complexity of the supply chain

Transition to circular economy necessitates cooperation amongst several stakeholders. Supply chain transformation to enable circular business is difficult, particularly when managing multinational supply chains. Every step involved in the creation and provision of a good or service is included in a value chain. It puts up certain obstacles to the adoption of the circular economy (5; 6). These obstacles arise when components that are acquired from several suppliers in various regions and nations, the supply chain is extremely fragmented, particularly in the electronics sector. Because the finished product (such as a smartphone) may be manufactured using parts from different vendors, each with their own requirements, it is challenging to integrate circular models and create a cohesive strategy to recycling or reusing materials (7).

The value chain's participants don't work together. The many value chain phases of the fashion sector, including the manufacture of fiber, fabric, and retail, are frequently overseen by separate businesses with little collaboration. Attempts to implement circular systems may be hampered by the absence of businesses involved in this system. It can be challenging for a clothing maker to create clothing that can be readily recycled

and extend its life cycle if they lack access to information on the recyclability of the fibers employed (8).

There are other obstacles. For instance, the value chain's usage of linear business models aims to establish processes that are simple to administer. Single-use packaging, which is inexpensive and simple to handle in a linear economy, is a common approach in the world of product packaging. Additionally, the circular model calls for the implementation of several packaging techniques, necessitating substantial and intricate adjustments along the whole value chain, from logistics to the procurement of components. New steel, concrete, and glass are among the materials used in established traditional methods, especially in the building sector. The use of recycled materials in new construction projects may be hampered by this mindset. While recycled steel might vary in quality and availability, contractors prefer to utilize new steel since it is more cost-effective and satisfies established criteria.

The value chain, such as in the consumer goods industry, typically concentrates on getting goods from manufacturers to customers. It lacks infrastructure for collecting and recycling used goods, though in some industries, like the furniture industry, it is not common for customers to return old furniture for recycling or refurbishment if it was not made of pricey wood. It is challenging to establish a circular economy without a robust logistical infrastructure.

The value chain has an unequal distribution of power. Large corporations frequently exert considerable control over smaller suppliers in the industrial, retail, and agricultural sectors. Small enterprises are unable to implement circular processes because of this power disparity. Small farms may wish to adopt sustainable measures like composting or recycling their trash, but they can lack the funds or motivation to do so if the bigger corporation they serve does not value these efforts.

The poor mobility of production processes, especially in the automobile sector where the linear production model typically results in highly specialized and optimized manufacturing processes, is a barrier to circular practices. Manufacturers of automobiles have had long processes in place for creating vehicles with easily assembled parts. Re-engineering these procedures to enable items to be disassembled and recycled is necessary to make the shift to a circular economy, but doing so can be expensive and challenging for businesses (9).

Barriers are created by limited access to circular materials; in the plastics industry, for instance, recycled polymers seldom ever satisfy the standards and quality that businesses want. Finding recycled plastics that satisfy the same criteria might be challenging because the value chain is frequently concentrated on creating high-quality new plastics.

In sectors where product safety and effectiveness are guaranteed by regulation and standardization, the supply chain is strong. One example of this is the pharmaceutical sector. Implementing circular practices, using recycled materials in packaging, and implementing programs for expired medications are all made more difficult by the value chain's rigidity. Reusing recycled or old materials in packaging is prohibited by strict

safety regulations, even when doing so benefits the environment.

Innovation in supply chain management, increased cooperation among value chain partners, and structural reforms are frequently needed to overcome these obstacles.

3. Issues with regulations and policies

Global policies now in place mostly support a linear economy in which goods are produced, consumed, and then discarded. Without political will, these restrictions cannot be changed to promote a circular economy.

There are laws in transitional countries that encourage the adoption of the circular economy in specific sectors, however merely enacting legislation pertaining to recycling, waste management, and the advancement of sustainable manufacturing is insufficient. There are difficulties with enforcement in this area: a lack of resources may result in inadequate enforcement. This may make it more difficult to adopt a circular economy. Encouragement of business incentives, including tax rebates and subsidies, is also necessary.

Overcoming the following obstacles is discussed in scientific literature (10; 11; 12; 13). Inconsistencies in what materials may be recycled and how they should be treated result from the EU's member states' disparate recycling laws and standards. Because of varying local laws, some plastic packaging types are considered garbage in one nation but recyclable in another. This discrepancy hinders the adoption of consistent circular economy policies and recycling initiatives for businesses that operate across several nations.

Even if a substance is still useful and reusable, regulatory systems in many countries mandate that it be categorized as waste after it leaves the original creator. For instance, by-products from one industrial process may be categorized as hazardous waste in the chemical sector, which makes it difficult to reuse them in another process because of stringent rules. As a result, they are destroyed, and the circular system's ability to circulate these materials is compromised.

Producers are not encouraged to design items for simple recycling or reuse in areas where strict Extended Producer Responsibility (EPR) has not been implemented. In the electronics industry, for instance, businesses in certain countries are exempt from paying for recycling initiatives or returning outdated technology, which does not guarantee that e-waste is recovered and recycled. On the other hand, because manufacturers are in charge of prolonging the life cycle of their products, countries with robust EPR laws see greater recycling rates.

Obstacles to the use of secondary raw materials are created due to restrictive regulations. For example, in the construction industry, strict building codes and safety regulations require the use of new materials, even if recycled materials meet the necessary standards.

Instead of encouraging the economic viability of recycling operations, the government makes it more affordable to produce new linear products when it offers subsidies, tax breaks, or incentives for linear business models (such as resource extraction or disposal) and fails to adequately support circular business models.

New business models like Product/Platform as a Service (PaaS), in which businesses keep ownership of their goods and lease them to clients, are sometimes not accommodated by regulatory frameworks.

Strict environmental laws in some places make circulation costly or challenging. For instance, a waste-to-energy facility in the municipal waste industry could have to adhere to stringent air quality regulations, necessitating costly technological advancements that render the operation unprofitable. Uncertain or rapidly changing legislation create uncertainty for businesses wishing to adopt circular practices, which also discourages innovation and investment in circular solutions.

Reforming policies and developing new frameworks that uphold the principles of the circular economy are frequently necessary to remove these regulatory obstacles. A coordinated strategy combining the government, private sector, and civil society is needed to address these issues. By working together, they can create a more robust regulatory environment, boost infrastructure spending, raise public awareness, and encourage innovation and cooperation among businesspeople.

Georgia's political attempts to implement the circular economy

The degree of circular economy is low in Georgia and other comparable countries. There are a lot of untapped resources, particularly in the fields of energy, building, and agricultural and food production. Not all of the issues and global difficulties mentioned above apply to Georgia. The shift of Georgia's economy from a linear model to a circular one and assuring sustainable growth are centered on waste reduction, reuse, and recycling of resources in specific industries and products because some industry sectors—mostly current high-tech sectors—are not well developed. It is predicated on regulatory actions taken by the government in areas like waste management, energy, and agriculture.

Circular regulation, policies that encourage circular behaviors, circular area designation, and strategy adaption to local needs are also under progress. Creating green jobs, cutting waste, raising recycling rates, and other objectives are among them. Expanding producer responsibility, encouraging public-private partnerships, measuring progress, putting in place a monitoring system, and supporting renewable energy are some of the main initiatives that are suggested. Georgia is emerging as a regional leader in the use of circular models, sustainable development, sustainability, and inclusivity with the help of international organizations. The political will and the plan created for the circular economy's implementation decide this (14).

Conclusion

Therefore, the challenges to the transformation of the circular economy are complex and include funding, the usage of economies of scale by businesses, consumer behavior and market demand, supply chain and infrastructural solutions, legislative backing, and political will. All countries that intend to switch to circular models must prioritize and systematize these issues in order to decide on the best state policy priorities and to plan the many criteria that guarantee the economy develops sustainably and effectively.

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MATHEMATICAL SCIENCES

RESEARCH ON INTEGRATING IDEOLOGICAL AND POLITICAL ELEMENTS INTO HIGHER ALGEBRA CLASSROOM TEACHING --- TAKING LINEAR TRANSFORMATION AS AN EXAMPLE

Zhang yu

*JiNing Normal University, School of Mathematics and statistic
Ulanqab, 012000, Inner Mongolia, P. R. China*

Research Project: 2022 Inner Mongolia Autonomous Region Education Science Research "14th Five-Year Plan" Project (NGJGH2022083)

Zhang yue

*JiNing Normal University, School of Mathematics and statistic
Ulanqab, 012000, Inner Mongolia, P. R. China*

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Abstract

After the national conference on ideological and political education in higher education, universities have gradually begun to develop curriculum integration of ideological elements, focusing on how to incorporate these elements into university mathematics teaching to construct a new educational model. This paper takes the teaching of linear transformations in higher algebra as an example, using case studies such as spacecraft attitude adjustment to explore the demand for ideological education in higher algebra, integration pathways, and implementation strategies. It aims to enhance students' mathematical abilities and sense of social responsibility while stimulating their scientific interest and innovative thinking.

Keywords: Ideological and Political elements; Curriculum-based ideological and political education; Linear transformations; Classroom teaching

1 Introduction

In May 2014, during a discussion with teachers and students at Peking University, Xi Jinping stated, "Knowledge is an important foundation for establishing core values." ^[1] This clearly indicates that knowledge serves as the basis for cultivating core values, and mastering professional knowledge helps students better understand society and the world, thereby establishing correct values and promoting personal and social development. In December 2016, General Secretary Xi emphasized at the National Conference on Ideological and Political Work in Universities that "we must consistently prioritize moral education as the central link and integrate ideological and political work throughout the entire education process, achieving comprehensive education and all-round development, and strive to create a new landscape for the development of higher education in our country." ^[2] Various universities actively implement the spirit of the conference by developing ideological and political education within their curricula, exploring and enriching educational resources in their courses to fulfill the mission of moral education. In May 2020, the Ministry of Education issued the "Guidelines for the Construction of Ideological and Political Education in Higher Education Curricula," stating, "Integrate ideological and political education throughout the talent cultivation system, and comprehensively advance the construction of ideological and political education in university curricula, maximizing the educational role of every course." ^[3] The guidelines require universities to incorporate ideological and political education into their talent cultivation systems to ensure the comprehensiveness and consistency of education.

Integrating ideological and political education with the teaching of advanced algebra not only enriches the educational content but also innovates teaching methods, making it a vital approach for cultivating well-rounded talent. By combining advanced algebra with cutting-edge practical applications, we can develop high-end professionals capable of solving real-world problems, which is of significant importance for technological advancement and economic development.

2 The Demand for Ideological and Political Education in Advanced Algebra Courses

The advanced algebra course not only establishes a foundation in mathematics but also cultivates logical thinking and problem-solving abilities. By integrating ideological and political elements, we can enhance students' mathematical skills while also strengthening their sense of social responsibility and moral character. Exploring the societal contributions of mathematicians and the impact of mathematical techniques on social development helps students understand the relationship between science, technology, and social progress, thereby igniting their sense of social responsibility and mission.

Moreover, modern education emphasizes the comprehensive development of morality, intelligence, physical fitness, aesthetics, and labor, with ideological and political education as a crucial component. This aspect not only relates to students' moral and ethical levels but also influences their values and outlook on life. By integrating ideological and political education into advanced algebra courses, and through discussions of practical problems, we can enhance students' awareness of social issues and improve their understanding of social responsibility and ethical standards. This teaching

approach not only enhances students' overall quality but also increases their sensitivity to social and cultural issues within the context of mathematics, achieving an organic integration of disciplinary knowledge and moral education, and cultivating high-quality talent with well-rounded development.

3 The Integration Path of Ideological and Political Education in Linear Transformations

Linear transformations are a core concept in advanced algebra, crucial for both theoretical understanding and practical applications. Integrating ideological and political education into the teaching of linear transformations not only helps students master mathematical knowledge but also enhances their sense of social responsibility and moral character. Here are several key paths for integrating ideological and political education into linear transformations:

First, incorporating historical context and social contributions into theoretical teaching aids students in deeply understanding mathematical concepts like linear transformations. Teachers can introduce mathematicians such as Hilbert and Cayley, highlighting their contributions to the development of linear transformation theory and how these theories respond to societal needs and scientific progress. Through historical narratives, students can appreciate the academic value of mathematics and its close relationship with social development, fostering a profound understanding of mathematics and its societal impact.

Second, organizing classroom discussions and moral education is essential. In linear transformation classes, teachers can design discussion topics that involve moral character and social responsibility, encouraging students to approach mathematical problems from these perspectives, thereby enhancing their moral awareness and sense of responsibility. Additionally, discussing different viewpoints and solutions cultivates students' critical thinking skills and teamwork spirit.

Finally, integrating ideological and political education in linear transformation teaching requires clear educational goals within the curriculum design, along with relevant teaching activities and assessment mechanisms. Such a design can enhance students' mathematical abilities while also fostering their social responsibility and moral character.

In summary, incorporating ideological and political education into linear transformation classroom teaching can not only improve students' mathematical literacy but also promote their overall development,

cultivating high-quality talent with a sense of social responsibility and moral character.

4 Case Study Based on Linear Transformations

Using "Matrices of Linear Transformations" as a case study to integrate ideological and political education into teaching helps students enhance their social responsibility and moral character while mastering professional knowledge.

First, when setting teaching objectives, two ideological and political goals can be added to the traditional objectives for teaching linear transformation matrices:

(1) Master the definition and properties of linear transformation matrices while incorporating stories of renowned mathematicians into the teaching. This aims to cultivate students' diligence, abstract thinking abilities, and problem-solving skills, inspiring perseverance and a spirit of exploration when faced with difficulties.

(2) Through social practice teaching, illustrate the applications of linear transformation matrices in real life to foster students' pursuit of truth, the application of scientific principles and methods, respect for facts and evidence, and the establishment of empirical awareness and a rigorous work attitude. [4]

Moreover, teachers can enhance students' interest in learning and help them intuitively understand abstract concepts by introducing linear transformation matrices through the stories of mathematicians.

In the 19th century, German mathematician David Hilbert stated, "Mathematics is a precise science, and its foundation is solid and stable." Learning about linear transformation matrices is about exploring this precision. The concept of linear transformation matrices was first introduced by 19th-century British mathematician Arthur Cayley. He discovered that matrices could represent linear transformations, laying a solid foundation for the development of mathematics. Another great German mathematician, Felix Klein, further expanded this concept by introducing the notion of "linear groups" and studying the relationships between linear transformations, providing important tools for understanding and manipulating linear transformation matrices.

Definition 1 Let V be a n -dimensional linear space over a field P , and let $\alpha_1, \alpha_2, \dots, \alpha_n$ be a basis of V . If σ is a linear transformation of V , then the image of this basis under the transformation σ is given by

$$\begin{cases} \sigma(\alpha_1) = a_{11}\alpha_1 + a_{12}\alpha_2 + \dots + a_{1n}\alpha_n, \\ \sigma(\alpha_2) = a_{21}\alpha_1 + a_{22}\alpha_2 + \dots + a_{2n}\alpha_n, \\ \vdots \\ \sigma(\alpha_n) = a_{n1}\alpha_1 + a_{n2}\alpha_2 + \dots + a_{nn}\alpha_n, \end{cases}$$

Record $\sigma(\alpha_1, \alpha_2, \dots, \alpha_n) = (\sigma(\alpha_1), \sigma(\alpha_2), \dots, \sigma(\alpha_n)) = (\alpha_1, \alpha_2, \dots, \alpha_n)A$

Among them $A = \begin{pmatrix} a_{11} & \dots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \dots & a_{nn} \end{pmatrix},$

Then, A referred to as the matrix a linear transformation σ under $\alpha_1, \alpha_2, \dots, \alpha_n$. Ошибка! Источник ссылки не найден.

At the same time, to help students better understand the definition of linear transformation matrices, teachers can incorporate the scientific story of Einstein's theory of relativity.

In the early 20th century, Albert Einstein proposed the theory of relativity, revolutionizing the understanding of time, space, and matter. He likened the universe to a curved stage, with celestial bodies and matter as actors, and gravity as the force that curves the stage. Einstein used linear transformations and matrices to describe this curvature phenomenon. On the cosmic stage, vectors represent each point, while matrices compute their changes. Linear transformation matrices reveal the mysteries of the universe and play a critical role in computer graphics, machine learning, and engineering design. By linking linear transformation matrices with Einstein's theory of relativity, we demonstrate the practical applications of mathematical concepts, inspiring students' scientific interest and curiosity, and helping them gain a deeper understanding of the connection between mathematics and the real world. Ошибка! Источник ссылки не найден.

Linear transformations and matrices are respectively geometric and algebraic concepts, and their relationship is evident in the way algebraic methods can be used to solve geometric problems, while geometric methods can also be applied to matrix problems. Mastering this approach is at the core of advanced algebra, allowing students to experience the rigor of mathematics and apply transformative thinking to solve real-world issues. Linear transformations and matrices are essential tools in scientific research and technological development, with significant applications for national progress, and through examples, students can appreciate their wide-ranging impact.

Example 1 Spacecraft Attitude Control

In the field of aerospace, spacecraft attitude control is crucial for ensuring proper operation and mission completion. By using multiple attitude thrusters, great scientists can change the orientation of the spacecraft. Now, suppose there is a spacecraft whose attitude can be adjusted by changing its angular momentum. Given the initial angular momentum vector of the spacecraft $Ha = pa \times L$, and the torque matrix of the attitude

thrusters $A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$, find the new angular momentum vector of the spacecraft after a series of thruster firings (L).

By demonstrating the application of linear transformation matrices in national development, students not only deepen their understanding of matrices but also recognize the important role of mathematics in the progress of the nation. This encourages students to explore unknown fields, cultivate innovative thinking and a spirit of inquiry, master scientific principles, respect

facts and evidence, and develop empirical awareness and a rigorous attitude. Additionally, through examples of multiple scientists collaborating to control the spacecraft, students learn the importance of teamwork, enhancing their communication and collaboration skills.

5 Implementation Strategies and Recommendations

Integrating ideological and political elements into the teaching of linear transformations in advanced algebra requires clear implementation strategies and recommendations.

First, establish clear teaching objectives by incorporating ideological and political education goals into the course syllabus, ensuring that each lesson covers both mathematical theory and discussions on social responsibility and ethics. Second, design teaching content related to ideological and political education. For instance, when explaining linear transformation matrices, introduce the social backgrounds and contributions of relevant mathematicians, emphasizing the role of mathematics in social development. Select practical cases related to current social issues, such as spacecraft attitude control, to demonstrate the real-world applications of linear transformations and their societal impacts.

By citing the perspectives and achievements of these great mathematicians, students can gain a deeper understanding of the importance and value of linear transformation matrices. Additionally, through analyzing the work and thoughts of mathematicians, students can learn to think critically, evaluate different viewpoints, and develop their abstract thinking skills and abilities to analyze and solve complex problems. The stories of mathematicians can also cultivate students' perseverance and spirit of exploration when facing difficulties.

Furthermore, provide teacher training and instructional support, and conduct regular training sessions on ideological and political education to enhance teachers' abilities to integrate these elements into the curriculum. Establish an effective feedback mechanism to adjust teaching strategies in a timely manner based on student feedback and classroom assessments, ensuring the effective integration of ideological and political elements. Through these strategies, it is possible to enhance students' mathematical abilities while also improving their sense of social responsibility and overall quality.

6 Conclusion

Integrating ideological and political elements into advanced algebra classrooms, particularly using linear transformations as an example, holds significant educational value. Through case studies, this paper explores specific paths for effectively incorporating ideological and political education into advanced algebra and presents implementation strategies and recommendations. This integration not only helps enhance students' mathematical abilities but also strengthens their sense of social responsibility and overall quality. Future research and practice will further refine these methods, providing more references and support for ideological and political education in advanced algebra, and promoting the comprehensive realization of educational goals.

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MEDICAL SCIENCES

TREATMENT OF ACUTE ODONTOGENIC INFLAMMATORY DISEASES IN CHILDREN

Novruzov Z.

*Doctor of Philosophy in Medicine, Associate Professor
Department of Orthodontics*

Ibragimov E.

Doctor of Philosophy in Biology, Assistant

Kalbiyeva N.

*Department of Pediatric Dentistry Assistant
Azerbaijan Medical University
Baku, Azerbaijan*

<https://doi.org/10.5281/zenodo.14236009>

The prevalence of caries in children of the in various age groups ranges from 83 to 98% [3]. In the structure of inflammatory diseases of the maxillofacial region, 50% are odontogenic processes [5]. The prevalence of dental anomalies among children and adolescents is quite high - from 33 to 78% [1,4]. Despite the fact that these diseases are often the reason for surgical interventions, the structure of surgical interventions in a clinic has not been studied enough. At the same time, the study of the duration of outpatient treatment in children with acute odontogenic inflammatory diseases remains relevant. The purpose of the study was to study the structure of surgical interventions and determine the average duration of treatment for acute odontogenic inflammatory diseases in children on an outpatient basis. 81 outpatient dental health records of children undergoing emergency surgery for acute odontogenic inflammatory processes were studied. At the same time, the diagnosis and timing of postoperative treatment were recorded. The data were processed statistically using the Student's significance test. The total number of patients requiring surgical interventions during the study period was 721 (17.16 people/month). Of these, 600 children (14.28 persons/month) were operated on outpatient basis. Of the total number of outpatient operations, 268 (44.67±2.03%) were emergency surgical interventions for inflammatory diseases of the maxillofacial area. Statistically significantly more often such operations were performed on children with complicated caries - 207 (77.25±2.56%). 34 (12.69±2.03%) operations were performed for anomalies of the maxillofacial region, 25 (9.32±1.78%) operations for tumors and tumor-like formations, 2 (0.03%) operations for trauma. 71±0.51%). Planned (clean) operations were performed in 332 (46.05±1.86%). STRUCTURE OF REPLANNED OPERATIONS AND A LARGE NUMBER a t y s t i c a l reliably ($p < 0,001$) as emergency - 247 (92.16 ±1.64%), and planned - 207 (62.35±2.66%) operations were performed on the soft tissues of the maxillofacial area. On the alveolar process, the number of operations was 21 (7.84±1.64%) and 125 (37.65±2.66%), respectively. Follow-up period 121 (16.78±1.39%) patient was sent to hospital treatment. For emergency reasons, 79 (65.00±4.51%) children were hospitalized. Of these, 17 (21.52±4.62%) were aged (children under 5 years old). The diagnosis was the reason for hospitalization for 36

(45.57±5.60%) patients. Other indications (non-contact with the patient, allergies to local anesthetics, general somatic diseases, etc.) were noted in 26 (32.91±5.29%) children. 42 (34.71±4.51%) children were hospitalized as planned. At the same time, according to age (up to 5 years), 16 (38.09±7.49%) children were sent to the hospital; in 9 (21.42±6.33%) cases, the cause of hospitalization was diseases not subject to treatment ulatory treatment, 17 (40.47±7.57%) children were hospitalized for other indications (non-contact of the patient, allergy to local anesthetics, general somatic diseases, etc.). As a result of studying outpatient dental health records, it was found that in a statistically significant majority of cases (82.71±4.20%), emergency outpatient operations were performed for acute purulent periostitis. Only 7 (8.64±3.12%) surgical interventions were performed for pericoronitis, 5 (6.17±1.08%) for suppurating dental cysts and 2 (2.48±1.72%) for suppurating radicular cysts. %). The overall average duration of treatment for children with odontogenic inflammatory diseases was 4.19±0.31 days. Treatment of acute purulent periostitis lasted an average of 3.72±0.31 days, pericoronitis - 2.00±1.77 days, suppurating tooth-bearing cyst - 8.60±0.78 and suppurating radicular cyst - 7.00±3.54 days. The duration of treatment for festering cysts was significantly longer than for periostitis and pericoronitis. We have not identified any cases of complications during outpatient treatment of acute odontogenic inflammatory processes. Thus, in the structure of outpatient surgical interventions in the maxillofacial area in children, planned (clean) operations prevail over emergency ones. A significantly larger number of emergency operations were performed for complicated caries, and planned operations for dental anomalies. The obtained data on the average duration of outpatient treatment of acute odontogenic inflammatory processes in children are comparable with the generally accepted treatment periods [2]. The absence of complications indicates the adequacy of the surgical treatment, and the high percentage of emergency surgical interventions for complicated caries may be associated with insufficient motivation of patients and their parents for planned sanitation of the oral cavity. Emergency hospitalization significantly prevails over planned hospitalization, while the indication for emergency hospitalization was mainly a dental diagnosis, while planned

hospitalization in most cases was carried out for other indications.

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COMPLICATIONS OF VOLUMETRIC ODONTOPREPARATION

Demirchiyeva M.*Doctor of Philosophy in Medicine, Assistant
Department of Therapeutic Dentistry***Rustamov E.***Doctor of Philosophy in Medicine, Assistant***Huseynova G.***Department of Therapeutic Dentistry Assistant
Azerbaijan Medical University
Baku, Azerbaijan*<https://doi.org/10.5281/zenodo.14236011>**Abstract**

Odontopreparation in orthopedic dentistry is the most important stage in the treatment with fixed orthopedic structures and is a mechanical process of removing hard dental tissues in order to form a stump that retains the signs of belonging to the corresponding group of teeth, and the planned design of a fixed prosthesis [1-3]. It should be noted that during the process of odontopreparation, a significant removal of tooth enamel, which plays the main protective role, occurs, followed by exposure of dentin.

Keywords: tooth preparation, metal-ceramic prostheses, temporary cements, dental pulp, orthopedic dentistry

Odontopreparation is accompanied by both thermal and mechanical trauma to the dental pulp, which depends on the doctor's compliance with the features of the tooth processing process [1, 3, 9, 10, 11]: •selection of the type, size of the abrasive and the condition of the burs; •speed of rotation of the bur; •time and force of bur pressure on the tooth; •type and quality of cooling; •knowledge of the location of the dental pulp and safe zones; •control of the depth of preparation.

Thermal trauma

In 1962, M.M. Berman established that the critical temperature for the prepared tooth is 42°C [6]. These data have been repeatedly confirmed and cited in other sources [4]. Increasing the temperature by 5.5°C to critical values reduces the reactivity of the pulp and leads to a thermal burn of the pulp, and subsequently to its necrosis [4, 5]. Dentin performs a protective function, absorbing the heat released during preparation, but with a decrease in dentin thickness, its protective function also decreases. The optimal thickness of peripulpal dentin is 1.0-1.2 mm, the critical one is 0.7 mm [3]. The literature draws attention to the fact that the use of coarse-grained (150 µm) diamond burs leads to a significant (by 3.2°C, up to 40.5°C) increase in the temperature of tooth tissues, therefore, to protect against pulp overheating, coarse- and medium-grained burs should be used only to remove enamel and superficial layers of dentin. Low-abrasive diamond and carbide burs should be used to remove deeper layers of dentin. The quality of the surface of the cutting instrument is of great importance, since with increasing wear of the bur, its cutting quality decreases and compensating pressure is created, which leads to a significant increase in the temperature of tooth tissues [5]. A pressure of 20 g on the tooth is optimal. It should be taken into account that the contact time of the cutting instrument also affects heat generation and should not exceed 3 seconds [1]. The most effective prevention of burns during odontopreparation is air-water cooling in a volume of 50-70 ml/min with a temperature within 35±3°C. Vi-

bration injury Excessive vibration of the cutting instrument during odontopreparation can lead to vacuolar dystrophy of odontoblasts due to osmotic shock. To prevent excessive vibration, attention should be paid to factors such as centering and wear of the bur, the condition of the tip sleeve, and the pressure during the preparation process [1, 4]. Traumatic injury During preparation for structures with a large preparation volume, there is a risk of opening the dental pulp and subsequent development of traumatic pulpitis. For successful processing of a vital tooth, it is necessary to take into account safety zones, the risk of opening the dental pulp in these zones is minimal. In dangerous zones, where the thickness of hard tissues is significantly less, it is recommended to carry out economical excision [1, 3]. The use of special marking burs and silicone templates from pre-made silicone impressions allows visual control of the volume of removed tissues, but these methods do not give an accurate idea of the location of the dental pulp [1]. Additional research methods, such as radiography and computed tomography, allow displaying the structure of all dental tissues. However, radiography creates only a two-dimensional image with possible projection distortions. In turn, computed tomography provides a complete three-dimensional image, but carries a significant radiation load, so frequent use of this method to control preparation at different stages is impossible [1]. The Prepometer DTM-800 device allows measuring the thickness of dentin at a certain point by measuring its electrical resistance, proportional to the thickness of the peripulpal dentin [10]. The result of the study was the development of a Russian analogue of the EndoEst-3D device, which is a multifunctional device for determining the thickness of suprapulpal dentin, apexlocation and electroodontodiagnostics. Microbiological factor Tooth preparation is accompanied by exposure of a significant layer of dentin and opening of dentinal tubules, the diameter of which can vary from 0.5 to 5 µm [7, 8]. In dental practice, great importance is attached to the penetration of mi-

croorganisms harmful to the dental pulp and their metabolic products through open dentinal tubules [7, 8]. The use of isolation of the working field and weak antiseptic solutions as water cooling helps prevent microbial invasion during odontopreparation.

PROTECTION OF THE TOOTH PULP AFTER ODONTOPREPARATION The process of odontopreparation is associated with trauma to the dental pulp, however, the penetration of chemical, thermal and microbial factors through open dentinal tubules is possible even after odontopreparation, which leads to the development of postoperative sensitivity, and sometimes to the development of inflammatory reactions of the dental pulp [4]. One of the main factors determining the success of prosthetics is the use of protective coatings and the manufacture of temporary crowns [11]. The use of adhesive varnishes ensures tooth protection by closing the dentinal tubules and providing antimicrobial action. The use of provisional structures for protection from external irritants ensures an aesthetic replacement of the defect and prevents displacement of adjacent teeth. According to the manufacturing methods, provisional structures are usually divided into direct and indirect [4]. The direct method involves manufacturing directly in the oral cavity using a previously removed silicone key and quick-hardening plastic or set teeth. It should be noted that the use of fast-hardening plastics, which include polymethyl methacrylate, is traumatic for the dental pulp, since the curing process is accompanied by the release of a significant amount of heat with an increase in temperature by 4-11 °C [4]. The use of such plastics in clinical practice is possible only with the manufacture of an additional model from fast-hardening plaster and a silicone key. The disadvantage of fast-hardening plastics is shrinkage during the curing process, and as a result - a violation of the marginal fit. The laboratory method of production is more accurate and aesthetic, but it entails taking additional impressions, and production requires at least 24 hours, which is unacceptable for prosthetics on vital teeth [21, 24, 25, 45]. Recently, a significant number of studies have been aimed at creating and studying various methods of protecting dental pulp by adding various substances to the composition of temporary cements for fixing crowns [11, 12]. In the course of his study, E.V. Teplov proposed a drug consisting of sodium diclofenac, calcium and zinc - "Diccalcin" in the composition of temporary cement for pharmacological protection of dental pulp after odontopreparation, which excluded all symptoms of acute pulpitis in the study group, and the pain reaction to temperature and physical stimuli disappeared by the 7th-10th day [39]. At the same time, with mechanical protection with repin and dentin paste, removal of dental pulp was required in 23% of cases. In recent studies, great importance is attached to the use of fluorapatite and hydroxyapatite in temporary cements, as well as laser radiation. It has been established that fluorapatite crystals in temporary eugenol-free cement block dentinal tubules up to 1 µm in diameter, which helps to normalize vascular tone after odontopreparation [10]. According to the same data, fluorapatite is most effective in combination with Temp Bond. In the study by P.A. Kashnikov, the use of ultrafine hydroxyapatite as a component for fixing crowns after 8

weeks reduced dentin permeability by 41%, while the use of temporary cement with ultrafine hydroxyapatite in combination with laser radiation reduced dentin permeability by 52% compared to the control. In a comparative study of the use of deep fluoridation, laser radiation and a desensitizer, the most desensitizing effect was found in the group using laser radiation. When using laser radiation, moisture evaporates from the dentinal tubules, resulting in a hermetic closure of the dentinal tubules, while no relapses were observed over the course of a year, and after two years, compared with the control group, the pain intensity was 10 times lower [12].

CONCLUSIONS

When performing prosthetics on vital teeth, orthopedic dentists should take into account all factors affecting the dental pulp at all stages of prosthetics, as well as use the entire modern arsenal of possibilities for the prevention of inflammatory reactions of the dental pulp. It should be noted that the development and creation of new methods for protecting and restoring the dental pulp after odontopreparation are relevant. The proposed method should have both a reparative, anti-inflammatory and odontotropic effect on the dental pulp, and activity against pulpitis pathogens.

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THE INFLUENCE OF FOCAL ODONTOGENIC INFECTION FOCI ON INFLAMMATORY EYE DISEASES

Guliyeva S.

Doctor of Philosophy in Medicine. Associate professor

Department of ophtalmologi.

Kalbiyeva N.

Department of Pediatruk Dentistry Assistant

Azerbaijan Medical University

Baku, Azerbaijan

Aliyev V.

Doctor of Philosophy in Medicine,

Department of Dentistry Faculty of Medicine, teacher

Nakhchivan State University

<https://doi.org/10.5281/zenodo.14236015>

Abstract

Numerous clinical observations indicate the significant role of "focal sepsis" in the development of inflammatory processes in the anterior segment of the eye, as well as the pathways through which infections spread from localized oral infection foci to the eye.

Keywords: infection foci, odontogenic infection, infection spread pathways.

Since ancient times, it has been believed that dental and oral diseases can have a detrimental impact on various human body systems.

For example, during excavations in Nineveh, the capital of ancient Assyria, a tablet was found in which a physician at the court of King Ashurbanipal wrote: *"The cause of the pain in his head, arms, and legs lies in his teeth, which must be removed."*

One of the Babylonian Talmuds contains a record describing the connection between oral and eye diseases, warning against the removal of the "eye tooth," as it could harm the eye. In the Jewish book *"Sefer ha-Olamot o Ma'aseh Toviya" ("The Book of Worlds")*, the human body is represented as a house, with the oral cavity as the front door that must be kept clean to prevent infection from entering the body.

In the 16th century, W. Ryff authored a medical treatise on dental diseases, *"Useful Instructions on How to Maintain the Health, Strength, and Clarity of the Eyes,"* which stated that the eyes and teeth are "extraordinarily closely interconnected, enabling them to easily transmit various diseases and disorders to each other, so that unless one of these organs is entirely healthy, the other will also be affected."

T. Berdmore, in 1768, described the impact of diseased teeth on the body as *"a dangerous inflammatory process that spreads to neighboring structures and affects the body through sympathetic pathways or by introducing infection into the bloodstream."*

At different times and in various nations, physicians have emphasized the importance of oral hygiene, considering dental diseases to be the source of many pathologies [1].

L. Cahn reported on the records of F. Hildanus (16th century), documenting a case of vision loss caused by a dental abscess, and Richter (18th century), who described a female patient suffering from recurrent keratitis for several years, whose vision was restored after the extraction of an affected tooth.

C. Jones detailed a clinical case involving a 16-year-old patient who developed parenchymatous inflammation of the corneas in both eyes. Despite six months of intensive anti-syphilitic and other anti-inflammatory treatments, the keratitis progressed to the point where both corneas became completely opaque, with no vascularization observed.

It was not until nine months after the onset of the disease that nine teeth with apical abscesses were identified and extracted, and a tonsillectomy of infected tonsils was performed. Cultures of the purulent material from the tonsils and the apical abscesses revealed the growth of the same microorganism: hemolytic streptococcus.

For the first time during the illness, within 48 hours after the sanitation of these focal infection sources, the patient's eye condition improved. There was a marked reduction in severe photophobia, hyperemia, and corneal infiltration. Visual acuity steadily increased, ultimately improving from correct light projection to 1.0 over the following eight months. Corneal transparency in both eyes was fully restored, except for some opacity in the upper outer quadrant of the right cornea [2].

Focal Sepsis The theory that the oral cavity is one of the primary sources of infection spread was widely accepted in 1826. However, the most significant contribution to its development was made by the English physician W. Hunter (1861–1937), who identified "focal sepsis" as the most common and predominant cause of various diseases.

In 1900, W. Hunter wrote in an article published in the *British Medical Journal*:

"Gold fillings, crowns, bridges, and fixed dental prostheses built on infected tooth roots or in their place bury an inflamed mass beneath a secure mausoleum, unparalleled in the entire realm of medicine and surgery. It is a perfect golden trap of sepsis that the patient proudly owns, and no persuasion will convince them to part with it, as it conceals their blackened, decayed teeth and came at a great cost."

The central idea of his theory was that focal sepsis serves as a trigger for the spread of infection to various systems and organs. According to Hunter, conditions such as gingivitis, periodontitis, granulomas, and purulent cysts at the tips of tooth roots were the most frequent precursors to oral focal sepsis.

The susceptibility of teeth to septic infections, he argued, is due to their structural and functional characteristics, as well as their connection to the bone tissues of the maxillofacial region.

T. Berdmore's studies demonstrated that the severity and manifestations of focal sepsis depend on both the nature and virulence of the causative microorganism and the general health of the individual.

F. Billings' theory [3] suggested that a focus of infection can remain inactive for an extended period, as the body's defense mechanisms inhibit the progression of infection. However, under adverse conditions such as trauma, hypothermia, stress, acute viral infection, fever, and other factors, a latent infection focus can activate, leading to septic complications.

R. Haden's research involved bacterial cultures from periapical tissues of 1,500 extracted teeth. Among 400 non-pulp-treated extracted teeth, streptococci were identified in only 15% of cases. However, in 500 previously pulp-treated extracted teeth with radiologically confirmed granulomas and cysts, streptococci were found in 72.4% of cases. Additionally, in 600 previously pulp-treated extracted teeth without radiologically visible infection foci, streptococci were identified in 55.7% of cases. The most common culture isolated was non-hemolytic streptococci.

Pulp removal of teeth can potentially create a risk of developing chronic infectious-inflammatory processes in the oral cavity due to improper or incomplete cleaning of root canals, incomplete removal of affected nerves, or insufficient sealing of open canals. These factors promote the spread of microbes and the formation of focal odontogenic infection sites [4].

In the study by A.S. Rabinovich [9], it was found that in the examination of root canals in 800 teeth, **70% contained numerous lateral canals and tubules ending blindly**. These tubules represent potential zones for the emergence of focal infection foci and are challenging to diagnose.

Particularly noteworthy are **hidden infection foci in "treated" pulp-removed teeth** that have been filled or covered with metal crowns. In cases where infection arises in the root tubules of such teeth, access to the infected area is blocked by the filling material, necessitating the extraction of the entire tooth.

P. Chojnacki conducted experiments in which infectious material obtained from the pulp-removed teeth of 10 patients with iridocyclitis and 4 patients with retrobulbar neuritis was intravenously introduced into test rabbits. In most cases, the rabbits developed the same eye pathologies as the patients. The researcher also observed that the extraction of the affected tooth in patients had a favorable impact on their eye condition.

C. Henry [5] described **50 cases of cyclitis, iridocyclitis, and conjunctivitis** that developed as a result of infection from unerupted third molars (wisdom teeth) and were rapidly resolved after their extraction.

The author emphasized that any search for dental sepsis should always include targeted X-rays of wisdom teeth.

While wisdom teeth, like any other teeth, can harbor infections, Henry provided several examples where perfectly healthy but unerupted, displaced, or impacted wisdom teeth caused eye inflammation due to pressure on the upper or lower dental nerve plexuses or reflex irritation of the trigeminal nerve.

J. Daggart regarded dental sources of infection as triggering factors for various eye conditions, including conjunctivitis, scleritis, episcleritis, various forms of keratitis (with or without ulcers), cataracts, chorioretinitis, retinal vein thrombosis, retrobulbar neuritis, orbital cellulitis, blepharitis, and dacryocystitis.

A. MacCallan [6] also linked keratitis to focal sepsis. In oral examinations of most patients with corneal ulcers, he identified active forms of "dental sepsis." According to MacCallan, these foci were a constant source of pus-producing bacteria migrating to the eye. He attributed significant importance to the absorption of toxic substances through the lymphatic system of the oral cavity and their subsequent systemic spread.

This, he argued, led to suppressed local immunity and the active proliferation of microorganisms on the conjunctival surface, which exerted erosive effects on the cornea. MacCallan advocated for dental examinations within the first 24 hours after diagnosing corneal ulcers, believing this to be critical for effective treatment. Drawing on extensive clinical experience in managing corneal ulcers associated with dental sepsis, he was confident in the link between these conditions.

P. Klieve and J. Reh documented more than 50 cases of iridocyclitis and keratitis successfully treated only after the removal of affected teeth. **F. Krusin** reported several cases of corneal ulcers that were completely healed following the elimination of dental infection foci.

S. Mujevic [7] conducted a thorough examination of **127 patients with iridocyclitis** and found that odontogenic infections were the direct cause of the condition in 49 (38.5%) cases. The author noted that treating the infection foci often led to a brief exacerbation of symptoms, followed by immediate recovery when accompanied by appropriate conservative therapy.

W. Lang [16] reported that **approximately one-third of his patients with iridocyclitis** had odontogenic infection foci. In some cases, he also identified ENT pathologies, particularly tonsillitis. However, odontogenic infections were **40 times more likely to cause iridocyclitis** than infections in the tonsils.

According to **E. Brown and E. Irons**, the number of cases where eye inflammation was linked to dental pathology was nearly the same as those associated with tonsillitis. Conversely, **S. Gifford** [8] found that iridocyclitis related to tonsillitis occurred **twice as often** as those stemming from dental issues.

K. Langmann highlighted the role of odontogenic infections in triggering recurrences of herpetic keratitis. He documented a case where a patient with severe recurrent herpetic keratitis and secondary glaucoma was found to have a dental granuloma in the upper jaw on the affected side. After the granuloma-bearing tooth was extracted, the patient rapidly recovered,

intraocular pressure normalized, and keratitis recurrences ceased.

Observations by **A.A. Kasparov**, detailed in the monograph "*Ophthalmic Herpes*" (1994) [9], aligned with this concept. In a study of 15 patients with herpetic keratouveitis, dental granulomas, typically in the upper jaw, were identified as the likely cause of recurrences. Among these, one-third exhibited mixed viral-bacterial corneal infections attributed to focal sepsis and chronic irritation of trigeminal nerve branches. Extraction of the affected tooth led to swift recovery, with no further keratitis relapses.

Streiff reported odontogenic infection as a cause of keratitis in 35% of cases. Eye damage was more often localized to the side of the affected tooth, rarely bilateral, and even less frequently on the opposite side.

Later, researchers proposed two pathways for the dissemination of bacteria and their metabolic products from infected teeth:

- **Open pathway:** through the digestive tract, respiratory tract, and adjacent ducts.
- **Closed pathway:** via blood and lymphatic vessels from the primary infection focus.

L. King et al. [10] documented a case of septic thrombosis of the central retinal vein resulting from transient bacteremia caused by deep caries in the upper molars. Systemic antibiotic therapy led to complete restoration of the patient's vision.

S. Blum and colleagues hypothesized that keratitis could develop due to irritation of the trigeminal ganglion caused by an inflamed tooth affecting the trigeminal nerve. Blum described **seven cases of keratitis**, where eliminating the odontogenic infection focus led to symptom reduction or full recovery.

S. Theobald (as cited in the literature) supported the idea of a reflex response in trigeminal nerve branches to stimuli from dental infection foci, causing corneal inflammation. He noted that the eye on the side of the affected tooth was more frequently involved, particularly when the focus was in the upper jaw. Theobald strongly advocated for the immediate removal of affected teeth to prevent ocular complications.

In 1954, **D.A. Entin** [11], building on I.P. Pavlov's theories, demonstrated that odontogenic foci serve as sources of infection and intoxication for the central nervous system. Entin's research, rooted in the neurotrophic concept of "oral sepsis" pathogenesis, revealed that physical and chemical irritants (e.g., toxins and infections) disrupt physiological connections between the central nervous system and other bodily systems and organs. This disruption triggers neuro-dys-trophic processes, leading to systemic diseases.

I.G. Lukomski developed the neurotoxic concept regarding the impact of oral infection foci on the body. He proposed that inflammatory processes in periodontal tissues produce intermediate protein degradation products, such as biogenic or proteinogenic amines, as well as cellular and tissue toxins. These substances, upon entering the bloodstream, irritate the neurotrophic apparatus, disrupt metabolism, and affect autonomic nervous system functions in specific organs.

Simultaneously, these substances act as antigens, sensitizing the body and causing general intoxication.

Lukomski identified **chronic granulating apical periodontitis** as the most active form of neurotoxic interaction between chronic periodontal foci and systemic health. He attributed this to the condition's ability to produce potent irritants affecting the nervous and immune systems.

Dental procedures inherently carry a **high risk of transient bacteremia** due to associated bleeding. Studies showed that in **88% of cases, odontogenic pathogens entered the bloodstream**, circulating for up to 15 minutes [12]. This underscores the potential for dental foci to act as systemic infection sources, influencing various organs and systems.

A. Heimdahl and colleagues reported bacteremia in 100% of patients following tooth extraction, in 70% after deep dental cleaning, in 55% after surgical intervention on third molars, in 20% after endodontic treatment, and in 55% after tonsillectomy. Similarly, **D. Kaye (1985)** found that tooth extractions resulted in bacteremia in 90% of cases. In 74% of extracted teeth, *Streptococcus viridans* was isolated from the root canals, while *Bacteroides melanogenicus* was found in 61%. Other organisms, such as staphylococci and enterococci, were also identified.

While most cases of bacteremia are asymptomatic, **immunocompromised patients** face a high risk of severe complications, including keratitis, endophthalmitis, orbital abscesses, superior orbital fissure syndrome, and even brain abscesses. These situations often necessitate the involvement of multiple specialists, including ophthalmologists, otolaryngologists, and neurosurgeons [13].

D. May and colleagues described a case of hematogenous infection dissemination one week after dental treatment. The patient developed progressive uveitis, which evolved into endophthalmitis (purulent inflammation of the eye's internal layers), requiring evisceration (surgical removal of the eye's contents while preserving the outer shell). Numerous studies have documented endophthalmitis following tooth extraction [14, 15].

In a study by **G. Debelian and colleagues**, advanced phenotypic and genetic methods were used to trace the spread of microorganisms from the oral cavity during endodontic treatment. Samples were collected from the root canals of 26 patients with asymptomatic apical periodontitis of single-rooted teeth. The findings identified anaerobic bacteria such as *Propionibacterium acnes*, *Peptostreptococcus prevotii*, *Fusobacterium nucleatum*, *Prevotella intermedia*, *Saccharomyces cerevisiae*, *Actinomyces israelii*, *Streptococcus intermedius*, and *Streptococcus sanguis*. Remarkably, these same strains were detected in the bloodstream of patients within 10 minutes after canal sealing, underscoring the systemic impact of dental infections and their potential to spread through hematogenous pathways.

To support the above, M. Kilian et al. [11] provide data indicating that the spread of microorganisms from the oral cavity into the bloodstream occurs in most cases in less than 1 minute after dental procedures, and microorganisms from infection foci can penetrate the

brain, heart, and lungs. Analysis of statistical data over the past 40 years shows a steady increase in the number of patients with acute odontogenic infections. According to dental clinics, in 1978, this rate was 51.1–56%, in 1992 it was 56–59%, in 2000 it was 63–70%, and in 2017 it was 85.5–95.6%. Periodontal diseases rank among the most significant problems in modern dentistry [18]. A survey conducted among dentists by the Department of Oral Pathology (India) in 2017 showed that 45.7% of respondents were unaware of the existing connection between focal infection sites in the oral cavity and eye diseases. Only 26.8% agreed with this theory, while 16.2% denied the existence of such a connection [17]. Chronic granulomatous and granulomatous periodontitis is accompanied by inflammatory and destructive changes in the bone of the alveolar process, and the breakdown products of tissue proteins (biogenic amines) pose a significant danger to the body, causing chronic intoxication and sensitization. In 85–98% of cases, dental periodontitis serves as an etiological factor for acute inflammatory processes in the maxillofacial area (periostitis, abscess, phlegmon, lymphadenitis, osteomyelitis of the jaw). As a rule, chronic apical periodontitis proceeds in an asymptomatic form. Granulomas and root cysts are often found in the area of a destroyed tooth, as well as in teeth after trauma or against the backdrop of insufficient or incorrect endodontic treatment of caries and pulpitis. Cysts can form in any damaged tooth, but purulent cysts are 2.5 to 3 times more likely to localize in the upper jaw. The cyst forms from a periapical granuloma, into which epithelial remnants of the periodontal ligament, activated by inflammation, proliferate, leading to the formation of a cyst-granuloma, which then transforms into a cyst. In its inactive state, granulomas and cysts contain a small amount of pus and do not cause complaints from patients, making clinical diagnosis difficult. During exacerbation, the amount of pus increases due to the death of macrophages. Purulent inflammation damages bone structures, nerve endings, and blood vessels in the alveolus and bone. The root cyst is always infected—the contents may range from transparent serous to purulent; microorganisms found in the oral cavity and carious teeth are present in it. The rupture of pus from the cyst into the perimandibular soft tissues leads to complications such as the development of an abscess or phlegmon, as well as the formation of a fistula, which may be located in the vestibule of the oral cavity, the palate, or the skin of the face [19].

Routes of Infection Spread. The complex pathways by which infection spreads throughout the body are not yet fully understood. However, experimental data suggest that there are three possible routes of infection dissemination in the body: neural, hematogenous, and lymphogenous.

Neural Route. Experimental studies conducted by I.F. Barinsky and co-authors in 1964 and 1986, using light microscopy, confirmed the assumptions of S. Blum, S. Theobald, A. Nesburn, and P. Absell regarding the spread of herpesvirus infection to various organs through two routes: the neural route (along sensory, motor, and sympathetic nerve fibers) and the hematogenous route (due to the strong erythrotropism of the herpes simplex virus – HSV), resulting in the infection of new cells. In experiments on rabbits, A. Nesburn and

co-authors, and P. Absell and co-authors proved that the trigeminal ganglion is the primary reservoir for the latent existence of herpes simplex virus (HSV) for many years. A.A. Kasparov suggests that infectious foci in the head (such as cysts, granulomas of the teeth, tonsillitis, sinusitis, dacryocystitis) irritate the second maxillary and/or third mandibular branches of the trigeminal nerve. This causes reflex irritation of the trigeminal ganglion, triggering the release of "legions of herpes viruses on the warpath," which, spreading through the first orbital branch of the trigeminal nerve, then along the nasociliary branch, ciliary branches, through the suprachoroidal space and ciliary body, reach the nerve plexus in the layers of the cornea, leading to the onset or exacerbation of herpetic keratitis (iridocyclitis).

In studying the mechanism of herpesvirus spread, K. Hayashi and Y. Uchida concluded that irritation of the trigeminal ganglion leads to reactivation of HSV and retrograde viral transport from the ganglion along the first branch of the trigeminal nerve to the target organ — the eye. This results in acute herpetic keratitis or its recurrences. The migration of the virus along neural pathways occurs through axoplasmic transport in both anterograde and retrograde directions, spreading intra-axonally, perineurally, and endoneurally, via leucocytes. J. Szanto and J. Rajcani demonstrated that herpesvirus virions, after attaching to nerve endings, are absorbed by axons and transported within them at a speed of 1.5 mm/hour. The authors consider the neural route of HSV spread to be predominant.

Hematogenous Route. According to J. Bullock and J. Fleishman, the presumed route of hematogenous spread of infection is retrograde entry through the ocular veins. The superior and inferior ophthalmic veins anastomose with the angular and facial veins at the medial corner of the eye. The inferior ophthalmic vein passes through the inferior orbital fissure and connects with the pterygoid venous plexus. These veins lack valves and offer no resistance to the spread of infection. The absence of valves, combined with anastomoses between the orbital and facial veins, the nasal sinuses, and the pterygopalatine fossa, creates conditions for blood drainage in three directions: to the cavernous sinus, the pterygopalatine fossa, and to the facial veins.

This creates the possibility for the spread of infection from the skin of the face, the nasal sinuses to the orbit and the cavernous sinus. Through the bloodstream via the mentioned veins, the infection spreads from the oral cavity and paranasal sinuses to the orbit, then through the ocular, vortex, and episcleral veins, which drain venous blood from the anterior segment of the eye

【21】. R. Brooks and D. Parke, along with their co-authors, described 38 and 32 cases, respectively, of hematogenous spread of *Candida albicans*, leading to the development of endophthalmitis.

Lymphogenous Pathway. The lymphatic system is closely connected with the circulatory system, actively participating in metabolic processes and providing the body's defense against infectious and toxic agents. Bacteria, viruses, and fungi from focal infection sites are able to reach lymph nodes (LNs) via afferent lymphatic vessels. From there, the infection spreads

from the affected LN to the next LN through efferent lymphatic vessels, reaching deep LNs and eventually entering the bloodstream [54]. According to Y. Shinomura and S. Higaki, HSV not only has tropism for nervous tissue and erythrocytes, but also has the ability to persist and replicate in leukocytes and lymphocytes, leading to further reactivation of the virus under certain conditions [22].

Infected HSV leukocytes and lymphocytes facilitate its further spread along the lymphatic vessels, affecting nearby structures. From the pericorneal lymphatic ring, lymph flows toward the equator into a dense network of highly anastomosing, winding lymphatic vessels. The first lymph nodes (LNs) for the conjunctival lymphatic vessels are the parotid nodes. Additionally, drainage connections have been identified between the conjunctival lymphatic drainage and the submandibular and cervical LNs. Lymphatic drainage from all teeth, except for the lower incisors and upper third molars, flows into the submandibular LNs (for these teeth, drainage flows into the deep cervical LNs). Therefore, the submandibular and cervical LNs can act as linking points for the lymphatic drainage from the teeth and eyes.

Conclusion

Numerous observations by doctors of various specialties (ophthalmologists, dentists), outlined in this review, confirm the undeniable connection between foci of odontogenic infections and inflammatory eye diseases. Untimely diagnosed or untreated "focal sepsis" (such as cysts and granulomas of the teeth) pose a risk for the spread of infection and the development of eye inflammation (herpesvirus, bacterial, and fungal etiology). Based on the literature data and personal experience, it can be concluded that infection foci can worsen the course of keratitis, keratoiridocyclitis, iridocyclitis, and others, as well as provoke their recurrences. According to the literature, focal infection foci exert an irritating or toxic effect on the second and third branches of the trigeminal nerve, causing reflex irritation of the trigeminal ganglion, which serves as a reservoir for the herpes virus. The herpes simplex virus, with its tropism for nerve tissue and erythrocytes, spreads from the trigeminal ganglion along the ophthalmic branch of the trigeminal nerve through both neurogenic and hematogenous pathways.

Thus, the infection reaches the anterior segment of the eye through the vessels and nerves in the suprachoroidal space. The hematogenous pathway for microbial infection is possible due to the anastomosis between the upper and lower ophthalmic veins and the angular and facial veins. The lymphatic pathway of infection spread is presumed to occur via the submandibular and cervical lymph nodes, which serve as a common link in the lymphatic drainage system from the teeth and eyes. Knowing that odontogenic infection foci are potential triggers for the onset and development of severe inflammatory eye diseases will help both dentists and ophthalmologists improve the quality of timely differential diagnostics with the identification of the disease's etiology, enhance treatment efficacy, and prevent recurrences of these serious conditions.

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IS THE BURNOUT SYNDROME COMMON AMONGST MEDICAL PROFESSIONALS

Todorova D.

Assistant Professor, PhD, Doctor of Medicine
Trakia University, Stara Zagora, Bulgaria

БЪРНАУТ СИНДРОМЪТ ЧЕСТО СРЕЩАН ЛИ Е ПРИ МЕДИЦИНСКИТЕ СПЕЦИАЛИСТИ

Тодорова Д.

Асистент, доктор по медицина
Тракийски университет, Стара Загора, България
<https://doi.org/10.5281/zenodo.14236017>**Abstract**

Chronic occupational stress can lead to a condition called burnout or burnout syndrome. Symptoms include a feeling of emotional exhaustion, decreased sensitivity to people in the workplace, and disappointment with one's own achievements at work.

Burnout has been studied since the 1970s. Initially, the concept was used in connection with the negative consequences of professional overload, forming three large groups of symptoms: emotional exhaustion, internal distancing, and reduced achievements. The professions that are most vulnerable include doctors, police officers, teachers, prison staff, pilots, air traffic controllers, and miners. At a later stage, people began to talk about stress syndrome in sociological professions that somehow support people in the service sector.

The syndrome is described as "a set of psychological, psychiatric, and somatic symptoms reflected in significant social interactions with a negative effect and developing overall functioning stress. Professionally burned-out individuals spent more and more time at work, managing to get less and less quality work done. Their time passed by, simply "hanging around," without doing anything useful. Their social lives also suffered because the daily overtime work negatively affected their relationships with other people outside of work.

Анотация

Хроничният професионален стрес може да доведе до състояние, наречено бърнаут или синдром на професионалното изпепеляване. Симптомите включват усещане за емоционално изчерпване, намалена чувствителност към хората на работното място и разочарование от собствените постижения на работното място.

Бърнаут се изследва от 70-те години на миналия век. В началото понятието се използва във връзка с отрицателните последици от професионалното претоварване, като се оформят три големи групи симптоми: емоционално изтощение, вътрешно дистанциране и намаляване на постиженията. Професиите, които са най-уязвими включват лекари, полицаи, учители, персонал на затвори, летци, управляващи полети, миньори. На по-късен етап започва да се говори за синдром на стрес при социологични професии, подпомагащи по някакъв начин хората в обслужващата сфера.

Синдромът се описва като „свкупност от психологични, психиатрични и соматични симптоми, рефлектиращи в значими социални интеракции с негативен ефект и развиващ цялостното функциониране стрес“. **Професионално изпепелените** лица прекарвали все повече време на работното място, успявайки да свършат все по-малко работа качествено. Времето им минавало, просто „мотаейки се“, без да се върши нещо полезно. Социалният им живот също страдал, защото ежедневният извънреден труд се отразявал негативно на взаимоотношенията им с другите хора, извън работата..

Keywords: medical professionals, burnout, workplace, incineration**Ключови думи:** медицински специалисти, бърнаут, работно място, изпепеляване**ВЪВЕДЕНИЕ**

Световната здравна организация (СЗО) описва професионалното прегаряне като синдром, свързан с хроничен стрес на работното място и характеризира се с чувство на изчерпване на енергията или изтощение, увеличаване на менталната дистанция от работата или чувство на негативизъм или цинизъм към нея, както и като цяло намалена професионална ефективност.. Синдромът на професионалното прегаряне сред съсловието се оформя като все по-нарастващ проблем.

Административното бреме в работата на медицинските специалисти утежнява допълнително и без това натовареното им ежедневие и също води до професионална умора. Макар да сме свикнали с

мисълта, че прекалено многото бумашина е „запазена марка“ за работещите в българската здравна система, на практика този проблем е налице сред колегите им на много места по света. „

Когато говорим за професионално прегаряне сред медицинското съсловие, не можем да подмигнем и една друга съществена причина за него, а именно – насажданото с години в обществото негативно отношение към медиците. Настоящата криза, породена от непознатия вирус, за пореден път извади на показ редица язви в здравната система, която въпреки уверенията на здравните власти, че беше подготвена през летните месеци за очаквания пик на пандемията през зимата, отново разкри трупани с години проблеми.

Има ли механизми, чрез които може да се помогне на медицинските специалисти за справяне с професионалното прегаряне? Специалистите по проблемите на психичното здраве са категорични, че особено в настоящата ситуация трябва да се постави фокус върху проблема с хроничната умора от работа и демотивацията. Това важи с особена сила и за медицинските специалисти

Продължителните часове работа и отговорността за редица дейности едновременно имат своята роля за евентуалното развитие на състояние на бърнаут. Но те далеч не са най-важните фактори за това. Смята се, че много по-значими в това отношение са обстоятелства, като:

- Липса на подкрепа в работата;
- Дългосрочна липса на почивка;
- Ситуации, при които служебните отговорности не съответстват на призиването на личността;
- Невъзможност за баланс между професионалния и личния живот;
- Работна среда, в която присъства емоционално или психическо насилие от страна на колеги или от представители на ръководството.

Някои професии се смята, че са по-предразположени към състояния на бърнаут в сравнение с други. Такива са професиите на медицинските специалисти.

Цинизмът, депресията и летаргията са основни характеристики на бърнаута. Същевременно това състояние обикновено се придружава от ментални и психически проблеми, включително главоболие,

безсъние, умора, различни симптоми, свързани със стомашно-чревния тракт, преяждане, предразположение към злоупотреба с алкохол или други вредни субстанции.

Страданият от бърнаут изпитва негативно отношение към работата си и са му необходими сериозни усилия, за да се съсредоточи и да започне работния ден. В допълнение се наблюдава раздразнителност, враждебност и отчуждение към колеги и бизнес партньори.

МАТЕРИАЛИ И МЕТОДИ

Проведено бе проучване чрез пряка анонимна анкета с 100 медицински специалисти работещи в различни лечебни заведения.

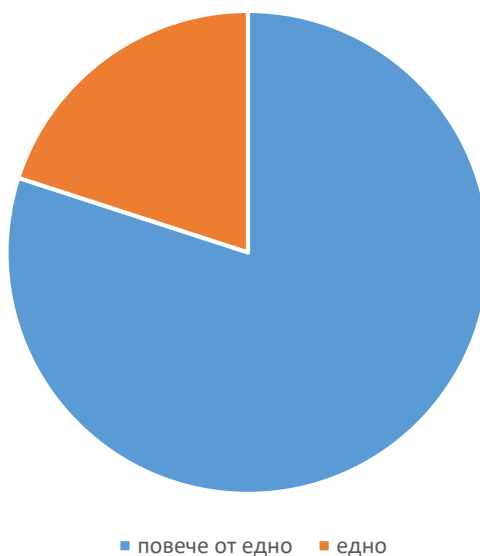
АНАЛИЗ НА РЕЗУЛТАТИТЕ

На въпроса *случвало ли ви се е да чувствате умора от работа* 90% от анкетираните медицински специалисти отговарят с да, а 10% с не. *Дали работят на едно работно място* 80% отговарят, че работят на повече от едно място, 20% работят само на едно. На въпроса *случвало ли ви се е да работите 7 дни без почивен ден* 60% от медицинските специалисти отговарят, че им се е случвало и то много често, а на 40% не им се е случвало. На въпроса *защо работят до прегряване* 100% от респондентите отговарят поради ниското заплащане на мед. специалист, 80% от анкетираните отговарят, че им се е случвало да бъдат неадекватни от умора на работното си място, а 20% отговарят, че не им се е случвало. Резултатите ясно говорят, че при медицинските специалисти бърнаут е много често срещан.



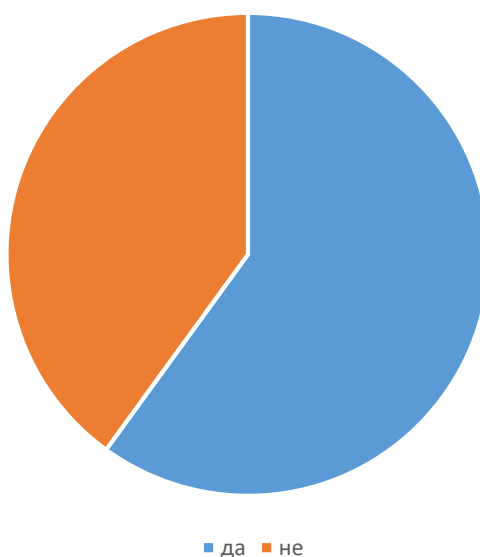
Фиг. 1

На едно работно място ли работите



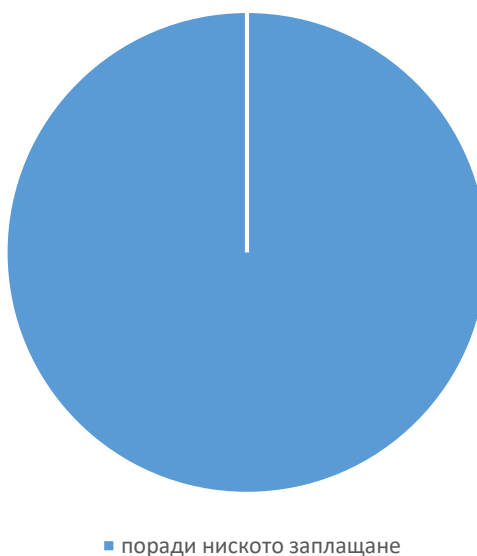
Фиг. 2

Случвало ли Ви се е да работите 7 дни без почивен ден



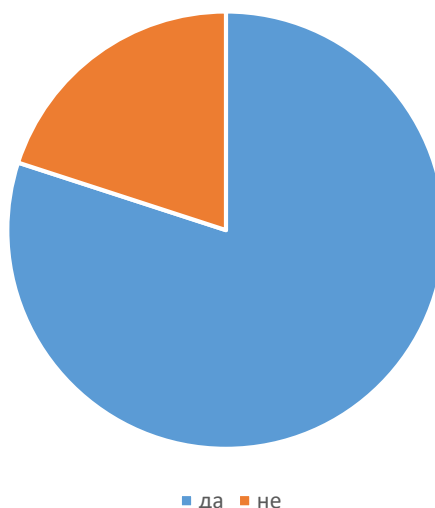
Фиг. 3

Защо работите до прегряване



Фиг. 4

Случвало ли ви се е да бъдете неадекватни от умора на работното място



Фиг. 5

ЗАКЛЮЧЕНИЕ

Бърнаут става все по-актуална тема в съвременния начин на живот. С този термин се означава специфично състояние, което засяга личността в емоционален, психически и физически аспект. На български език буквално се превежда като прегряване. Зад този термин няма общоприето определение, нито представлява медицинска диагноза. Характеризира се с емоционално, психическо и физическо изтощение.

Смята се, че основно се провокира от продължително излагане на стрес на работното място, а не толкова от обстоятелства, свързани с личния живот. Въпреки това събития в личния живот, както и някои характерови черти, могат

Някои професии се смята, че са по-предразположени към състояния на бърнаут в сравнение с

други. Такива са например професиите на здравните работници, учителите и др.

В резултат е силно намалена производителността му в работата. Като последствия от бърнаута е възможно да се развият и физически заболявания, като диабет, сърдечни проблеми, високо кръвно налягане, рецидивиращи инфекции и други.

Въпреки че бърнаутът не е медицинска диагноза, е важно да се знае, че СЗО го включи в Международната класификация на болестите като “професионален феномен”. Той е вписан в специална глава като фактор, поради който страдащите от него често търсят здравни услуги.

Най-ефективна за овладяване на това състояние е психотерапията. Тя подкрепя личността да се справи с възникналите предизвикателства, да приеме и преживее емоциите и страховете си и да се

справи с несигурността и стреса. По този начин се възстановяват и изграждат пълноценни отношения с хората в личния и професионалния живот.

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Todorova D.*Assistant Professor, PhD, Doctor of Medicine
Trakia University, Stara Zagora, Bulgaria***СТРЕСЪТ ПРИ МЕДИЦИНСКИТЕ СПЕЦИАЛИСТИ****Тодорова Д.***Асистент, доктор по медицина
Тракийски университет, Стара Загора, България
<https://doi.org/10.5281/zenodo.14236019>***Abstract**

Stress in psychology, neurology and psychiatry is a state of strong physical, nervous tension caused by negative factors or negative physical or emotional impact and feeling.

However, stress is not an inevitable consequence of a given event: it depends a lot on how a person perceives the situation, how he reacts and how he copes with it. The stress inside us is partly instinct, partly comes from our way of thinking. Any factor that can disrupt the balance in the human body is called a stressor. The concept of "stress" covers both its action and the reaction of the body. Stress is the psychophysical reaction to a number of emotional, cognitive or social tasks perceived by a person as excessive. Excessive stress can easily lead to numerous stress disorders. The term stress was first used in 1936 by Hans Selye. He defined it as "the non-specific response of the body to any demand made on it".

Анотация

Стрес в психологията, неврологията и психиатрията е състояние на силно физическо, нервно напрежение, предизвикано от негативни фактори или отрицателно физическо, или емоционално въздействие и усещане.

Стресът обаче не е неизбежно последствие от дадено събитие: зависи много от това как човек възприема ситуацията, как реагира и как се справя с нея. Стресът вътре в нас отчасти е инстинкт, отчасти идва от начина ни на мислене. Всеки фактор, който може да наруши равновесието в човешкия организъм, се нарича стресор. Понятието „стрес“ обхваща както действието му, така и реакцията на организма. Стресът е психофизическата реакция на количество емоционални, когнитивни или социални задачи, възприемани от човека като прекомерни. Прекомерният стрес може лесно да доведе до множество стресови разстройства. Терминът стрес е използван за първи път през 1936 г. от Ханс Селие. Той го определи като „неспецифичен отговор на организма към всяко искане, отправено към него“.

Keywords: stress, medical professionals**Ключови думи:** стрес, медицински специалисти**ВЪВЕДЕНИЕ**

Използваме думата „стрес“, когато чувстваме, че всичко около нас ни идва в повече – пренатоварени сме и не сме сигурни, че бихме могли да се справим с натиска, под който сме подложени. Стресови реакции се наблюдават както у човека, така и при по-низши животни без нервна система и при растения. Стресът не е просто нервно напрежение. Причина за появата му често са интензивни емоционални и дори физиологични преживявания. Понякога напрежението ни кара да продължаваме напред и е нещо хубаво. Ако се замислим, без никакъв стрес животът би бил скучен. Когато обаче той започне да вреди както на психическото, така и на физическото здраве, се налагат мерки. Каква е разликата между „стрес“ и „стресор“? Стресорът е факторът, който причинява стреса. Самият стрес е чувството, което имаме, когато сме под напрежение. Като цяло, но не винаги, колкото повече са стресовите фактори около нас, толкова по-стресирани се чувстваме. Начинът, по който организмът отговаря на предизвикателството, също може да бъде вид стрес. Част от тази реакция е на психологическо ниво и може да засегне физическото състояние. Когато сме

изправени пред предизвикателство или заплаха, тялото активира своите „ресурси“, за да се защити – да се отдръпнем възможно най-бързо или да се борим.

Този отговор представлява реакцията на нервната система на тялото при стресиращи събития. Организмът произвежда големи количества от хормоните кортизол, адреналин и норадреналин, които водят до ускоряване на сърдечния ритъм, потенето, бдителността и подготвят мускулите за предстояща активност. Всички тези фактори ни защитават, когато попаднем в опасна ситуация. Симптомите при професионално изчерпване може да бъдат разделени на:

- физически – главоболие, безсъние, мускулно напрежение, болки в гърба, чувство за умора и изтощение през целия ден; значителна умора след работа; чести настинки, развитие на психосоматични заболявания и др.

- психологически – когнитивни промени: трудна концентрация, ригидно мислене и съпротива към промени, раздразнителност, гняв и фруст-

рация, загуба на интерес към работата и неизпълнение на служебните задължения, липса на енергия и ентузиазъм, загуба на самоуважение и увереност в себе си, чувство на неадекватност, безпомощност, чувство за вина и неодобрение, усещане за безпокойство, потиснатост и претовареност, лабилност и честа смяна на настроението, негативизъм, усещане за неуспех, тревога за бъдещето, депресия и др. Липса на вътрешни стимули; прехвърляне вината на другите. Чувство за натиск, преса и невъзможност да се оплачете.

- поведенчески – емоционални избухвания, нетърпение и раздразнителност в общуването, отдалечаване от приятелите и семейството, изолиране, отдръпване, избягване на дискусии с колегите, загуба на точността и прецизността, пренебрежение към задълженията, намаляване на критичността. Отлагане на срещи, контакти или кратки разговори и срещи с клиентите, невъзможност за концентрация в разговора, загуба на отношение, стереотипно, цинично поведение, към клиентите. Нарастваща употреба на алкохол, лекарства, наркотици, промяна в хранителния режим. Трудно общуване с хората, понижаване на трудовата активност, съпротива да се ходи на работа, усещане за провал, невъзможност за промяна и др.

- Подобно на много други заболявания, както медицински, така и психологически, всеки човек реагира по различен начин в зависимост от емоционалното и физическото си състояние, независимо дали страда от депресия, тревожност или друго медицинско състояние.

- Повече от половината специалисти съобщават, че негативните им емоции и мисли не повлияват на работата им с пациенти. Друга част съобщават единствено, че имат по-малко търпение и по-лесно могат да се ядосат на работното място.

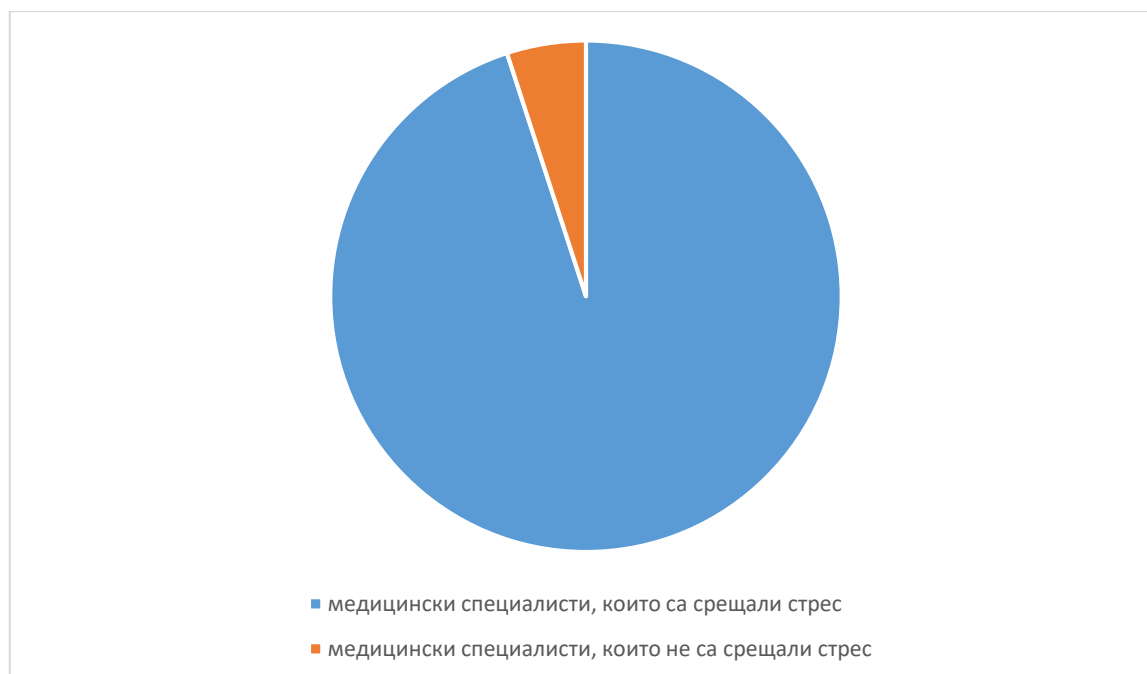
- Основният начин, по който повечето лекари се справят със стреса и напрежението от работата е чрез физически тренировки, изолиране от околните, разговори със семейство и близки приятели, както и повече часове сън.

МАТЕРИАЛИ И МЕТОДИ

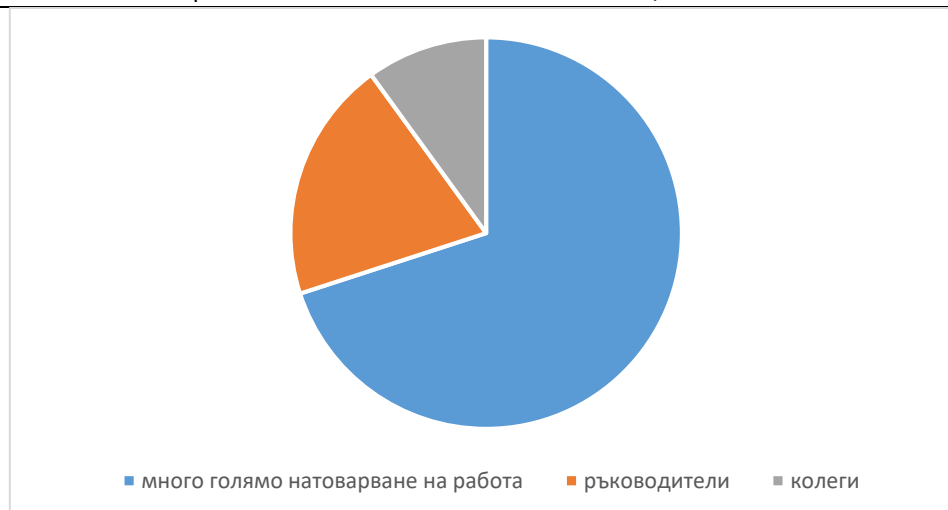
Проучени са 100 медицински специалисти чрез интервю и пряка анонимна анкета.

АНАЛИЗ НА РЕЗУЛТАТИТЕ

На въпроса срещали ли сте стрес на работното си място 95% от медицинските специалисти отговарят, че са срещали, само 5% отговарят, че не са срещали стрес. Според 70% от анкетираните стреса на работното място най-често се предизвиква от много голямо натоварване на работа 20% отговаря, че стреса е предизвикан от ръководители, 10% от колеги, 70% отговарят, че работят на повече от едно работно място и това е причината за пораждаване на стрес. Как се справят хората работещи в здравеопазването със стреса 50% отговарят с разходка в планината, 30% с четене на книги, а 20% борят стреса със сън. От проучването се разбира, че медицинските специалисти са подложени ежедневно на стрес. От всички професии медицинските специалисти са подложени най-много на стрес.



Фиг. 1 Срещали ли сте стрес на работното място?



Фиг. 2 От какво се предизвиква стресът на работното място



Фиг. 3 Как се справят работещите в здравеопазването със стреса

ЗАКЛЮЧЕНИЕ

Когато сме изправени пред криза, тя засяга негативно на първо място психичното ни благосъстояние. То, по ирония, е и това, което на първо място ни помага да издържим и преживеем същата тази криза. Медицинските специалисти са хората, които успокояват с експертните си мнения, извършват животоспасяващи операции, съветват в кризисни моменти и взимат важните решения. Тези, които не са били част от здравеопазването, трудно биха могли да оценят стреса, на който са подложени медицинските специалисти и психическото натоварване, което носи със себе си призванието да бъдеш лекар. Професионалният стрес все повече бива дискутиран, анализиран, изследван от специалисти в различни области – медицински професионалисти работещи в областта на общественото здраве, трудовата и социалната медицина, психолози, икономисти, социолози и др. Професионалният стрес е не по малко важен от трудовите злоупотреби. Професионалният стрес се отразява както на здравето на служителя и качеството на живот, така и на организацията.

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PEDAGOGICAL SCIENCES

THE WAYS OF USING OF GAMIFICATION IN EDUCATION

Davletova A.

L.N. Gumilyov Eurasian National University, Candidate of Pedagogical Sciences, Acting Associate Professor of the Department of Informatics, Astana

Myrzanova A.

PhD student of the L.N. Gumilyov Eurasian National University, 1st year in the educational program 8D01511-Computer Science, Astana city

БІЛІМ БЕРУ ҮДЕРІСІНДЕ ГЕЙМИФИКАЦИЯНЫ ҚОЛДАНУ ЖОЛДАРЫ

Давлетова А.Х.

Л.Н. Гумилев атындағы Еуразия ұлттық университеті, педагогика ғылымдарының кандидаты, «Информатика» кафедрасының доцент м.а., Астана қаласы

Мырзанова А.К.

Л.Н. Гумилев атындағы Еуразия ұлттық университеті, «8D01511-Информатика» білім беру бағдарламасының 1 курс докторанты, Астана қаласы
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Abstract

The article discusses gamification in education and its theoretical foundations, which increase interest in the assimilation of educational material. It is shown that gamification of education can increase the level of student participation in the educational process, improve their specific skills and optimize learning.

Аңдатпа

Мақалада білім берудегі геймификация және оны оқу материалын игеруге қызығушылықты арттыратын теориялық негіздер қарастырылады. Білім беруді геймификациялау білім алушылардың білім беру процесіне қатысу деңгейін жоғарылатуға, дағдыларын жақсартуға және оқуын оңтайландыруға себін тигізеді.

Keywords: Education, game, gamication, gamification in education, motivation.

Кілт сөздер: Білім беру, ойын, геймификация, білім берудегі геймификация, мотивация.

Қазіргі уақытта білім беру саласындағы жаңа технологиялардың дамуы және цифрлық трансформацияны жеделдету білім беру жүйесінің мазмұны мен әдістерінің өзгеруіне әкелді. Бұл өзгерістер болашақ мұғалімдерден кәсіби білім мен дағдыларды игеруді ғана емес, сонымен қатар олардың шығармашылық дамуы мен инновациялық технологияларды игеруін талап етеді. Бұл тұрғыдан алғанда, геймификация технологиясын қолдану болашақ информатика мұғалімдерінің кәсіби қабілеттерін дамыту үшін өте маңызды.

2002 жылы алғаш рет «Геймификация» ұғымын американдық бағдарламашы және өнертапқыш Ник Пеллинг (Nick Pelling) қолданған болатын. Геймификация (gamification) термині 2010 жылға қарай таныла бастады. Қазіргі таңда қызметтің көптеген салаларында (білім беру, бизнес, денсаулық сақтау) күрделілік деңгейі әртүрлі мәселелерді шешудің ерекше әдісін белгілеу үшін қолданылады. Бұл әдіс компьютерлік ойындарға тән тәсілдерді геймплейлерге қолдануды көздейді. Г. Цикерманның айтуынша, геймификация – үлкен әлеуетке ие жаңа пән [1].

Білім алушыларды қызықтыру және олардың мотивация деңгейін арттыру үшін оқу үдерісінде оқу элементтерін геймификациялауды қолдануға болады. Геймификация – ойын элементтерін басқа үдерістерде, мәселен, білім беруде қолдану. Геймификацияның мәні-пәндерді қайта өңдеу

презентациялар мен бейнероликтер жиынтығы (иллюстрациялық материал үшін), флэш-роликтер (интеллектуалды ойындар) және көрнекі құралдар [2].

Технологиялық жетістіктер және олардың қарқынды дамуы әрқашан білім алушыларды оқу процесіне тартудың және білім берудің өсіп келе жатқан қажеттіліктерін қанағаттандырудың жаңа және қызықты жолдарын өмірге әкеледі. Сонымен қатар, дәстүрлі оқыту әдістері немесе тіпті бүгінгі күнге дейін қолданылып жүрген қосымшалар әрқашан жеткіліксіз болып отырады [3]. Ақпараттық қоғамның қалыптасуы білім берудегі ойын компьютерлік технологияларының тиімділігін өзекті етеді. Шынында да, оқу процесінде ойын формаларын қолдану зерттеудің маңызды бағыттарының біріне айналды.

Білім берудегі геймификация – ойын элементтері мен ойын дизайнының принциптерін академиялық компоненттерде ойын тақырыптарына қолдану процесі. Геймификация оқу процесін жақсартуға бағытталған және білім алушыларды ынталандырады.

Геймификацияның негізгі мақсаты – белгілі бір қабілеттерді жақсарту, оқытуға мақсат беретін тапсырмаларды енгізу, білім алушыларды тарту, оңтайландырып оқыту, мінез-құлықты өзгертуді қолдау және әлеуметтену [4]. Білім алушыларға өздерінің оқу стратегиясын ойын түрінде

қалыптастыруға көмектесетін білім берудегі геймификацияның бірнеше тамаша мысалдары бар. Басқа мысалдарға көшпес бұрын, алдымен білім алушылар ескеруі керек ойын элементтерін қарастырайық:

- Зерттеуге арналған әңгіме;
- Білім алушылар тарапынан болатын дереу кері байланыс;
- Білім беру үдерісіне деген қызығушылық;
- Күрделі міндеттері бар кешенді оқыту;
- Прогресс көрсеткіштері (мысалы, ұпайлар, белгішелер, көшбасшылар тактасы);
- Әр білім алушымен әлеуметтік байланыс;
- Білім беру саласындағы ойыншыны басқару.

Білім беру үдерісінде ойындарды қолдану оларды оқу процесінің бір бөлігіне айналдырады. Бұл – білім алушылардың миын дамытатын, белгілі бір дағдыларды немесе білімді игеретін әдіс. Геймификация мазмұнды түсінуді жақсарту және ақпаратты тиімдірек есте сақтау үшін ойын элементтерін ойын емес сценарийлерге қосуды қамтиды. Оқытушылар сонымен қатар білім алушылардың үлгерімін тиімдірек қадағалай алады және қажет болған жағдайда мақсатты шаралар қолданады.

Ойын ұғымы – білім беру теориясы мен әдістемесіндегі дәстүрлі зерттеу нысаны. Ойын элементтерін ғасырлар бойы мұғалімдер қолданған, ойын технологиялары жақсы сипатталған, зерттелген және жүйеленген. Егер біз компьютерлік және видео ойындар саласы туралы айтатын болсақ, онда қазіргі әлемде бұл аудиторияны тартудың керемет нәтижелерін беретін жаңа механизмдер мен платформалармен қарқынды дамып келе жатқан қызмет [5].

Педагогикалық университеттердегі оқу процесі тек теориялық білімді ғана емес, сонымен қатар болашақ информатика мұғалімдерінің кәсіби қызметінде қолданылатын практикалық дағдыларды қажет етеді. Геймификация негізгі кәсіби құзыреттіліктерді дамыту үшін жағдай жасауға мүмкіндік береді. Мысалы:

- **Технологиялық құзыреттілік.** Болашақ информатика мұғалімдері әртүрлі білім беру технологияларымен жұмыс істеуге дайын болуы керек. Геймификация білім алушыларды жаңа бағдарламалық өнімдермен, ойын платформаларымен таныстыруға, сондай-ақ оларды осы технологияларды оқытуда қолдануға үйретуге көмектеседі. Мысалы, білім беру ойындарын құру немесе интерактивті тапсырмаларды әзірлеу үшін бар платформаларды пайдалану IT ресурстарымен жұмыс істеу дағдыларын дамытуға ықпал етеді.

- **Педагогикалық құзыреттілік.** Геймификация ойын формалары мен оқыту әдістерін қолдану арқылы педагогикалық дағдыларды дамытуға ықпал етеді. Геймификация элементтерін пайдалана отырып, болашақ мұғалімдер ойын механизмдері оқытушыларды оқу процесіне белсенді қатысуға қалай ынталандыратынын түсіну арқылы

оқытудың әртүрлі тәсілдерімен тәжірибе жасай алады. Зейінді жандандыруға ғана емес, сонымен қатар білім алушылардың сыни ойлауы мен шығармашылық қабілеттерін дамытуға ықпал ететін ойын элементтерін енгізуді үйрену маңызды.

- **Шығармашылық және инновациялық тәсіл.** Геймификация болашақ мұғалімдерге стандартты емес жағдайларда жұмыс істеуге, оқу міндеттері үшін өзіндік шешімдер іздеуге мүмкіндік береді, бұл олардың шығармашылығы мен инновациялық тәсілін дамытады. Бұл әсіресе оқытуда соңғы технологияларды қолдануға дайын болуы керек информатика мұғалімдері үшін өте маңызды.

- **Топтық жұмыс және байланыс.** Геймификацияланған процестерде білім алушылардың өзара әрекеттесуі жиі қабылданады, бұл динамикалық білім беру процесінде командалық жұмыс, қарым-қатынас дағдылары мен өзара әрекеттесу дағдыларын дамытуға көмектеседі.

Әлеуметтік өзара әрекеттесу және ынтымақтастық ойын оқу ортасының негізгі элементтері болып табылады. Кооперативті геймплейді, топтық тапсырмаларды немесе пікірталас форумдарын енгізу күрдастар арасындағы ынтымақтастық пен өзара әрекеттесуге ықпал етеді, білім алмасуға және топтық жұмыс дағдыларын дамытуға ықпал етеді.

Болашақ информатика мұғалімдерін даярлау процесіне геймификация технологияларын интеграциялау білім беру практикасындағы перспективалы бағыт болып табылады. Геймификация білім алушылардың мотивациясын арттыруға ғана емес, сонымен қатар табысты педагогикалық қызмет үшін қажетті негізгі кәсіби құзыреттіліктерді дамытуға ықпал етеді. Ойын элементтерін пайдалану материалды тиімдірек игеруге және білім алушыларды кәсіби тәжірибеге дайындауға ықпал ететін неғұрлым серпінді және қызықты білім беру ортасын құруға мүмкіндік береді.

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PHILOLOGICAL SCIENCES

DIVINE LOVE IN THE CREATION OF MUHAMMAD FÜZULI AND A CHANT OF PURE LOVE

Rzayeva G.

Senior teacher

Aghjabedi branch of Azerbaijan State Pedagogical University, Azerbaijan

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Abstract

The article discusses Muhammad Fuzuli's philosophy of love and its main essence. It is shown that an important part of the artistic heritage of the artist, which is extensive in volume, is the works on the theme of love. His philosophy of love has its own characteristics. The works written on this subject can be mainly grouped along two lines: examples dedicated to worldly love, that is, metaphorical love; examples of divine love, that is, true love.

The poet's philosophy of love finds its artistic expression mostly in his ghazals and the poem "Leyli and Majnun". Most of the examples of love-themed poetry in the artist's work derive from the "unity-body" philosophy of Sufism. In other words, it rests on divine love. According to Fuzuli, true love is love for a divine being. A person should love the beings in the material world, including his fellow man, as a particle of the divine world, that is, the world of unity.

Keywords: Muhammad Fuzuli, literature, philosophy of love, divine love, pure love, artistic thinking, spiritual world, power of love, love and madness, love and admiration, love and drunkenness, love and shame, etc.

Muhammad Fuzuli, a magician of artistic words, is recognized as one of the most talented representatives of lyrical poetry worldwide. As he said, "shairi-Museyi-kalam" ("Musa kalam poet") created a miracle from a single word, and as the author of unique lyrical (and epic) works, he took a leading position among the artists who became the pride of world poetry. Whether it is meaning-content, form, language-stylistic beauty, musical tone and tone, aesthetics, "word game" and system of metaphors, logical communication and unity within the text, etc. it rose to its highest, honorable and incredible level with the pen of this Azerbaijani artist.

According to Fuzuli, all beings in the material world, including man, are a particle separated from the divine world and fallen into the material world. Since the human soul is given the love of the body by God, at the necessary moment, it leaves the divine world and descends to the world we live in and unites with the body, the material body, takes a copy and image. However, this world turns into a land of suffering and hardship for him, a "night of separation" ("shabi-hijran"). That's why he is throbbing with desire, desire and love to return to his original self. That is, in the presence of the spirit that gives life to man and belongs to the divine world, there is a feeling of infinite love for the original world from which he left and came. Therefore, he wants to return to the world of eternal unity, the land of happiness. In a word, Fuzuli understands and preaches the way of love ("tariqi-esq") as the only means to reach God. This issue is the main essence of the philosophy of love of the philosopher artist. In the poet's philosophical interpretation, it is specially emphasized that this supreme truth can be understood not by the ignorant, the ignorant, but only by the wise, the open-minded, and the perfect. These issues mentioned in the article and its philosophical essence are interpreted on the basis of specific examples from the poet's work.

In the theme gallery of the artist's work, the main colors and shades are related to love. Love is the foundation and yeast of Fuzuli's lyrics. He is known first and foremost as a love poet. The best genius thinker himself explains the reason for this. The lyricist addresses his "I" and declares that it is not worth expecting poems of praise and blame from him. The words of the perfect people who are in love should be loving:

Don't ask me, Fuzuli, to praise me.

I am in love, my word is always love (Fuzuli, I c., 2005).

Fuzuli's divan's first poem in Azerbaijani Turkish - "Qad Anarel..." ghazal is also about love.

This ghazal is, in a way, the bismillah of Fuzuli divan. That is, it contains the main idea load and thematic direction of the poet's lyrics. And here we are talking about Sufi love. The poet takes the mystical shades of love as a basis, that is, true love. It is the main condition for the people of perfection to be the master of the path of truth, to know the secret of unity, to accept the reality of the Truth itself, not the vastness of existence (all creation except God) and to live with the pleasure of love with this understanding. Because the poet does not imagine that there is a path to virtue and wisdom other than love:

O Fuzuli, I do not want to abandon-taryk-eskh who,

This virtue makes me inwardly perfect (Fuzuli, I c., 2005).

The lyrical hero of our genius thinker does not see love as a worldly passion. This hero of a philosophical nature approaches the issue in a broader way, with the expectation of gnosis. He is free from the sorrow of love ("Giriftari-gami-esq olali azadeyi-dahram"), that is, he is free from all other concerns of the property

world. Because he fell into the sea of love, he forgot the pleasure of the world ("You fell in love with the sea, oh tongue, forget the pleasure of the world"). That is why it is "pleasant with love". According to him, the work of those who burn in the fire of hell is easier than those who burn in the fire of love. Because those who burn in hell, burn once in the fire and save their lives. And the fire of love is constant torment. But the punishment is great. This is an eternal destiny, which was given to the lyrical hero at the beginning of the dawn of love ("safayi-eshq"), at the time of the creation of his soul. The pain of love is such a sublime feeling because of this lover that the one who tries to cure it is like the enemy of that lover:

Love comes with trouble, a lover's temperament is independent,

It is my enemy, friends, who is the mediciner in this trouble (Fuzuli, I c., 2005).

The ghazal "I was tired of the soul..." occupies a special place among Fuzuli's love-themed lyrical works. The poem has impressive content, clear idea, flowing language, beautiful style, perfect artistic form. The author was able to create a proportional harmony of content and external effect here.

The ghazal is told in the first person - the language of the lyrical hero. This lover expresses the hero's inner feelings and complaints about his soul in a simple and convincing way. The fact that the poem is based entirely on artistic questions and internal rhyme, i.e. *saj'*, makes its poetic aura even more beautiful. The declaration of the lover's complaint and inner impression is so simple, sincere, and figurative that it convinces the reader. It affects his emotions and aesthetically pleases him:

He made me tired of the soul, isn't he tired of suffering?

The stars have burned out, won't the candle of my wish burn?

The soul of Gamu Bimarin is the best medicine for pain.

Why don't you give me medicine, don't you think I'm sick? (Fuzuli, I c., 2005).

The lover, who suffers from the long agony of love, is bored to death. His sigh burns the stars (exaggeration), but the candle of his wishes does not burn. However, the lover does not tire of his suffering. The complaint of the lonely lover is also that the soul provides a cure for the pain of all those who love him. Only this lover is indifferent. However, his burden of love is heavier than others. Of course, God is meant here by the living being.

A lover who hides his love grief reveals it to his lover with the advice of others. However, he does not see loyalty and grace from it. Since he falls on "Shabi-hijran" ("night of separation"), that is, he leaves his family, his job is to live the suffering of this hijran. Here, when the poet says "shabi-hijran", he means the mood of a particle that is separated from its original essence - the divine world. Because the particle that is

separated from the unity and fell into the material world cries because of this separation. Yara longs to be reunited with her true self. This explanation is related to love in Sufism and "Shabi-Hijran" philosophy. Thus, according to Sufism, the human soul (divine "I"), separated from its reality and reunited with the physical body, falls into "shabi-hijran" in the material world, suffers torment and cries out for it.

In the ghazal, Fuzuli's imagery, abundance and fullness of metaphors attract attention. Of course, this enriches the artistic quality of the ghazal and increases its poetry.

Bloody running water from my eyes next to Guli-rukhsarina,

My dear, this is the season, don't the running waters get cloudy? (Fuzuli, I c., 2005)

several eloquent devices are used in the verse. Artistic question - is it not blurred?; *saj'* (internal rhyme) - neighbor, water, this; artistic address - *habibim*; epithet - *guli-rukhsar* (rose face); exaggeration - bloody running water from my eyes; *talil* or *illat*: (This is such a poetic figure that any event, concept, process causes the emergence of another event, concept, process, etc. That is, the existence of one concept and event, the creation of another concept and event, appears as the cause and effect of the case). In the first verse of the verse, against the lover's rose face (because her face is like a rose and the color of the rose is red), water flows from the lover's eyes with blood (that is, red in color); allusion (metonymy) - season-flower. The season of spring is not mentioned, but it is clear that spring is meant by that expression; simile - the bloody water flowing from the lover's eyes is compared to the muddy water flowing in the spring. The poet is not so inclined to describe the external beauty of the charmer in the ghazal. However, he resorts to such a method of persuasion that the lover is ashamed of the reproach he made when he sees the unsuspecting soul who loves that soul, who is his "rindu shayda".

The poem also touches on the philosophy of love and shame in the sense of Sufism. The main essence of this philosophical view is that it is impossible to hide love in the heart. He inevitably exposes himself to the world. Therefore, people of love should always be disgraced and should be known among the people as the devil of love:

Fuzuli is always a disgrace to the people.

Who is the question, what is this deal, isn't he tired of this deal? (Fuzuli, I c., 2005).

M.Fuzuli's lyrical hero is a philosopher in love. At the level of love, this lyrical hero's relation to body, soul and spirit is based on religious and Sufi-mystical sources. Rather, the lover forgets his physical existence, thinks it does not exist. He is also ready to sacrifice it entirely to the soul. Because not only the body, but also the soul itself belongs to the soul. A lover who has risen to the level of enlightenment loves his soul only because of his soul. He does not think that there is a truth other than the soul in the world of testimony (and in general, existence), including his body and soul.

In the lower layer, in the inner sense of the meaning, the soul mentioned is actually the divine substance - the Truth itself, to which everything belongs. Habib's love for his soul also stems from his concern for his beloved. The wise love their lives for their lives, and the ignorant love their lives for their lives:

He who loves his soul for his soul's sake loves his soul,

Whoever loves his life for his life, loves his life (Fuzuli, I c., 2005).

In relation to love, our philosopher-poet sometimes thinks like a Sufi, but sometimes he approaches it from a real, worldly position. In other words, Fuzuli accepts metaphorical love as well as real love. The artist justifies this with such a philosophical-poetic logic that the metaphor is connected to the truth. More precisely, the metaphor is the shining, the dawn of the rays of the sun of truth (physical-absolute) and, therefore, it is not beyond it. Its existence depends on:

Of the blessings, O counsellor, do not make me who I am,

Pertovi-Anvari-Khurshidi-truth is a metaphor (Fuzuli, I c., 2005).

In Fuzuli's world of love and wisdom, love and hijran, love and exile, the desperation of love pain, love and infatuation, love and admiration, love and drunkenness, love and shame, love and reproach, love and trouble, love and grief, crying, etc. we find related artistic-philosophical nuances, poetic declarations, intellectual insinuations. In fact, these are specific lines established in the system of views of the Sufism sect. In the gnostic thought, each of them has its own interpretation and meaning about love. Fuzuli's artistic idioms and savings also get their nourishment from here.

The essence of those philosophical categories in our thinking artist and in Sufism in general can be very succinctly interpreted as follows:

Love and hijran: The lover (particle) who is separated from the divine world, from his original essence (unity), descends to the material world and becomes lonely. This is "shabi-hijran" ("night of separation") for him. The time he lives in the world of martyrdom is in proportion to the world of hell, "sustenance-doom" because of the lover:

I knew that the night of the Hijran was the night of Hell

Who, Ruzi-Qiyamat is tomorrow's Shabi-Hijran (Fuzuli, I c., 2005).

Love and Vusal: Love is the only way out of Hijran and meeting the Truth. Love is a bridge, a direct means of communication between a servant and God, without intermediaries (without the help of someone else). But the one who is in the wishful thinking should forget both his physical reality, the world and the blessings of the world, and, in general, the massif. A steadfast lover must destroy his physical existence with the

pleasure of Dildar's meeting, in order to reach the eternal state of "seeing-state", the permanent presence of the physical-absolute:

I destroyed your language with pleasure and sight,
They say that the state is permanent, the state is visible (Fuzuli, I c., 2005).

Fuzuli's lyrical hero says in his ghazal "Dwelling O Nightingale..." that, O Muslims, if my place were "yar kuyi" (tomorrow's abode), if I were inclined to Rovzei-Rizvan, I would be an infidel. In other words, on the level of belief of Sufism, for the people of wisdom and perfect love, directly reaching tomorrow's destination is even better than achieving the bliss of heaven.

The helplessness of love pain: If love is true, in other words, if it is the immortal grace of God instilled in the soul, "I" of the human body, then there is no cure or remedy for it. It is impossible to erase it from the human heart:

Whatever ails you, there is a cure in the world.

Love is such a difficult pain that it cannot be treated (Fuzuli, I c., 2005).

Love and intoxication: Love for a true lover is a source of feiz. He must be intoxicated by the pleasure of this drug. From Majn to the lyrical hero in Fuzuli's poems, those who bear the title of lover are, as a rule, drunk on love. Any number of examples can be cited from the poet's works. He often talks about mey (the wine of divine wisdom and virtue) and meykhana (the place where the truths of God are studied, the inn). These are, of course, philosophical-metaphorical concepts and artistic idioms related to the symbolism of Sufism.

Love and disgrace: It is impossible to keep the secret of love hidden in the heart. Because the intensity, degree, scale and nature of true love is such that it should overflow from the world of the heart, it should be promiscuous and overwhelming. The fate of a true lover is disgrace. Fuzzy:

It is impossible to make people happy and love,
Fall in love and you will be a disgrace in the world (Fuzuli, I c., 2005).

This is exactly what he means in his verse. We often find this conclusion in medieval gnostic poetry. For a true lover, shame is a standard, a characteristic vital-moral and spiritual-psychological indicator. In a word, "Love is not pretentious, Risvay should always be in love" (Fuzuli, II c., 2005).

O Fuzuli, I am the sultan of the domain of rebuke, the lightning of my anger is a golden crown, and my silver tears are an ivory throne.

In the 2nd stanza of the poem, the poet skilfully makes use of the plural, which is a type of metaphor belonging to Eastern poetics (this is a type of metaphor in which two or more signs, characteristics, concepts are attributed to the same subject, combined in the same subject), simile and exaggeration.

Love and trouble (torment): The greater the joy of the pleasure of love, the greater the humiliation. If the

lover does not suffer on the path of his love (and does not want it), then he cannot be considered a true lover, nor will he be blessed with vasa joy. The more troubles and hardships a lover suffers in the field of love, the more he proves the reality and greatness of his love. Therefore, a true lover always wishes to be "acquainted with trouble-love" in the world of possessions (the world of Hijran). In short, the hero of the gnosis thinks that the value of the vassal cannot be known without suffering the hardships of the Hijran world. The darkness and pain of separation from the Lord (from the original substance to which the lover belongs) revealed the most mysterious secrets to the wise lover:

I didn't know Wasl without the hardship of Hijran.
Darkness-Hijr made a very mysterious work clear
(Fuzuli, I c., 2005).

The present world is also a world of trials and tribulations for the lover, the measure of which is the burden of suffering and sorrow.

Love and grief (crying): A lover who is separated from his original nature - Yar and fell into "shabi-hijran" (a particle) is condemned to grief and crying in the world of possessions. Because in the existing world, there cannot be absolute, constant joy, comfort and joy (although there is, this is why). The suffering of Hijran and the longing for vasa makes the lover fall into grief, toil, misery, and misery. Fuzuli's lover is also a subject of the explained belief and faith. It is the scale of the scale of effort in the market of love, "Gafilasalari-cari-vani-gam":

Scales-adjustment-market-market-love fill,
My eyes are always full, my head is like a thousand stones every hour (Fuzuli, I c., 2005).

The result. It is known that in the medieval Islamic world, one of the main problems that engaged fiction as a means of education and spiritual and moral agitation was the question of man and his attitude. In the social-aesthetic, philosophical-ideological practice of artistic thought, the human race was considered an ideal creature. Humanism, the art of speech, which treated man with this higher intention and placed him above all creatures in creation, consistently followed and promoted philanthropy as an important mission. This merit is also clearly manifested in Fuzuli's poetry. Also, the fact that our thinker poet is a more professional and powerful pen holder stands as high in his work as the level of his art compared to his predecessors and successors.

In the work of a humanist artist, man is the most valuable creature in existence. His honor, majesty and beauty are worthy of all praise. In general, as in Eastern literature, in Fuzuli, the highest position after God belongs to human beings. In the poet's lyrics, the definition of the glory and beauty of God begins with the definition of human glory and beauty on a micro scale. However, it is worth noting that, as in Sufi poetry, in Fuzuli, the human race is divided into two groups in terms of perfection and ignorance: the perfect person and the ignorant person. Of course, in the artistic and philosophical evaluation, the place, position and level of these people are sharply distinguished from each other. In exchange for the highness of the first, the cheapness of the second is brought into consideration. Man is called to spiritual and moral perfection, to understand his beauty, dignity and honor. This is one of the main rocks that Fuzuli poetry follows. According to the poet, it is impossible to "produce honorable poetry" with ignorance. For this, it is necessary to reach a mystical rank. The main way of this is related to love and passes through the field of love. In short, the journey of love and the mission of falling in love constitute the main essence and pillar of Fuzuli's philosophy of love. Also, this journey is a mystical journey based on divine love.

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IBSEN'S ECHOES IN WILLIAMS: LINKS BETWEEN "THE WILD DUCK" AND "A STREETCAR NAMED DESIRE"

Beridze G.

Master of Scandinavian Studies, Invited lecturer at Ivane Javakhishvili Tbilisi State university, Faculty of Humanities, Tbilisi

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Abstract

The article focuses on the renowned works of Henrik Ibsen and Tennessee Williams, specifically uncovering how Ibsen's influence reverberates through the narrative and character structures of Williams' work. The research, supported by scholarly literature, acknowledges the existing scholarly dialogue surrounding the relationship between 20th-century American drama and 19th-century European modernist drama. Through a comparative analysis, the study highlights the thematic parallels of life-lie, identity, and disillusionment that shape both plays, as well as the innovative techniques that enhance their psychological complexity. Beyond the direct comparison with 'Wild Duck,' the study reveals numerous common elements linking Williams' play to other Ibsenian works such as 'A Doll's House,' 'Hedda Gabler,' and 'Ghosts.' By examining Williams' adaptation of Ibsenian motifs within an American cultural framework, this research provides new insights into the transatlantic legacy of modernist drama and its evolution in 20th-century American theater. The findings underscore the depth of Williams' indebtedness to Ibsen, revealing a sophisticated interplay of homage and reinvention that enriches our understanding of both playwrights' contributions to the genre. The analysis encompasses structural, thematic, and formal elements, providing a deeper, more nuanced understanding of the claims made by established scholars and supplementing these claims with concrete examples. Additionally, the research identifies areas and aspects that hold potential for future study.

Keywords: Henrik Ibsen, Tennessee Williams, The Wild Duck, A Streetcar Named Desire, Comparative Literature, Theater, Life-lie, livsløgn, Ibsen's influence, Modernist drama, American drama

1. Introduction

"A Streetcar Named Desire" was created in the mid-20th century, during the late modernist period, and is characterized by its 11 distinct scenes. Given that the play was written in the mid-20th century, it is not surprising that it contains frequent metatheatrical allusions to drama classics, particularly the plays of Ibsen. "A Streetcar Named Desire" has clear connections to other works by Ibsen ("A Doll's House," "Hedda Gabler"), and these connections are evident on the surface. Discussing the relationship with "The Wild Duck" separately without considering these other connections would be out of context, so we will briefly overview these allusive relationships in the introduction.

In relation to "The Wild Duck", there are no overt allusions; here, the connection is, in our opinion, more profound and structural, and is typically not perceived by the reader/viewer. That is why we believe that critical analysis in this direction is more relevant and necessary. The main part of the paper, therefore, and all subsequent chapters, are devoted to the relationship with "The Wild Duck". The second chapter analyzes the structure of the works and highlights particularly interesting structural sections; the third chapter is devoted to the significance of "truth" and the Ibsenian concept of "life's lie" (livsløgn) in relation to Williams's play; the similar functions and content of several individual symbols are analyzed in the fourth chapter. This is followed by a concluding analysis summarizing the main results of the discussion.

While the mid-20th century witnessed a seismic shift towards experimental and avant-garde theater in Europe, with playwrights like Eugène Ionesco, Samuel Beckett, Bertolt Brecht, and Luigi Pirandello challenging traditional dramatic conventions, American playwrights such as Eugene O'Neill, Arthur Miller, and

Tennessee Williams were producing works that, while undeniably modernist, remained more closely aligned with the conventions of realist drama. This divergence can be attributed to the commercial demands of Broadway, which favored plays that were more accessible to a wider audience. This period in American theater is often referred to as late American modernism.

In his essay, "The Debt of Williams and Miller to Ibsen and Strindberg," Seymour L. Flaxman argues: Williams and Miller have continued the dramatic tradition of Ibsen and Strindberg, but have transferred it to a thoroughly American milieu. Without slavish imitation, they have made use of symbolic and expressionistic elements, even pantomime and dream sequences, to get beyond the realistic and naturalistic drama. Whether they have extended this dramatic tradition, whether they have gone beyond the point reached by Ibsen and Strindberg, however, is questionable. They have made no real innovations in dramatic structure. [Flaxman, 1963, p. 58]

Both Seymour L. Flaxman in his 1963 essay and Ian McAdam in his more recent 2012 piece, "Remembering Ibsen in Tennessee Williams," have highlighted the need for further exploration of Ibsen's influence on Williams. McAdam, in particular, suggests that "the allusion noted here suggests that some renewed attention to the influence of Ibsen may be in order" (2012, p. 2). Given these calls for a more in-depth analysis, it is imperative to examine the specific parallels between *A Streetcar Named Desire* and Ibsen's other plays. Such a comparison would not only deepen our understanding of Williams's engagement with Ibsen but also provide valuable insights into the broader thematic concerns of both playwrights

The most overt and readily identifiable allusions in *A Streetcar Named Desire* are to Ibsen's *A*

Doll's House. Given the immense popularity of *A Doll's House* during Williams's time, it is reasonable to assume that a significant portion of the theater-going audience would have recognized these allusions, suggesting that Williams intentionally employed them for dramatic effect. Indeed, the scholarly literature has noted some of these parallels. Ian McAdam, for instance, highlights Blanche DuBois's iconic line, "Whoever you are - I have always depended on the kindness of strangers" (Williams, 1947, scene 11, p. 153), as a clear allusion to Nora Helmer's similar reliance on others in *A Doll's House*. However, McAdam does not address another, arguably more significant, parallel that occurs at the end of Scene 3, when Stella leaves the house. "STANLEY: Stella! [There 'is a pause] My baby doll's left me!" (Williams, 1947, scene 3, p.59)

"Helmer: Nora! Nora! (ser sig om og rejser sig) Tomt. Hun er her ikke mere" Empty. She is gone. (Ibsen, 2009, Et dukkehjem, scene 3, 379)

I believe that this instance transcends mere metatheatricality and carries a deeper dramatic function, therefore we will examine it in the main part too.

The history of world drama features relatively few female protagonists, among whom Hedda Gabler stands out as a particularly significant figure. Drama, as a literary genre, often, if not always, draws upon or revisits classical archetypes. It is difficult to imagine the character of Blanche DuBois without the influence of Hedda. From the perspective of gender dynamics, Blanche is often compared to August Strindberg's Miss Julie; however, Hedda Gabler is curiously overlooked. In reality, the characters of these two women are so closely aligned that one could argue not merely for a literary kinship but for a shared identity.

Both characters share a central trait: an inability to live without ideals, yet their life experiences are in constant conflict with these ideals. Ultimately, this incompatibility shapes their destinies—one takes their own life, while the other descends into madness. However, Hedda can be seen as taking a step further; her suicide is a choice, a choice aligned with her ideals, making her a less straightforward tragic figure. A degree of idealism can be found in all of Ibsen's major plays, a distinctive characteristic of this Norwegian playwright; we will see below that Blanche shares this trait with the male character Gregor Werle. Hedda's idealism, particularly her shared gender-specific ideals, connects her to Blanche DuBois. In both cases, universal idealistic notions intertwine with the high-class stereotypes associated with the behavior and relationships of true ladies and gentlemen. This discussion could be extended further, but that would require a separate research.

Moreover, a brief observation reveals an intriguing potential comparison between 'A Streetcar Named Desire' and 'Ghosts'. This suggestion is prompted by the conspicuous symbolism of light and darkness recurring throughout the play. 'Ghosts' also features similar symbolism. It would be equally interesting to explore the thematic implications of this formal detail, as the protagonists of both works initially present themselves as someone other than who they truly are.

The plays we are examining, centered around the Ekdal and DuBois-Kowalski families, also reflect the

personal lives of their authors, Ibsen and Williams. Specifically, they relate to the authors' sisters: Hedvig is the name of Henrik Ibsen's sister, while Blanche DuBois is partly based on Tennessee Williams' sister Rose, who suffered from severe mental illness (FIZZAH ALI, 2016). The greatness and similarities between these two writers are evident in their frequent use of their immediate family members as inspiration, transforming highly personal experiences into universal stories. A comprehensive psychological study could potentially reveal why the sisters had such a profound impact on the writers and whether there are commonalities between these influences. For now, however, we will simply consider this a coincidence.

2. Structure

While 'The Wild Duck' adheres to a fairly classical structure, the same cannot be said for 'A Streetcar Named Desire', which is divided into 11 scenes. Unlike Ibsen, Williams does not progress towards the finale in a direct and concise manner, but rather through a convoluted and lengthy path. Consequently, it is easier to identify the core thematic and formal characteristics of 'The Wild Duck': the problem of truth as its central theme and symbolism as its primary formal device. Symbolism also plays a significant role in 'A Streetcar Named Desire', but the play's primary theme is the battle of the sexes. The question of truth, as it eventually becomes clear, is merely a decisive factor in the play's development, not its central focus (we will elaborate on this below). It is therefore evident that the similarities between these two works are partial, primarily manifested in the first half of Williams' play, where the audience is not yet fully aware that the play's central theme is the conflict between men and women.

As is well-known, 'The Wild Duck' has previously served as a source of inspiration for works exploring the dynamics of gender conflict. Notably, August Strindberg's 'The Father' is a case in point. After reading 'The Wild Duck', Strindberg recognized himself in Hjalmar Ekdal and his wife Siri von Essen in Gina, leading him to confront a profound deception in his own life. This realization significantly influenced Strindberg's subsequent work, with 'The Father' being a direct result (Brandell, 1974, 46). Strindberg borrowed the exposition from 'The Wild Duck', maintaining the central theme of truth, but shifting the primary focus to the naturalistic theme of gender conflict. The play explicitly references Ibsen's 'Ghosts', creating a potential for comparative analysis due to the presence of ghostly characters in both works (M. Bunc, 2002).

We hypothesize that 'The Wild Duck' is utilized in a similar manner in 'A Streetcar Named Desire' as it is in 'The Father' (referring to the intertextual relationship between the texts rather than the biographical prehistory of their creation). We will attempt to clarify and substantiate this claim through the following argument.

To initiate our discussion, we need to order and delineate the numerous and somewhat confusing actions within 'A Streetcar Named Desire'. Given the specific focus of 'The Wild Duck', we are particularly interested in the role of truth in 'A Streetcar Named Desire'. While truth is not the central theme, it undoubtedly exists as a significant theme and holds a pivotal position within the play. Upon a second reading

or viewing, the reader/viewer discovers that in the first half of the play, particularly from the fourth to the sixth scenes, we witness not so much a battle between the male (Kowalski) and the female (Blanche), but rather between the male (Kowalski) and the human (Blanche) over what the male considers his possession, his doll (Stella). Unlike Blanche, Stanley is a more static, pre-determined, and unambiguous character, whose extensive characterization is provided by Blanche herself in the fourth scene:

He acts like an animal, has an animal's habits! Eats like one, moves like one, talks like one! There's even something--sub-human--something not quite to the stage of humanity yet! (Williams, 1947, scene 4, p. 74)

In contrast, Blanche is a completely enigmatic and multifaceted, mutable character. In the initial scenes, Blanche is not a direct antithesis to Stanley; she is more concerned with liberating her sister from her brother-in-law's domination, than with battling Stanley. Stella has willingly ensnared herself in his clutches. Blanche seeks to awaken Stella and lead her to an inner truth, a characteristic of Ibsen's characters ("For Ibsen, on the other hand, truth is that of interiority" (Szondi, 1983, 202)). She attempts to awaken the ideal within Stella, even though she herself has a far-from-ideal past and is, in fact, destined to be dependent on her sister and brother-in-law for the rest of her life. In these scenes, Blanche acts as if she herself is unaware of the truth about her past, which is the only plausible explanation for her behavior. Due to her fragile mental state, she manages to forget her past; Blanche genuinely believes she is an innocent and morally upright person: "Never inside, I didn't lie in my heart..." (Williams, 1947, scene nine, p. 119). With such an innocent perception, Blanche cannot reconcile herself to the subjugation of humanity, to the transformation of desire into love, and to the acceptance of fate in the name of such love, i.e., surrender: "What you are talking about is brutal desire--just--Desire!" (Williams, 1947, scene 5, 73). She is willing to do anything to fight for her ideal, a truly noble and virtuous English teacher who cannot tolerate any compromise with immorality. Her profession as a teacher is not accidental; the author has deliberately chosen a profession that would make the character's preaching about morality and idealism convincing to contemporary American society. At the beginning of the play, Blanche DuBois is a female Brand (from Ibsen's play 'Brand') or, if you prefer, a female Gregers Werle...

It's important to remember that at this point, neither the reader nor the viewer knows anything about Blanche's past. Consequently, they accept the on-stage events at face value and follow the narrative until the truth about Blanche is revealed. After this revelation, Blanche's character undergoes a transformation, essentially becoming a different person, and the play takes a new direction. The audience essentially witnesses two distinct plays, a play-within-a-play, similar to the murder of Gonzago in Hamlet. The first play unfolds before the truth about Blanche's true life is revealed (the first 6 scenes), and the second after the truth is revealed (the last 5 scenes). Based on this, we can determine the particularly interesting analytical segment for us - the first 6 scenes.

If we examine the plot of the first six scenes closely, we will find that the characters of Blanche DuBois and Gregers Werle serve similar dramatic functions. Both represent high social values (class conflict), both arrive from distant places, and both introduce their own ideals into ordinary, undistinguished, impoverished families; they attempt to awaken their loved ones (Hjalmar and Stella), in whose goodness and idealism they somehow believe, and to open their eyes to their resigned fate.

"Blanche- Pull yourself together and face the facts." (Williams, 1947, scene 4, p. 64)

"GREGERS- Jeg har i sinde at åbne Hjalmar Ekdals øjne. Han skal se sin stilling, som den er; – det er det hele." (Ibsen, 2009, tredje act, p. 141)

However, these ideals, both in the cases of Gregers and Blanche, are defeated when they collide with reality - Stella returns to Stanley, which is unexpected and inconceivable for Blanche: 'Why! I've been half crazy, Stella! When I found out you'd been insane enough to come back in here after what happened--I started to rush in after you!' (Williams, 1947, scene 4, p. 63).

The similarity in the functions of Gregers and Blanche is particularly evident in these two practically identical phrases uttered by Gina and Stanley:

"GINA- Uf, den vederstyggelige fyren, som skulde få sin passasje her i huset!" (Ibsen, 2009, fjerde act, p. 161).

"STANLEY: And wasn't we happy together? Wasn't it all okay? Till she showed here." (Williams, 1947, Scene 8, p. 112)

The dramatic development of the first six scenes is particularly interesting. Blanche begins her active attempts to awaken Stella from the fourth act, gradually increasing her efforts. However, these attempts are doomed from the outset, as the author has transposed the typical Ibsenian finale - Stella's departure from home - from the conclusion to the exposition, thus ruling out its repetition and suggesting that this play will not have the same ending as those by Henrik Ibsen. We are referring specifically to the final scene of the third act, which, as mentioned above, is very similar to the ending of 'A Doll's House'.

Goethe attributed crucial importance to the exposition in ancient drama, a view echoed by Peter Szondi in his foundational essay on modern drama: 'Goethe had written Schiller that the exposition was hard work for a dramatist "because one expects him to produce an eternal forward movement, and I would call that dramatic material best in which the exposition is already part of the development" To which Schiller responded on April 25, that Oedipus Rex approached this ideal to an amazing degree' (Szondi, 1983, p. 199). The significance of exposition in *A Streetcar Named Desire* is also explicitly indicated in the play's text itself, when Kowalski utters one of the most memorable lines: 'We've had this date with each other from the beginning!' (Williams, 1947, scene 10, p. 130).

3. The Dramatic Function of 'Truth' and the 'life lie'

The eventual revelation of the truth about Blanche (in the seventh scene) leaves everyone, including the audience, fully aware and paves the way for Kowalski's unabashedly naturalistic desires. This truth seals the

fate of Blanche and Mitch's relationship and extinguishes any remaining hope that Blanche might one day lead a normal life.

Of course, it is essential to consider how this crucial truth is revealed. Szondi specifically addresses the problem of introducing the past in modernist drama: 'for the Ghost Sonata presents the same formal problem that Ibsen's late work did: how to reveal dramatically a secret and deeply internalized past, how to prevent it from escaping dramatic presentation. In Ibsen's work discovery is made possible by intertwining the past with a topical dramatic action; in Strindberg's one-act *The Stronger*, by the use of monologue. In the Ghost Sonata both these methods are employed to a certain degree' (Szondi, 1983, 217).

In both 'Wild Duck' and 'A Streetcar Named Desire', the truth is revealed to the characters (Hjalmar Ekdal and Stanley Kowalski) offstage. Interestingly, in 'A Streetcar Named Desire', the character who reveals this significant truth to Kowalski does not even appear on stage. There is also a significant difference between the ways in which the truth is revealed: in 'A Streetcar Named Desire', the truth is explicitly stated on stage when Stanley recounts a passerby's story to Stella, thus making the audience privy to it as well; in 'Wild Duck', the truth is never explicitly voiced.

The reason for this is that Ibsen's play is structured in such a way that the audience is able to discern the truth and understand the situation far earlier than Hjalmar Ekdal. In Williams' play, however, both the audience and Stella are the last to learn the truth. Stella is least affected by this truth, despite it concerning her sister's past. The revealed truth only alters the actions of Kowalski and Mitch, ultimately leading to Blanche's destruction. For Stella, little changes as a result of this revelation, as she has already resigned herself to her fate in the third scene when she leaves the house and returns at the beginning of the fourth. After this point, Stella's destiny is sealed; she has already reconciled herself to everything that has happened and will happen. In other words, Stella's character can no longer alter the course of the play. Consequently, we can say that when Kowalski tells Stella the truth, the real addressee (or perhaps the author's intended audience) is the viewer.

Another crucial issue related to the theme of truth, and in a sense its opposite, that can be discussed in both works is *livsløgn* or 'the lie of life'. This concept was coined by Dr. Relling, a character in 'Wild Duck', who defines it as follows:

"RELLING - Det er jo bare noget sludder, som jeg fandt på for at berge livet i ham. Havde jeg ikke det gjort, så var det stakkers skikkelige svinet bukket under i selvforagt og fortvivelse for mange herrens år siden. Og så gamle løjtnanten da! Men han har nu rigtignok 16 fundet på kuren selv." (Ibsen, 2009, femte act, p. 203)

From Relling's discourse, we learn not only that ordinary people need an idealistic lie, or a 'life-lie', to sustain themselves, but also that the old lieutenant (who is mentally ill) has found his own personal 'medicine', suggesting that mental illness itself can serve as a similar kind of 'life-lie'. This is, of course, highly relevant to Blanche DuBois's life. We can say that Blanche has

not one, but several 'life-lies' that she uses to sustain herself, but in Tennessee Williams' play, Dr. Relling's prescription does not work, and ultimately Blanche's only 'medicine' is similar to that of the old lieutenant—mental illness.

The Ibsenian concept of *livsløgn* or 'life-lie' has been widely discussed in academic literature, not only in the humanities but also in psychology: 'Freud and Ferenczi transcribe *livsløgn* as transference, "self-taught attempts on the patient's part to cure himself" (Durbach, 1984, 326). It is also significant that, like Relling, Blanche is a frequent user of alcohol. "It seems quite deliberately to restructure Ibsen's central dialectic by throwing off balance its delicate equilibrium and endorsing even the most destructive and neurotic of alcoholic fantasies as the necessary lie. O'Neill's counterpart to Dr. Relling is, of course, Larry Slade – failed idealist, self-styled misanthrope and consoler of "the breed of swine called men in general." (Durbach, 1984, p. 329). I think it is clear that what Durbach says about Eugene O'Neill and Relling can, to a significant extent, also be applied to Blanche DuBois.

Erol Durbach, in his article, places great importance on linguistics and highlights specific words: "Geggers Werle's destructive clumsiness is diagnosable in precisely these terms, and the vehemence of his self-justification underscores the irony: "Jeg er ikke over-spændt" (p. 183). In translating this assertion as "I am not neurotic," James McFarlane may be introducing an anachronism into his Oxford edition. But he makes my point: Vildanden anticipates, in a language searching for a modern semantics of the human psyche, the fundamental concepts of twentieth-century psychiatry, cultural anthropology, and existential philosophy. (Durbach, 1984, p. 330) Stella uses the same words in the early exposition of 'A Streetcar Named Desire' when addressing Blanche: STELLA - You seem a little bit nervous or overwrought or something. (Williams, 1947, Scene 1, p. 23).

While I have already drawn extensively from Durbach's analysis, it is worth noting his compelling connection between the popularity of Ibsen's 'Wild Duck' structure in American drama and the societal construct of the 'American Dream'. Durbach posits that 'The American Dream is just such another *livsløgn*, so thoroughly located in the creative/discreative duality of Ibsen's idea that nearly every major play in the American repertoire seems a variation on Vildanden' (Durbach, 1984, p. 329). This observation resonates strongly with our own findings, and our study provides empirical support for Durbach's broader claim.

4. Symbols

As noted in the introduction, both texts exhibit a strong symbolic dimension. Among the numerous symbols employed in 'A Streetcar Named Desire', some can be linked, in various ways, to the symbolism found in 'Wild Duck'. The titles themselves are symbolic. In 'Wild Duck', the title serves as a metaphor for the complex system of lies that has become so entrenched within the family that it is no longer challenged.

"GREGERS- Min kære Hjalmar, jeg tror næsten, du har noget af vildanden i dig. HJALMAR- Af vildanden? Hvorledes det, mener du? GREGERS- Du

har dukket under og bidt dig fast i bundgræsset" (Ibsen, 2009, tredje act, p. 128)

While the streetcar itself is not explicitly discussed throughout Williams' play, Blanche's description offers a significant clue to its symbolic meaning. She associates the streetcar with the neighborhood where she has come to visit, a place where women endure domestic violence, which they perceive as a form of love, but which Blanche sees as 'brutal desire': "What you are talking about is brutal desire--just--Desire!--the name of that rattle-trap streetcar that bangs through the Quarter, up one old narrow street and down another..." (Williams, 1947, scene 4, p. 73).

The symbolic significance of the titles in both 'Wild Duck' and 'A Streetcar Named Desire' is evident. Both titles serve as metaphors for the dysfunctional family dynamics depicted in the respective works. However, the specific nuances of these symbols differ. Hedvig's attachment to the wild duck underscores her deep-rooted connection to her family, despite its flaws. In contrast, the streetcar symbolizes both arrival and escape for Blanche.

The symbolism extends to the names of the protagonists. Both Blanche DuBois and Gregers Werle carry symbolic weight, and the texts deliberately explore the characters' reactions to and interpretations of their own names.

" GREGERS Ja, vidste jeg bare det, du – da var jeg ikke så ilde faren endda. Men når en har det kors på sig, at hede Gregers – «Gregers» – og så «Werle» bagefter; har du hørt noget så fælt, du? HJALMAR Å, det synes jeg slet ikke.

GREGERS Huf! Isch! Jeg kunde ha' lyst til at spytte på den fyren, som heder sligt noget. Men når en nu engang har det kors på sig at være Gregers – Werle her i verden, således som jeg er det. " (Ibsen, 2009, anden akt, p. 92)

"BLANCHE It's a French name. It means woods and Blanche means white, so the two together mean white woods. Like an orchard in spring! You can remember it by that." (Williams, 1947, scene 6, p. 55)

Despite the contrasting attitudes of Blanche and Gregers towards their names, there is a shared element of alienation. Both names are perceived as foreign and out of place, marking them as outsiders within their societies. This sense of otherness ultimately hinders their efforts to connect with and influence the communities around them.

Another shared symbolic element is the use of music. While music is only briefly featured in 'Wild Duck', it permeates 'A Streetcar Named Desire', evolving throughout the play to reflect the changing circumstances of the characters. The sound of the blue piano in 'A Streetcar Named Desire' symbolizes the traditional, working-class culture of New Orleans, where people find joy even amidst hardship. Similarly, the flute playing in 'Wild Duck' provides a moment of respite for the Ekdal family, highlighting their ability to find happiness even in the face of adversity.

As we've discussed, Blanche initially functions similarly to Gregers, serving as a catalyst for change in the first six scenes. However, as the play progresses and Blanche's mental state deteriorates, she begins to resemble Old Ekdal. This parallel is reinforced by the

symbolic use of objects. Blanche's trunk, filled with relics of her past, mirrors Old Ekdal's attic, both serving as spaces of retreat and nostalgia. Both characters rely on a 'life-lie' to maintain their fragile sense of self. However, these 'life-lies' prove insufficient to sustain them in the face of reality. Ultimately, both characters become trapped in the past, unable to psychologically adapt to the demands of the present.

Conclusion

Our analysis of 'A Streetcar Named Desire' and 'Wild Duck' supports Erol Durbach's contention that 'nearly every major play in the American repertoire seems a variation on Vildanden' (Durbach, 1984, p. 329). Our findings provide concrete examples that illustrate the extent to which these two plays are interconnected, thus reinforcing Durbach's claim. Our findings not only corroborate Durbach's assertion but also reveal unique correspondences between these two works that may not be found in other American plays. Thus, our analysis contributes to a deeper understanding of the relationship between 'A Streetcar Named Desire' and 'Wild Duck' and enriches Durbach's broader claim.

To further characterize the relationship between these two works, we can draw an analogy to the world of jazz, particularly the jazz of New Orleans. Williams exhibits a willingness to freely deviate from conventional dramatic structures, replacing long acts with shorter scenes to achieve greater flexibility and variety. He also engages in bold experimentation, such as placing the exposition at the end of the play, effectively transforming the entire play into a prelude to the final five acts. Moreover, Williams incorporates a significant amount of music, which serves almost as a narrative backdrop. Just as jazz musicians often improvise on established jazz standards, Williams appears to have improvised on Ibsen's dramatic structure in "Wild Duck". In this sense, "A Streetcar Named Desire" can be viewed as a "dramaturgical jazz" that builds upon the foundational "standard" provided by Ibsen's "Wild Duck".

Our findings indicate that the primary objective of this study has been achieved. The key connections between the two works have been thoroughly explored in Chapters 2 and 3, and these findings have been further corroborated through an analysis of shared symbols and themes. While it is challenging to definitively categorize the exact nature of the relationship between two artistic works 'Wild Duck' can be seen as a text that influenced Tennessee Williams and provided a structural foundation for 'A Streetcar Named Desire'. However, Williams has developed this foundation in a highly original and artistic manner, creating a distinct and multifaceted work of his own.

Beyond our initial research goals, we have uncovered unexpected similarities between the two works, particularly in the realm of psychology. Our analysis, beginning in the chapter on the 'life lie,' revealed striking parallels in the symbolism employed in both plays. For instance, the nearly identical symbolic significance of the attic and the suitcase in both works highlights this psychological connection. While both plays have indi-

vidually attracted the attention of psychologists, we believe that a comparative analysis from a psychological perspective could yield valuable insights for both psychology and literary studies. Indeed, a professional psychologist could likely uncover even more significant parallels and nuances in a comparative analysis of these two works.

Furthermore, we believe that literary scholars should continue to explore this area of research. Despite the extensive critical attention 'A Streetcar Named Desire' has received, it has yet to undergo a comprehensive analysis by an Ibsen scholar. We believe that such an analysis would be invaluable.

This study represents a preliminary exploration of the specific parallels and connections between the works of Ibsen and Tennessee Williams. As indicated in the introduction, beyond 'Wild Duck,' Williams exhibits clear affinities with other modernist dramas, both Ibsenian and non-Ibsenian. We are confident that this topic warrants further investigation, potentially through an interdisciplinary approach involving psychologists. We hope that this modest study can serve as a foundation for future researchers who wish to delve deeper into this fascinating area of comparative literature.

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STYLISTIC ANALYSIS OF WORD COMBINATIONS AND SENTENCES DEPICTING THE 44-DAYS PATRIOTIC WAR

Akbarli T.

The teacher and PhD student of Baku Slavic University

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Abstract

The presented article is devoted to the stylistic analysis of sentences and word combinations formed in the context of the Second Karabakh War or the 44-days Patriotic War. No word or sentence is enough to describe the victory won by our brave sons and the valiant army of Azerbaijan which fought heroically in the Second Karabakh War. We proudly present to you only some of them. We believe that their analysis will form interesting ideas about the description and analysis of the war in the people reading the article.

Keywords: The Second Karabakh War, word combination, sentence, phonetic stylistic devices, lexical stylistic devices, syntactic stylistic devices.

Azerbaijan is a country with an ancient and glorious history, rich culture, literature and customs. In the history of every country, it is possible to witness not only honorable victories, but also tragedies and massacres that turned into bleeding wounds of the country. The Karabakh conflict has been a problem that has left tracks in the hearts of every Azerbaijani for many years. The elderly people and our parents who were witnesses of the First Karabakh war, remember the Karabakh fights and tragedy with sharp pain in their hearts. Notwithstanding the bloody history embracing these events, our nation never gave up and kept believing that the occupied lands would be regained thanks to the reasonable decisions of our President Ilham Aliyev and the strong army of Azerbaijan. On top of that, the reality about this conflict and the disgusting politics of Armenia and its supporters were explained to the growing young generation. The young born during the First Karabakh war and the following periods have always been brought up in the spirit of patriotism. The history of the occupation and the mass murder of population in Nagorno-Karabakh war have been depicted in various books, textbooks and articles. In our opinion, the heroic fight of the young generation, which constituted the main part of the Azerbaijani army in the 44-days war and further periods, is a clear evidence of patriotism. During the Second Karabakh war, countless young people joined the armed forces voluntarily, fought tooth and nail and died heroically.

Looking back on the history of Karabakh, we can clearly see that the dishonest policy of Armenians began many years ago. After the treaties of Gulistan (1813) and Turkmenchay (1828) concluded between Russia and Iran, the Russian state in a short time moved and settled 40,000 and 90,000 Armenians to the Karabakh region from Iran and Turkey respectively (1828-1830). Tsarist Russia started the "armenianization" process in Karabakh. Thus, the Karabakh region of Azerbaijan became a hotbed of conflict. At the beginning of the 20th century, the policy of ethnic cleansing became widespread in Karabakh. This resulted in the massacre of Turkish-Muslims by armed Armenians in 1905-1906 [1]. Armenians were able to strengthen themselves in Karabakh due to the comprehensive support of tsarism and the favorable conditions created by it. From the beginning of the 20th century, Armenians

systematically expelled Azerbaijanis from their historical lands, massacred and committed national genocide of them.

In 1991, Armenian armed forces started open military operations. On September 2, 1991, Armenian separatists announced the creation of an illegal "puppet" entity, the Republic of Nagorno-Karabakh, in Upper Karabakh. In 1992-1993, the territory of Nagorno-Karabakh and 7 other regions of Azerbaijan - Lachin, Kalbajar, Aghdam, Fuzuli, Jabrayil, Gubadli, Zangilan were occupied by the military forces of Armenia. As a result of military aggression by Armenia, 20 percent of Azerbaijani lands were occupied, more than 30,000 people were killed, up to 50,000 people were injured and maimed, up to 1 million Azerbaijanis became refugees and internally displaced persons, more than 4,581 people were captured and disappeared [4]. The first phase of the war ended with the officially signed armistice.

In response to the next attempt of military aggression by Armenia, the Azerbaijani Army launched a counter-offensive operation and as a result of the 44-days long Patriotic War, it succeeded in destroying the Armenian army, bringing it to its knees, and liberating the occupied territories. The "Iron Fist" operation carried out by the victorious Azerbaijani Army under the leadership of the Supreme Commander, President of the Republic of Azerbaijan Ilham Aliyev, was written in golden letters in the history of the Azerbaijani people and resulted in the surrender of Armenia [3].

The Karabakh conflict has been reflected on literature, art, social media, newspapers, radio and TV programmes, almost in all spheres of our life for many years. Another interesting fact is related with quotations, free and fixed word combinations which had been created on the process of the patriotic war. Such units expressing love for the homeland, heroism and bravery of Azerbaijani sons had been used in the languages and speeches of both authorities and citizens.

In the presented research project it is possible to get acquainted with interesting expressions and sentences, their translations into English, and semantic analysis. Such type of sentences depicting the heroism and dedication of martyrs, the atmosphere of the patriotic war and its consequences are the followings:

1. *Qanları ilə tarix yazan Şəhidlər* (Martyrs who wrote history with their blood) - the given epithet is a

lexical stylistic device in Azerbaijani. The literary device reflects that the occupied lands were regained at the cost of the blood and life of Azerbaijan's brave sons whom we owe our victory.

2. *Azərbaycan xəritəsini bütövləşdirən Şəhidlər* (Martyrs who unified the map of Azerbaijan) – the mentioned expression is an epithet in Azerbaijani. The expression symbolizes the bravery of the martyrs and their invaluable role in history. It is known that as a result of Armenia's military aggression, our ancient historical lands, which constitute 20 percent of Azerbaijan, remained under occupation for nearly 30 years. These lands were liberated from occupation through military and political means during the 44-days Patriotic War, and the territorial integrity of our country was restored. As it is seen from the given epithet, Azerbaijan achieved its territorial integrity years later precisely at the expense of the lives of martyrs.

3. *Qayıdan torpaqlardan qayıtmayan oğullar* (Sons who didn't return from the returned lands) - An interesting contrast is created by the means of antithesis. In the presented stylistic opposition, it is noted that although the lands of Azerbaijan were returned after 30 years, the sons of Azerbaijan, who fought in those lands to the last drop of their blood in the snow, frost, and the most difficult conditions, did not return from those lands.

4. *Qarabağın hər qarış torpağına Şəhid qanı səpələnib* (Martyr's blood was splattered on every inch of Karabakh's land) - Every inch of Karabakh's land is sacred, because these lands were watered with the blood of Azerbaijani sons who died both from enemy bullets during military operations and from landmines. In the given example, expressions such as "blood was splattered" and "lands were watered with blood" both have emotive meaning.

5. *Şəhidlər insanlığın ən uca fövqünə yüksəliblər. Ey insanlar, Qarabağ torpağına ayaq basanda asta basın, hər qarış torpaqdan Şəhid qanı fışqıracaq!* (Martyrs have risen to the highest level of humanity. O people, tread gently when you set foot on the land of Karabakh, the blood of martyrs will gush from every inch of the land!) - Martyrs gave their lives so that Azerbaijanis could live prosperously and happily in the lands liberated from occupation today, schoolchildren could study at school, and students could study at Karabakh University. We owe the freedom of these lands to them. We must not forget this reality in every inch of the land we step on. The expression "Martyrs' blood will gush from every inch of the land" has high emotional colouring.

6. *Əsrə bərabər bir ay* (A month equal to a century) – the given combination is an epithet in Azerbaijani. The expression symbolizes a glorious victory. Although the Second Karabakh War covered a short period, a great victory was achieved in this period. Thanks to this victory, Azerbaijan proved to the whole world that it is an independent country capable of ensuring the national interests of the people and the country. This victory showed the power of the Turkic world.

7. *Biz evimizə qayıdırıq* (We are returning home) - The given sentence expresses a broad meaning. Here, a lexical stylistic device, metonymy is used. Thus,

when we say "home", we mean the ancestral lands of Azerbaijan, which have been under occupation for 30 years. These lands have belonged to Azerbaijan throughout history, and after many years we were able to return to our lands - our home. On the other hand, after returning to these lands people found their homes, renovated them, restored historical monuments, and even found the headstones of their ancestors and repaired broken ones.

8. *Heydər Əliyevdən İlham Əliyevə* (From Heydar Aliyev to Ilham Aliyev) - Throughout his meaningful life, the national leader Heydar Aliyev thought only about Azerbaijan, its modernization, strengthening, and prosperity. The President of the Republic of Azerbaijan, Mr. Ilham Aliyev, is a worthy successor of the national leader Heydar Aliyev. The return of our ancestral lands was one of Heydar Aliyev's greatest dreams. He wanted to see Azerbaijan as a developed and independent country that is known all around the world. Ilham Aliyev was able to fulfill his father's dream, and this once again proved that he is both a wonderful son and a far-sighted and wise leader. We are proud of our president.

9. *Bir millət, iki dövlət/ Tək millət, iki dövlət* (One nation, two states) – In the presented expression we can come across the contextual antonyms. In fact, the words "one" and "two" are not antonyms separately. However, within the context, these two words are considered antonyms by creating a contrast. The mentioned expression reflects the great moral and military support shown by the neighbour country Turkey throughout history, as well as during the Second Karabakh War.

10. *Vətən savaşında tarixi zəfər* (A historic victory in the Patriotic War) – this is another vibrant epithet which depicts the importance of the victory gained in the patriotic war. This victory is engraved in the history of Azerbaijan with both its grandeur and its countless losses. Azerbaijanis will never forget this history.

11. *İşğaldan azad olunmuş ərazilərə "Böyük Qayıdış"* ("The Great Return" to the liberated territories) - The presented expression has a very broad meaning. The phrase "The Great Return" refers to the "return" of people who were forced to run away from their homeland barefoot and bareheaded 30 years ago. They returned back to their lands and homes that were unjustly taken from them. In this expression, the word "return" symbolizes the following ideas: Azerbaijanis will restore destroyed historical monuments, improve cities, and build schools, kindergartens, hospitals, and recreation areas that meet the most modern standards in these areas.

12. *İndi biz göstərdik kim-kimdir* (Now we have shown who is who) - The given expression in the Azerbaijani language uses both assonance, which is a phonetic stylistic device, and stylistic inversion, which is a syntactic stylistic device. Both the harmony of vowels and the violation of word order add special imagery to the given expression. Thanks to the victory gained in the second Karabakh war, Azerbaijan made its power known to the whole world. The whole world witnessed the restoration of Azerbaijan's territorial integrity. Now every country is aware of the power of

the Republic of Azerbaijan, which has rich history, literature, culture, customs and traditions.

The listed word combinations, expressions and sentences allow us to describe the process and results of the war in words. On the other hand, phonetic, lexical and syntactic stylistic devices such as assonance, epithet, metonymy, antithesis, stylistic inversion found in the presented examples express emotional colouring and form artistic quality and aesthetic values.

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SOCIAL SCIENCES

PECULIARITIES AND PROSPECTS OF ECOLOGICAL EDUCATION AT PRESCHOOLS OF KAZAKHSTAN

Makulbayeva A.

Master's student

Academy of Public Administration

under the President of the Republic of Kazakhstan

Astana, Kazakhstan

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Abstract

The article discusses the goals and methods of environmental education in preschool institutions of Kazakhstan. At a time when the issue of ecology is becoming increasingly important for modern society, a special role is assigned to preschool organizations. The article emphasizes the importance of preschool institutions in the formation of ecological culture, highlights important steps such as using gaming technology, creative activity that lay the foundation for raising children in harmony with nature.

Keywords: ecological education, sustainable development, preschool, environment, ecology

Environmental education of a preschool institution is considered one of the directions of sustainable development. The main goal of the preschool institution is the safety of the child's life. And the main goal of environmental education is the formation of an ecological attitude, consciousness, great common sense, responsibility, attitude to nature of the younger generation. Through this upbringing, a person's sense of culture and environmental consciousness are formed. Preschool is the period when the child's worldview is formed. Environmental education given at this young age increases children's responsibility for nature, teaches them to protect the environment, the formation of environmental behavior. Instilling ecology in the child's mind, teaching him to follow environmental orders will not only lay the foundation for nature conservation, but will allow in the future to educate a generation that is more environmentally friendly and empathetic [1].

The main goal of environmental education in kindergarten is to awaken children's interest in living in harmony with nature, increase their environmental knowledge and form an ecological culture. There are several main tasks of these areas of education:

- Education about nature and the environment;
- Development of love for nature, care;
- Formation of environmental skills such as energy saving, water saving;
- Teach children to take responsibility for environmental issues [2].

In addition, information technologies are also used in the implementation of environmental education. It is effective to introduce children to the problem of ecology through electronic textbooks, video content, vertical excursions. Strengthen the child's relationship with nature through environmental games and practices. Control is the only way to form environmental education in kindergarten. Every time children go for a walk, observing nature, they see many different phenomena. On the basis of this, the ability not only to observe children, but also to show the connections of objects and phenomena. In the process of control, it is necessary to

guide the activities of preschool children, ask questions and set them problematic tasks.

The main thing is to awaken an emotional reaction in children and the desire to continue such actions on their own. For example, if we control the strong wind and control the scattering of the surrounding area, we can give an example of the role of humanity in organizing its collection. At the same time, the presence of animals and plants in kindergarten, which children themselves observe and care for, teaches them to take care of the environment, love for work and get used to it, and gradually such qualities as responsibility for the assigned task were formed in the child. "Corner of Nature", which brings closer to nature in the preschool organization. In a corner of nature, children not only observe, but also defend various experimental projects. From the same projects can show the laws of nature, its benefits and harms to humanity.

The child's concern for nature from an early age can be realized through this observation and experimental work. Will the great thinker of the Kazakh people A. Kunanbayev be a child who will grow up without playing games and singing? - as they say, the game occupies a special place in the life of a child. The game helps preschoolers develop their personality, develop their language, learn literacy, and get closer to friends. After all, the means of educating a child from infancy to honesty, courage, kindness, and work are games. The fate of the future society also directly depends on the upbringing of this child. It is these children who are both developing and advancing in society. The first educational ladder, which establishes simple skills in the child's mind that solve a wide variety of problems of upbringing, is kindergarten. [3] For the general purpose of environmental education, it is written that it is possible to lay the foundations of environmental culture in preschool age, based on the peculiarities of the development of child psychology, at this stage bright, figurative emotional impressions, the first natural science concepts, form the basis of the correct attitude to the environment and value orientations in it.

Comprehensive work on environmental education of preschool children is an important aspect of their development, which is characterized by the formation of environmental awareness, a responsible attitude to nature and a healthy lifestyle. The preschool organization plays a key role in educating children about nature conservation and teaching them a responsible attitude to nature. [4] The problem of the relationship between man and the environment and the implementation of specific measures to protect and preserve natural resources today becomes not only an independent task of each state, each country, but also a national problem that all states unite, unite and unite. This led to the creation of an environmental International Society of different countries.

It has become one of the most important issues discussed by the United Nations. Protecting natural resources is not about not using them at all, but rather about using them carefully, efficiently and not allowing waste. Affordable and high-quality preschool education is included in the list of 17 Sustainable Development Goals of the United Nations (UN). The state policy in the system of preschool education and training is aimed at creating conditions for children from different social groups and families with different living conditions to have equal initial opportunities and receive a quality education.

Over the past 10 years, the issue of covering children with preschool education and training has been largely resolved. Today, the preschool is:

- not only a place to take care of the child and look after him, but also a developing educational environment, which primarily and mainly creates comfortable and safe conditions, aimed at comprehensively meeting the needs of children;
- make children healthy, intellectual, moral, emotional, partner of the family in matters of Social Development;
- every teacher is a territory of joy and well-being, which is a friend of the child and an assistant in his development.

This position should become the foundation of preschool institutions. Assessment of the quality of preschool education and training to determine the quality of pre-school education, since 2017, the development, approval and implementation of the system of indicators (monitoring) (methodological principles, 2018) for the development of skills and abilities of children who have not reached the school conducted by the preschool institution itself has begun in Kazakhstan. This monitoring is important for regulating the process of raising and educating children. The internal assessment of the quality of preschool education includes its own assessment, which provides for the collection and analysis of materials on the professional activities of teachers and the effectiveness of the educational environment. It provides for the stages of monitoring the development of preschool children, the formation of skills and flexibility of children in accordance with age characteristics, the introduction of actions that regulate the work process of the teacher.

Children's abilities and acquired skills are reflected in the child's development card. This tool for in-

ternal evaluation is maintained. Assessment of the quality of preschool education includes independent assessment and voluntary institutional accreditation through state certification, which includes a certificate between parents.[5] External monitoring of kindergartens is carried out only in order to ensure the quality standard of education and safety of children. For the same purpose, the requirements for the procedure for opening and monitoring the activities of a preschool institution on issues of safety, ensuring the rights of children and their legal representatives in accordance with the legislation of the Republic of Kazakhstan will be revised. It is necessary to create a system of quality assurance of preschool education, which determines the level of training of teachers, permission to work with children and the conditions created for the early development of children. In case of violation of the rights and legitimate interests of children based on the results of an external assessment, information is transferred to the

Committee for the protection of children's rights. Issues of restoring children's rights, ensuring comfortable living conditions are considered at interdepartmental meetings of the commission on juvenile affairs under Representative and local executive bodies. Thus, a comprehensive system of Independent National Assessment of the quality of preschool education is formed using the ECERS early childhood environment Rating Scale, which is used in the world as a comprehensive assessment tool.[6] In conclusion, for our own children, whether they are in kindergartens, study at school, college or university, national goals, educational aspirations in terms of what we want should be an incentive for a wide discussion of society. The time has come to establish a public agreement between the state and society in order to determine the real nationwide priorities of Education, which we all dream of for the future of our children, and equally distribute responsibility for the development of the industry.

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TECHNICAL SCIENCES

ETHICAL AND LEGAL ASPECTS OF AI-GENERATED CONTENT USAGE

Bukhtueva I.

bachelor's degree, Lomonosov Moscow State University

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Abstract

This article analyzes the legal aspects of using generative artificial intelligence (GenAI) in the context of intellectual property rights (IPR) for B2B companies. The basic concepts such as IPR and its main types, GenAI and types of generated content are considered. A legal analysis is conducted on issues related to authorship and rights over AI-generated content, as well as questions of licensing and liability for third-party rights infringement. The article outlines the main advantages and limitations brought about by the introduction of GenAI in the B2B sector. Recommendations are also provided to minimize legal risks for companies utilizing these technologies.

Keywords: generative artificial intelligence (GenAI), intellectual property rights (IPR), copyright, B2B, licensing, content, legal risks.

Introduction

The development of artificial intelligence (AI) technologies over the past decades has fundamentally transformed many aspects of business operations, including content creation processes. One of the technological innovations is the emergence of generative artificial intelligence (GenAI), capable of automatically generating text, images, music, and code. In business, particularly in the B2B sector, GenAI has quickly found applications in marketing, product development, data analysis, and other areas. Its use opens up new possibilities for increasing efficiency, reducing costs, and accelerating content creation processes. However, along with these benefits come new challenges, especially in the field of intellectual property rights (IPR).

As an important element of business competitiveness and value, IPR plays a vital role in protecting the interests of the company. Issues related to authorship and ownership of AI-generated content require special attention in the B2B sector, where the transfer of IPR often forms part of contractual obligations. The purpose of this article is to explore the legal aspects of GenAI use in the B2B context, particularly from the perspective of IPR.

Main part. Defining GenAI and its use in business

An AI class that can create new data based on the analysis and processing of existing information is called GenAI. Unlike traditional AI models that perform predefined tasks, it generates original content using complex machine learning algorithms and neural networks. The use of GenAI in business, especially in the B2B sector, has rapidly grown due to its ability to

automate complex processes and create personalized content for clients and partners. In the B2B environment, such technologies are applied to automatically generate reports, marketing materials, product prototypes, and to enhance user experience by adapting content to individual client needs.

The process of AI content creation starts **with data collection**. Data may be gathered from open sources or from specially curated datasets provided by developers. At this stage, data undergoes cleaning and preprocessing to remove irrelevant or incorrect elements and to format it for model training. **During the training stage**, GenAI uses this data to build a model capable of generating content. Machine learning and deep learning methods, particularly the use of artificial neural networks, form the basis of this training. The model learns patterns in the data. Although GenAI can generate content without human involvement, **optimization and refinement of the results are often required**. Various techniques are used for this, such as fine-tuning the model on additional data or adjusting model parameters to improve the quality of generated content. Approaches like user feedback or quality evaluation algorithms may also be employed to enhance the model's accuracy.

One of the advantages of modern GenAI models is their ability to iteratively create content. This means that based on initially generated data, the algorithm can continue improving the result. This process allows for the creation of higher-quality and more complex outputs in several steps. The GenAI application allows you to create a wide range of content that is actively used in the B2B sector to solve various tasks (fig. 1).

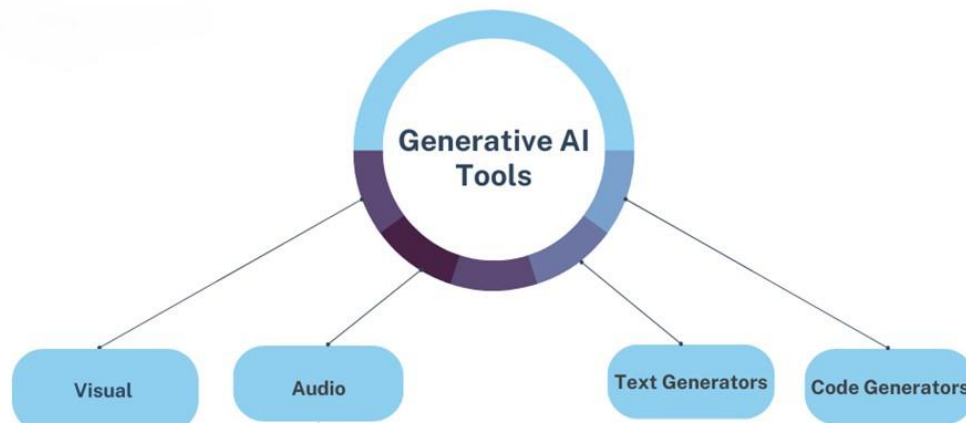


Figure 1. Types of content created by GenAI [1]

One of the applications of GenAI is **text generation**, which includes the creation of marketing materials such as press releases and articles, as well as the automation of report generation. Another significant use of GenAI is in the creation of **visual and audio content**. Companies can use GenAI to develop graphic materials, such as logos, banners, and infographics, accelerating the process of preparing marketing and advertising campaigns. Using GenAI, you can create soundtracks, voice messages, and musical compositions for advertisements, presentations, or podcasts. Another area of application is the **automatic generation of software code**. Using GenAI, it becomes possible to create new software products, optimize existing code and accelerate the development process by creating prototypes of applications and functions, which are then finalized by specialists. This significantly reduces development costs and accelerates the time-to-market for new software products.

Thus, GenAI demonstrates significant potential for transforming business processes in the B2B sector by automating content creation and improving the user experience. Its use helps speed up processes, reduce costs, and enhance the quality of products or services.

Intellectual property in the B2B context

The set of rights protecting the results of human creative and intellectual activity is called IPR. Its primary purpose is to provide legal protection for creative achievements and innovative solutions, granting the owner exclusive rights to use and commercially exploit such results. There are various forms of legal protection for intellectual activity, such as copyrights, patents, and trademarks. Copyrights protect original works of literature, music, art, and other creative forms, granting authors exclusive rights to use and distribute their works. Patents safeguard new technical solutions, including inventions, while trademarks protect brands and commercial names from unauthorized use by third parties.

Companies operating in the B2B space often develop innovative technologies, software, products, or services that require protection to maintain their competitive edge in the market. By providing legal protection for developments, IPR allows companies to protect their assets from unauthorized use or copying by competitors [2]. One of the important aspects of IPR in the B2B environment is the ability to monetize intellectual

assets through licensing, franchising or the sale of patents and trademarks. Companies can license their technologies or products to other enterprises, earning revenue from the use of their intellectual assets. This is especially important for tech companies that can transfer their developments to other firms for further application and adaptation while maintaining control over their innovations.

The introduction of GenAI into the business domain raises new legal questions concerning authorship and ownership rights. Traditional IPR norms assume that a work must have an identifiable author. In the case of AI-generated content, there is legal uncertainty because AI, including GenAI, does not have legal personhood and cannot be recognized as an author or rights holder. As a result, questions arise who owns the rights to the content created by AI, and how are rights distributed among AI users, software developers, and companies utilizing this content.

Copyright over content created by GenAI presents one of the most complex areas of legal practice. The principle of originality, which is the foundation of copyright protection, requires that content be the result of a creative process initiated by a human. However, if AI creates a text or image based on vast datasets and algorithms without direct human intervention, questions arise as to whether such content meets the originality criteria.

In addition to authorship issues, the responsibility for GenAI-generated content is of paramount importance. For instance, if AI generates content that infringes on third-party copyrights (by using protected data elements or copying existing works), who bears responsibility for such infringement. Such situations may lead to complex legal disputes and financial risks, especially in cases where copyright infringement was unintentional but resulted in significant losses for the rights holders. This makes the issue of licensing and rights to training data a critical aspect of developing and using GenAI systems. Thus, for companies operating in the B2B sector, using content generated by GenAI can have both positive and negative consequences (table 1).

Table 1.

Advantages and challenges of using GenAI in the business environment [3, 4]

Advantages of using AI	IPR-related challenges	Business implications
Automation of content creation: Fast creation of texts, images, program code and other content.	The uncertainty of copyright: the lack of a clear interpretation regarding who holds the rights to content created by artificial intelligence.	Potential disputes over the right to created content.
Scalability: AI can generate large amounts of content with minimal cost.	Using training data: training AI on copyrighted data can lead to violations.	The risks of lawsuits for unlicensed use of data.
Personalization and adaptation: AI allows you to create materials tailored to the needs of each client.	Challenges in licensing content created by AI.	Possible restrictions on the commercial use of the content.
Innovation and creativity: AI can offer unique solutions that are not available to humans.	Issues in identifying the parties responsible for third-party rights violations.	Possible fines or reputational losses due to litigation.
Reducing the cost of human resources for routine tasks.	Difficulties in law enforcement: the limited number of legal precedents complicates legal protection.	Uncertainty in the protection of IPR and long-term obligations.

According to the author, the implementation of GenAI offers companies the opportunity to scale content production and introduce innovations in communication and product creation processes. On the other hand, legal risks associated with the use of AI-generated content can significantly complicate companies' operations.

To minimize legal risks, companies using GenAI should develop IPR management strategies that include:

- Clear allocation of rights and responsibilities: concluding contracts with AI developers and clients that clearly outline rights to content created by GenAI and liability for potential IPR violations.
- Licensing of training data: verifying the legality of the data used to train AI models, considering third-party rights and ensuring appropriate licenses.
- Monitoring generated content: regularly reviewing AI-generated content to ensure compliance with IPR requirements and the absence of third-party rights violations.
- Internal control implementation: Creating internal monitoring mechanisms and fine-tuning the AI to reduce the risk of IPR violations and enhance legal transparency.

Content created by GenAI can significantly improve business processes and efficiency in the B2B sector but requires careful attention to legal aspects such as authorship, liability, and IPR protection.

Legal framework for IPR and GenAI-generated content

Currently, most countries lack a clear legal framework regulating IPR for content generated by AI. The legal framework related to IPR is adapted to traditional forms of creativity, where the copyright holder must be a human being.

The Berne Convention, which governs the international protection of copyright, states that the author of a work must be a physical person. This excludes the possibility of assigning copyright to AI-generated content [5]. National laws, such as the USA Copyright Act, are based on the principle of «creative contribution»

which implies that only a human who has engaged in creative activity can claim authorship [6].

In the realm of patent law, there are also limitations regarding inventions created by AI. Most national patent office's require that an inventor be a human. In 2019, there was a precedent where a patent application was filed for an invention created by the AI system DABUS. Patent offices in the USA rejected the application on the grounds that AI cannot be recognized as an inventor [7].

However, the rapid advancement of AI technologies calls for a revision of legal norms. Some jurisdictions have already begun discussing possible legislative changes to regulate the rights to AI-generated content. In the USA, discussions are underway about adapting copyright law to technological changes, but no specific laws have yet been adopted to define how to regulate AI content [8].

Most commonly, user agreements for GenAI specify that the platform or its parent company retains certain rights to the content generated by the AI, especially when it uses proprietary algorithms or data sets. For example, the agreement might state that the user is granted a limited, non-exclusive license to use the AI-generated content, but the company retains the right to use, modify, or distribute the generated material as it sees fit.

With regard to copyright, these agreements often include provisions that aim to clarify how intellectual property rights apply to content generated by AI systems. However, the question of authorship and ownership of AI-generated content remains legally ambiguous, as existing copyright laws typically recognize a human author, and AI systems do not currently meet the legal definition of authorship [9].

Conclusion

The use of GenAI in B2B opens significant opportunities for automation, innovation, and productivity enhancement. However, alongside these benefits, serious legal challenges related to IPR rights arise. Issues of authorship, licensing, and liability for AI-generated content remain largely unresolved within current legal

frameworks. This creates uncertainty for companies using GenAI and can lead to serious legal and financial risks, especially in cases of third-party rights violations.

In the absence of a clear legal framework for regulating AI content, B2B companies must approach IPR management carefully, developing internal policies and clear contracts regarding the use and distribution of rights to GenAI-generated content. Companies should consider potential conflicts related to the use of training data and implement licensing mechanisms to protect against potential lawsuits. The successful use of GenAI requires a balanced approach that combines technological innovation with reliable IPR protection.

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MICROSERVICE ARCHITECTURE IN FRONTEND DEVELOPMENT

Dudak A.

specialist degree

Tomsk State University of Control Systems and Radioelectronics

Russia, Tomsk

<https://doi.org/10.5281/zenodo.14236033>**Abstract**

This article explores the use of microservice architecture in frontend development. It examines core principles and benefits of micro frontends, such as scalability, modularity, and flexibility, as well as the challenges of implementation, including integration, dependency management, and security. Special focus is given to system support and monitoring issues to ensure high performance and fault tolerance in high-growth applications. To further support scalability and reliability in dynamic market environments, the article highlights essential practices in integrating microservice-based frontends for enhanced adaptability to evolving technical and business requirements.

Keywords: microfrontends, microservices, scalability, modularity, web development.

Introduction

Modern web applications have become critically important tools for businesses, enabling user interaction across a variety of devices and platforms. As data volume, functionality, and user base grow, the need for flexible, scalable, and easily maintainable systems has emerged. One promising approach that addresses these needs is microservice architecture, where an application is structured as a set of independent services, each performing a specific task. Although microservice architecture was initially applied in backend development, its principles are now successfully integrated into frontend development, creating so-called micro frontends.

Micro frontends allow the frontend to be divided into autonomous modules that can be developed and maintained independently. Unlike traditional monolithic architectures, micro frontends offer a higher level of modularity, which is especially valuable for large teams working on extensive applications. This separation

accelerates the development process, enables updates of individual components without reworking the entire application, and allows for more flexible system scaling. The application of micro frontends makes the system more resilient to potential failures and adaptable to changing business requirements.

The purpose of this article is to analyze the advantages and limitations of microservice architecture in web development, as well as to identify specific constraints and features. The article will examine how micro frontends contribute to maintaining flexibility and resilience in the system, the challenges they present, and the scenarios in which they are most effective.

Main part. Fundamentals and benefits of microservice architecture and micro frontends

The rapid growth of internet users and the need to ensure the reliable operation of web services require developers to continuously improve the performance and fault tolerance of their applications. According to Statista, the total number of internet users reached 5.4 billion in 2023 (fig. 1).

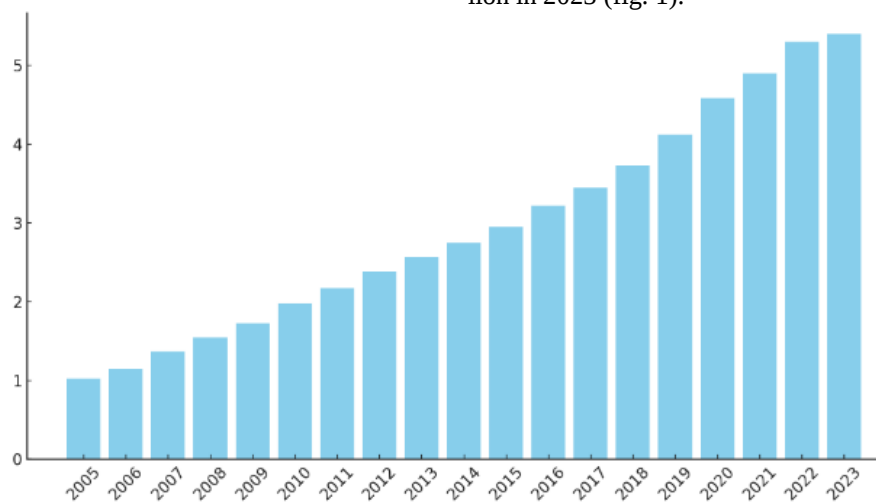


Figure 1. Number of internet users worldwide from 2005 to 2023, millions [1]

To create reliable and high-performing web resources, microservice architecture is often used. This technology represents an approach to application development where a system consists of separate, independent components that interact through well-defined interfaces. Each microservice is responsible for a specific

functional area and can be developed, deployed, and scaled autonomously. In the field of frontend development, these principles have led to the concept of micro frontends, where each user interface component functions as a separate microservice with its own dependencies and infrastructure [2].

One of the main advantages of the microservice approach is its **scalability**. Unlike monolithic applications, where scaling requires increasing resources for the entire system, microservice architecture allows only those parts of the application that need it to be scaled. Specifically, in conditions of significant user growth and high load, micro frontends enable scaling of only critical services (e.g., search systems or shopping carts in an online store) without increasing the load on other parts of the interface [3].

The technology provides a **high level of modularity**, enabling the creation of independent components that can be reused in other projects. Thanks to this principle, developer teams can work in parallel on different parts of the system without interfering with each other. This is especially important for distributed teams, where developers may be in different time zones or regions. It also allows such teams to work on different components of the system simultaneously, minimizing interdependence. In the context of remote work and global team distribution, this becomes an essential factor for project success. Each team is responsible for its functional area, reducing the likelihood of conflicts and code duplication.

The architecture offers developers a high degree of flexibility in choosing technologies and approaches. Different micro frontends can use various technologies, programming languages, and even frameworks. For example, one part of the interface may be written in React,

another in Vue or Angular, allowing optimal tools to be selected for specific tasks.

This flexibility also extends to the deployment process. Since each microservice is autonomous, teams can deploy new versions of individual micro frontends independently of each other, avoiding delays associated with synchronous updates across the entire system. This is particularly valuable in a dynamic market where the speed of product release can become a competitive advantage.

An example of successful micro frontend implementation is the American company **Netflix**, which has adopted microservice architecture for its user interfaces. Here, each micro frontend is responsible for a specific part of the platform, such as recommendations, film descriptions, or viewing. These micro frontends can be independently updated and scaled according to load, increasing system resilience and enhancing user experience [4].

Challenges and limitations of microservice architecture

Implementing microservice architecture in frontend development unlocks many possibilities, but it also comes with various challenges and limitations, requiring careful planning and strategic approaches. Understanding these challenges helps developer teams prepare for potential difficulties and develop strategies to use micro frontends effectively in projects (table 1).

Table 1.

Advantages and disadvantages of micro frontends [5]

Aspect	Advantages	Disadvantages
Scalability	Ability to scale individual modules as needed without affecting other parts of the system.	Increased network requests between micro frontends can negatively impact performance.
Modularity	High level of module independence enables easy updating and reusing components across projects.	Developing a dependency management system between modules can be complex and requires extra effort.
Development speed	Different teams can work on their micro frontends in parallel, speeding up development and deployment.	Due to integration and testing complexities, overall development speed may decrease during initial adoption.
Integration	Flexibility in choosing technologies and tools allows optimal solutions for each team or functionality.	Integrating components requires additional effort and often involves special frameworks (e.g., Single-SPA, Module Federation).
Security	Centralized access control and data protection for individual modules using technologies like OAuth and JWT.	Increased interaction points between micro frontends raise the risk of data leaks and require extra measures for authentication and authorization.
Dependency management	Allows independent library and framework updates for each micro frontend, reducing compatibility risks during updates.	Versioning and compatibility issues among modules, especially in large applications with many independent micro frontends.

Dividing an application into independent micro frontends **increases integration and management** complexity, as each component may have its dependencies and require coordinated interaction with other system parts. In a monolithic approach, interaction between interface parts is relatively straightforward because all modules reside in a single application. In micro frontend architecture, each component can have its

dependencies and libraries, necessitating the development of an additional layer of integration and synchronization.

One way to address this issue is by **using specialized frameworks** like Single-SPA or Module Federation in Webpack (a module bundler for JavaScript). Single-SPA enables each micro frontend to operate independently, allowing them to be loaded and executed autonomously. This approach allows adding, updating, or removing individual micro frontends without the

need to recompile or restart the entire application, accelerating development and deployment. The Module Federation tool enables component sharing across micro frontends, allowing multiple teams to work independently on different system parts. It also helps manage library versions and prevents conflicts, ensuring compatibility among different parts of the application.

Microservice architecture can also **increase overhead for interactions between modules**. Since each micro frontend operates independently, requests between them may lead to delays and performance degradation across the system. For instance, for large interfaces with multiple interacting micro frontends, developing additional caching and request optimization mechanisms may be necessary to minimize latency [6]. Addressing performance issues requires managing network requests between microservices and efficiently using caching. These measures can significantly reduce server load and provide acceptable response times for users, but they also increase development complexity and require additional resources.

Security becomes more complex when using micro frontends. Each micro frontend interacts with other components and may access data that requires protection. In the case of data leakage or authorization failure, the entire system can be put at risk.

Ensuring security in a microservice architecture requires a centralized approach to user authorization and authentication. One solution could be using technologies like OAuth and JSON Web Token (JWT), which allow centralized authorization to prevent unauthorized access to microservices. However, security issues remain relevant, especially in distributed teams and when using third-party services.

Support and maintenance of microservice architecture

One of the most critical tasks in maintaining a microservice architecture is monitoring and diagnosing performance. Given the multiple microservices that operate independently, it's essential to monitor each component's performance and manage their interactions to avoid bottlenecks. Tools like Prometheus and Grafana are often used for this purpose [7].

Prometheus is an open-source monitoring system designed for metric collection and processing. In a microservice architecture, Prometheus tracks each component's status by collecting data on resource usage, latency, request count, and errors. This data can be used for graphing, trend analysis, and identifying bottlenecks.

Grafana complements Prometheus by providing powerful visualization capabilities for the collected metrics. With Grafana, customizable dashboards display real-time load and component statuses, enabling rapid detection and response to emerging issues, which is especially useful for monitoring micro frontends where each component may have specific metrics. Both tools support creating alerts based on metrics, allowing teams to respond quickly to potential failures.

Monitoring and diagnostics are essential for identifying and resolving performance issues, especially under heavy loads. Effective use of these tools helps prevent outages and maintain high-quality user service.

A key element in microservice architecture is fault tolerance, as the failure of one component should not cause the entire system to crash. To ensure fault tolerance in micro frontends, replication, resilience patterns, and distributed logging and tracing are often applied.

Service replication across multiple servers or nodes distributes load and prevents data loss if one node fails. This is crucial for high-traffic systems where even brief downtimes can lead to serious consequences.

In microservice architecture, patterns like Circuit Breaker and Retry are used. The Circuit Breaker pattern prevents cascading failures by disconnecting from a component if it frequently returns errors, protecting other microservices from being overloaded by repeated requests. The Retry pattern automatically retries service requests if it's temporarily unavailable, helping restore connectivity without user intervention.

With micro frontends, where each component may be managed by different teams and developed in various programming languages, centralized log management is crucial. Using tools like the ELK Stack (Elasticsearch, Logstash, Kibana) and Jaeger for distributed tracing enables quick identification of problem sources and diagnostics. These tools help track request chains across various microservices and detect failures in any system component.

Maintaining micro frontends requires managing versions and dependencies between components. When changing one microservice, compatibility with others must be ensured, which can be challenging. In a large system where each component may update frequently, this creates additional complexities [8].

To address compatibility among different versions as each microservice evolves independently, API versioning is used, enabling individual microservices to update without requiring all components to update. This is achieved by creating API versions that can co-exist, supporting multiple components.

Version management and dependency management also involve integrating microservices into a CI/CD pipeline, automating deployment and testing processes. Tools like Jenkins, GitLab CI, or CircleCI are typically used to automatically test and deploy new versions of micro frontends. Integration of these tools minimizes update errors, as each new version undergoes automated testing before reaching production.

Canary testing and A/B testing should also be mentioned. These approaches allow deploying a new microservice version for a limited group of users to test its stability and performance in real-world conditions. Canary deployment helps detect errors and production issues early on, before the update becomes available to all users. This significantly reduces risks and allows evaluating the impact of changes on system performance.

Conclusion

Microservice architecture in frontend development, despite its complexities, is a powerful tool for creating scalable, flexible, and resilient systems, especially for applications experiencing rapid growth and meeting complex modern business demands. Dividing the user interface into micro frontends allows distributed teams to develop, test, and deploy independent modules in parallel, accelerating update rollouts and

minimizing the risk of dependency-related errors between application parts.

Ultimately, micro frontends are especially valuable for large projects and distributed teams, allowing approaches that ensure system adaptability to growing and changing requirements. A balanced approach to managing the complexities and benefits of micro frontends will enable the creation of a productive and flexible application that can withstand high loads and changing market conditions.

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Manafov E.*Doctoral student,**Department of Electronics and Automation**Azerbaijan State Oil and Industry University**Baku, Azerbaijan*<https://doi.org/10.5281/zenodo.14236035>**Abstract**

The integration of smart home technologies with sustainable practices represents a transformative shift in how we address environmental challenges. Smart homes, characterized by their devices and advanced automation, contribute to energy efficiency, resource conservation, and reduced carbon footprints. This paper explores the nexus of smart homes and environmental sustainability, examining their current capabilities, potential for promoting a green world, challenges in adoption, and future prospects. By analyzing innovations in renewable energy, waste management, and eco-friendly living, this study underscores the importance of smart homes in driving a sustainable future.

Keywords: smart systems, green world, automation, smart transformation

Introduction

The rise of climate change as an existential threat necessitates innovative approaches to environmental sustainability. Smart home technologies, which employ interconnected devices to optimize resource use, offer a promising avenue for reducing energy consumption and promoting green living. These systems leverage automation, data analytics, and artificial intelligence (AI) to enhance efficiency and convenience while minimizing ecological impact.

This paper investigates the role of smart homes in creating a green world, focusing on their ability to integrate renewable energy, reduce waste, and foster sustainable behaviors. The discussion also highlights challenges, such as cost and accessibility, and explores how emerging technologies and policies can shape the future of sustainable living.

The Concept of Smart Homes

Smart homes are residential spaces equipped with technology to automate and control systems such as lighting, heating, cooling, and appliances. Key features of smart homes include:

Connectivity: Devices communicate with each other and with users through networks, enabling remote control and data sharing.

Energy Optimization: Systems like smart thermostats and lighting adjust dynamically to minimize energy waste.

Integration with Renewable Energy: Smart homes often incorporate solar panels and energy storage systems to reduce reliance on nonrenewable resources[1,2].

Technological Foundation

Smart homes rely on advancements in sensors, AI, and machine learning. These technologies enable predictive maintenance, adaptive energy use, and user-centered customization. For instance, AI-driven algorithms can learn a household's habits to optimize energy use while ensuring comfort.

Environmental Benefits of Smart Homes

Smart homes contribute to sustainability through several mechanisms:

Energy Efficiency

Smart homes use intelligent systems to reduce energy consumption:

Smart Thermostats: Devices like Nest and Ecobee adjust temperatures based on occupancy and weather conditions, reducing unnecessary heating or cooling.

Smart Lighting: LED lighting systems with motion sensors and natural light adjustments minimize energy use.

Energy Monitoring: Real-time data on energy consumption helps users identify inefficiencies and adopt energy-saving practices.

Renewable Energy Integration

Smart homes support the adoption of renewable energy sources:

Solar Panels and Batteries: Systems like Tesla's Powerwall allow homes to generate and store renewable energy, reducing reliance on grid electricity.

Smart Grids: Homes with renewable energy systems can interact with smart grids, feeding excess power back into the system.

Water Conservation

Smart technologies help manage water use:

Irrigation Systems: Smart sprinklers adjust watering schedules based on weather forecasts and soil moisture levels.

Water Monitors: Devices detect leaks and optimize water usage for appliances and plumbing systems.

Waste Reduction

Advanced technologies in smart homes can minimize waste:

Smart Appliances: Refrigerators with inventory tracking reduce food waste by alerting users to expiring items.

Recycling Management: Smart bins sort recyclables and track waste disposal patterns.

Challenges in Implementing Smart Homes for Sustainability

Despite their potential, several barriers limit the widespread adoption of smart home technologies:

High Initial Costs

The upfront investment for smart devices and installation is a significant deterrent. While energy savings can offset costs over time, affordability remains a

concern, particularly in low-income households and developing countries.

Privacy and Security Risks

IoT-enabled devices collect and transmit sensitive data, raising concerns about cybersecurity and user privacy. Cyberattacks on connected systems can compromise both personal information and the functionality of essential devices.

Technological Accessibility

Smart home technologies are often limited to urban areas with reliable internet connectivity. Rural regions and developing nations face infrastructural challenges that hinder adoption[2,3].

The Future of Smart Homes in a Green World

The evolution of smart home technologies is expected to amplify their environmental benefits. Key trends include:

Advancements in AI

Predictive Energy Management: AI will enable homes to anticipate energy needs based on historical data and real-time inputs, further reducing waste.

Device Interoperability: Standardized protocols will allow seamless communication between devices, enhancing overall efficiency.

Integration with Smart Cities

As urbanization accelerates, smart homes will play a crucial role in the development of smart cities. These cities will integrate smart homes into broader networks for energy distribution, transportation, and waste management.

Policy Support and Incentives

Governments worldwide are introducing policies to promote sustainable living:

Tax Incentives: Subsidies for renewable energy installations and smart devices.

Green Building Standards: Certification programs encouraging eco-friendly construction practices.

Consumer Awareness

Raising public awareness about the environmental and economic benefits of smart homes will drive adoption. Educational campaigns and user-friendly technologies can help bridge the knowledge gap.

Ideas and Suggestions for Future Development

To further the potential of smart homes in fostering a sustainable and greener world, innovation must focus on improving efficiency, expanding accessibility, and integrating cutting-edge technologies. Below are suggestions for future advancements in smart home technologies.

Enhancing Integration with Renewable Energy Systems

Community Energy Sharing Platforms: Develop decentralized systems allowing neighborhoods to share excess energy generated from solar panels or wind turbines. This approach can create microgrids that enhance energy efficiency and reduce dependency on centralized power plants.

Advanced Energy Storage: Research and implement next-generation storage solutions such as solid-state batteries or hydrogen fuel cells to provide reliable and sustainable energy storage for smart homes.

AI-Driven Energy Optimization: Leverage artificial intelligence to predict energy consumption pat-

terns, dynamically adjust energy production, and balance grid demand, further integrating smart homes with renewable energy sources.

Improving Water Management and Conservation

Real-Time Leak Detection and Repair Systems: Equip smart homes with advanced water sensors capable of detecting leaks early and triggering automatic repairs or alerts, preventing water wastage.

Smart Greywater Recycling Systems: Develop user-friendly greywater systems that recycle water from sinks, showers, and laundry for purposes like irrigation or toilet flushing.

Rainwater Harvesting Integration: Build automated rainwater collection systems that use weather forecasts to optimize storage and distribution for household needs[4].

Expanding Waste Management Capabilities

Intelligent Composting Units: Integrate smart composting systems into kitchens to help households process organic waste efficiently. These units could provide feedback on compost quality and encourage better waste segregation.

Automated Recycling Assistants: Design IoT-enabled recycling bins that use sensors and AI to identify, sort, and compact recyclable materials, reducing contamination and encouraging proper disposal habits.

Digital Waste Footprint Trackers: Provide homeowners with detailed insights into their waste generation patterns, paired with actionable recommendations for reducing non-recyclable waste.

Increasing Accessibility and Affordability

Low-Cost Smart Devices: Develop affordable smart home solutions for low-income households and communities in developing countries to democratize access to green technology. **Open-Source Platforms:** Promote open-source software and hardware for smart home devices, enabling innovation and customization at reduced costs. **Government Subsidies and Incentives:** Advocate for policies that provide financial assistance, tax benefits, or grants for individuals and businesses investing in smart home technologies.

Enhancing Interconnectivity and Usability

Unified Smart Home Ecosystem: Create standardized communication protocols to enable seamless interaction between devices from different manufacturers, reducing fragmentation in the market.

Voice and Gesture Controls: Advance user-friendly interfaces with natural language processing (NLP) and gesture recognition to make smart homes accessible to all age groups and abilities.

Personalized Eco-Suggestions: Equip smart homes with AI-driven systems that provide tailored recommendations for reducing energy and resource consumption based on individual usage patterns.

Leveraging Big Data and AI for Sustainability

Predictive Maintenance Systems: Utilize AI to monitor the health of appliances and systems, alerting users before malfunctions occur and minimizing downtime or waste.

Sustainability Dashboards: Design comprehensive dashboards that combine data on energy, water, and waste usage, empowering users to make informed decisions for greener living.

Climate-Adaptive Smart Homes: Develop homes capable of adapting to local climate changes, using AI to adjust settings for heating, cooling, and ventilation to reduce environmental impact.

Collaboration with Smart Cities and Governments

Integration with Smart Cities: Align smart homes with broader smart city infrastructure, such as energy grids, public transportation, and waste management systems, to amplify sustainability efforts on a community scale. **Urban Planning Synergies:** Collaborate with urban planners to design neighborhoods where smart homes are optimized for solar exposure, natural ventilation, and resource-sharing systems.

To achieve these advancements, collaboration between technology developers, policymakers, and researchers is crucial. By focusing on these areas, smart homes can evolve from convenient tools into critical enablers of a sustainable and green world. The future lies in bridging technological innovation with environmental responsibility, ensuring that smart homes become accessible, secure, and impactful for all[5,6].

Conclusion

Smart homes represent a powerful tool in the global effort to combat climate change and build a sustainable future. By enhancing energy efficiency, integrating renewable resources, and encouraging eco-

friendly practices, smart homes can significantly reduce environmental impact. However, addressing challenges such as cost, accessibility, and security is essential to unlocking their full potential.

The transition to a green world requires collective action from governments, industries, and individuals. Smart homes, as part of this broader movement, exemplify how technology and innovation can align with environmental stewardship to create a better future for all.

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INCREASING THE EFFICIENCY OF DEVELOPMENT OF SLOPING THIN ORE DEPOSITS IN ENERGY-DISTURBED MASSIFS**Lyashenko V.***candidate technical Sciences, State enterprise "Ukrainian Research and Design and Intelligence Institute of Industrial Technology",*ORCID: <https://orcid.org/0000-0001-8361-4179>**Andreev B.***Dr. Eng. Sc, Senior Researcher, Professor, Head of the Department State Construction geotechnology Kryvyi Rih National University,*ORCID: <https://orcid.org/> h-index (Scopus or Google Scholar) <https://www.scopus>.**Stus V.***doctor of medical sciences, professor, Professor of the Department of Surgery No. 1 and Urology of the Dnipro State Medical University,*ORCID: <https://orcid.org/0000-0002-4539-8126>**Oliynyk T.***Senior Professor, Head of the Department of Mineral Processing, Kryvyi Rih National University,*ORCID: <https://orcid.org/0000-0002-0315-7308> h-index 5 Scopus Author ID: 36173274800, h-index 7Google Scholar <http://surl.li/snyll><https://doi.org/10.5281/zenodo.14236037>**Abstract**

Topicality. It is caused by the growing needs of industrial society for metal supply. To achieve this, it is necessary to increase the efficiency of subsoil use and use the reserves of the existing mining technology. The greatest problems are associated with the development of gently dipping thin ore deposits in energy-disturbed massifs, where it is difficult to use high-performance mining machines and mechanisms with large overall dimensions.

Research object. Technologies and technical means for the development of gently dipping thin ore deposits with separate extraction of ore and host rock in energy-disturbed rock massifs.

Objective. Justification of the possibility of increasing the efficiency of developing gently dipping thin ore deposits with separate extraction of ore and rock in energy-disturbed massifs by implementing the reserves of the organization of work during the separation of ores from the rock massif, as well as improving the quality of ore raw materials, mining and environmental safety. This will improve the rational use and protection of the subsoil, reduce the volume of waste rock and off-balance ores in terms of useful component content on the surface and reduce the negative impact of the mining region on the livelihoods of the population and the environment.

Methods. The methods of complex generalization, analysis and assessment of practical experience and scientific achievements in the field of underground geotechnology, theory and practice of explosive destruction of solid media, methods of continuum mechanics, mathematical statistics, as well as methods for studying wave processes according to standard and new methods of leading specialists from developed mining countries of the world with the participation of the authors were used.

Results. Based on experimental studies of the indicators of a continuous development system with gross ore extraction, the results of dilution calculations for the compared variants of development systems are substantiated. The indicators of ore sorting and graphs of ore distribution by metal content in balance reserves and mined ore are given. The variants of development systems with selective ore extraction, tested experimentally, are proposed. The technical and economic indicators of the development of deposit reserves by a continuous development system along the rise with selective extraction of the ore body, as well as gross extraction of ore and rock are presented. The recommended technology can be in demand at enterprises of the mining industry, in particular, ferrous, non-ferrous, radioactive and other metal ores.

Keywords: ore deposits, main stresses, low power, gentle dip, ore quality, mining and environmental safety.

1.Introduction

The growing needs of industrial society require metals. The trend in the development of mining production is the intensification of deposit development processes with an increase in the size of ore fields due to geometrization and the use of mobile high-performance equipment [1, 2]. Increasing the efficiency of subsoil use is increasingly ensured by using the reserves of the existing mining technology. The greatest problems are associated with the underground development of gently dipping, thin ore deposits, where it is impossible to use high-performance mining machines and mechanisms

with large dimensions [3, 4]. This work is a continuation of research, the main scientific and practical results of which are most fully presented in works with the participation of the authors [5, 6].

Research object. Technologies and technical means for the development of gently dipping thin ore deposits with separate extraction of ore and host rock in energy-disturbed massifs.

Objective. Substantiation of the possibility of increasing the efficiency of development of gently dipping thin ore deposits with separate extraction of ore and rock in energy-disturbed massifs by implementing

reserves in the organization of work during separation of ores from the rock massif, as well as improving the quality of ore raw materials, mining and environmental safety. This will improve the rational use and protection of the subsoil, reduce the volume of waste rock and off-balance, in terms of useful component content, ores to the daylight surface and reduce the negative impact of the mining region on the life of the population and the environment.

To achieve this goal, the following tasks were solved:

1. To establish the deformation in the support, which is activated after the first 3 months, steadily maintaining the trend of increase over time.

2. To develop a technology and technical means for the development of gently dipping thin ore deposits with separate extraction of ore and host rock in energy-disturbed rock massifs.

- 3..Recommend further research aimed at establishing the patterns of development of the massif's stress-strain state in the zone of its weakening (geomechanical monitoring).

2. Materials and research methods

The dependence of the quality indicators of ores mined using different variants of a continuous development system is studied within the framework of an industrial experiment, during which the general quality indicator, ore dilution, is assessed using direct and indirect methods [7, 8]. The curves of ore distribution by metal content make it possible to clarify the mechanism of interaction of different grades of process products. The quality of ores during their extraction is assessed during the development of experimental blocks using a generally accepted method based on block development maps with geological and mine survey data. The metal content in the ore was calculated based on the results of ore testing in blocks at all stages of work. The data on the technology indicators were interpreted using graphs. Recommendations for the selection of development system options are substantiated by the results of experimental development of ore bodies. Based on the results of the experiment using the engineering forecasting method, development system options optimized by the dilution criterion were proposed [9, 10].

2.1. Discussion of research results. The main direction of solving these problems remains the improvement of the indicators of completeness and quality of extraction of minerals from the subsoil due to the still hidden resources of known technologies and technical means [11, 12]. From thin ore bodies with a dip angle from 0 to 30° and a thickness of 0.7 to 2.0 m, up to 50% of non-ferrous and rare metal ores are mined by the underground method. Gently dipping thin deposits exceed 20% of vein deposits [13, 14]. Low thickness and difficult bedding conditions of ore bodies are accompanied

by high dilution of the mined ore, the damage (economic consequences) of which reaches 40% of the cost of metals and is the reason for the low efficiency of extraction and processing of ores from such deposits. The direction of improving the quality and environmental safety of mining such ores is to improve the technology of breaking, taking into account the location of the useful component in the ore-bearing massif [15, 16].

The ore bodies of the type under consideration are characterized by variable angles of incidence, uneven thickness, faults and constrictions. The host rocks are generally stable and allow significant outcrops of roof rocks, which makes it possible to use development systems with an open stope. For their development, options for a continuous development system are used. The main disadvantage of a continuous development system is the high dilution of the ore, reaching 60% and reducing the content in the commercial ore compared to the metal content in the subsoil by up to 40%. The reason for the high dilution is the seizure of 0.3 to 1.0 m of rocks during breaking, due to the need to work in a stope and the lack of small-sized mining equipment [17, 18].

There are two prevailing trends in improving the technology of intersecting ore body extraction: continuous mining with ore breaking from boreholes and mining with separate ore and rock extraction. In the first trend, it was found that under comparable conditions, breaking from boreholes compared to bench breaking from the working space allows increasing the productivity of a miner in cleaning operations by an average of 10...12%, increasing the productivity of the production block by 15...18% and reducing dilution by 10...12%. With a decrease in the depth of mining operations, the conditions for ore extraction become more complicated. A decrease in capacity, variability in the angle of incidence, dumps and constrictions necessitate a decrease in the width of the extraction panel and, consequently, an increase in the volume of cutting operations by up to 50%, which reduces the efficiency of the system [19, 20].

3. Research results

The Ishim deposit (Republic of Kazakhstan) is composed of gently dipping ore bodies with an average thickness of 2 m, located in large geological faults. The strength coefficient according to M.M. Protodyakonov of ores is 8...14 and of host rocks 8...10. To assess the quality indicators of the continuous development system with bulk ore extraction, experimental blocks were developed, the development conditions of which are typical for most ore bodies of the deposit (Table 1).

Table 1.

Conditions for testing experimental blocks

Parameters of ore bodies	Block 1	Block 2
Interval of change of the angle of incidence, degree	33-41	20-31
Width along the stretch, m	116	136
Area, m ²	4030	6170

Preparation and cutting of blocks consisted of making inclined raise, ventilation and boring drifts, ore passes, ore breaking was carried out by blasthole charges, ore delivery was carried out by scrapers. Characteristics of block 2: dip angle 250, ore thickness 0.78 m, ore body area 5167 m, metal content 75 conventional units. Dilution (R) was calculated by the direct method and indirect method based on the metal content in balance and commercial ore, as well as in the diluting

$$\text{ore mass: } R = \frac{c-a}{c-b} \times 100, \% \quad (1)$$

Where c , a , b – respectively, the metal content in balance and commercial ore and diluting rock mass, %.

Under generally identical conditions of development of the experimental blocks, the dilution of the

mined ore was 41...43%, and after sorting 3...38%. The quality indicators of block 1 development: dilution of ore issued for sorting 46%, sorting tailings yield 7.1%, marketable ore dilution 42.0%, metal content in marketable ore 55 conventional units, decrease in metal content in marketable ore 36 conventional units. The quality indicators of block 2 development: dilution of ore issued for sorting 50%, sorting tailings yield 13.2%, marketable ore dilution 42.5%, metal content in marketable ore 47 conventional units, decrease in metal content in marketable ore 38 conventional units [21, 22]. In Fig. 1 shows the curves of ore distribution by metal content in reserves and ore received for sorting determined for experimental blocks 1 and 2.

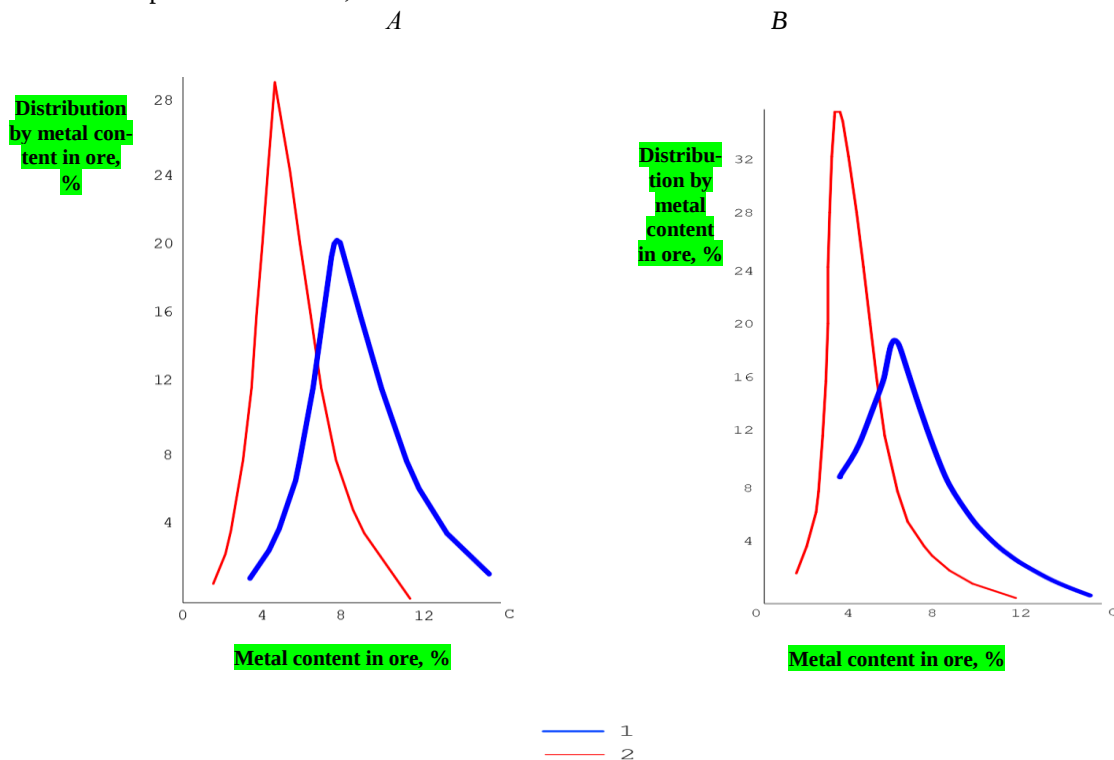


Fig.1. Ore distribution by metal content in blocks: A -block 1, B - block 2; 1:1 - metal content in the subsoil; %; 2- metal content in the issued ore

The graphs show a shift in the curve of commercial ore distribution with its maximum towards lower contents, characterizing a decrease in the metal content in commercial ore compared to the metal content in balance reserves. This occurs when off-balance ore and waste rock are mixed with balance ore during bulk ore breaking and its movement along the block. In blocks 1 and 2, the metal content in commercial ore turned out to be 37% lower than in balance ore. The output of sorting tailings fluctuates by blocks from 3 to 14%, averaging 8...10%. However, it should be noted that with metal content in balance ore, When due to dilution the metal content in balance ore decreases in broken ore to the level of off-balance ore, the output of tailings at the ore control station (RCS) rises to 40%, and metal losses in tailings increase to 40% or more. [23, 24]. The main task of increasing the efficiency of development of thin and gently dipping intersecting ore bodies is to reduce the level of ore dilution, while ensuring the mining and

environmental safety of their development in energy-disturbed rock massifs.

3.1. *Geomechanical audit of the dynamics of the stress-strain state (SSS) of a rock massif (theory of the issue).* One of the methods for studying the dynamics of the load on rigid metal arch support of mining development workings was measurements using strain gauges. In addition, the change in the dimensions of the support section was determined by measuring the distances between the benchmarks embedded in the support by mine surveying surveys.

Strain gauges and survey benchmarks were placed on the supports installed in the workings. In working No. 1, metal frames were installed on the rigid metal supports of a 13 m long section at intervals of 0.5 m from each other. In working No. 2, 9 metal frames were installed at intervals of 1 m. The measuring strain gauge station was placed on 5 metal frames in working No. 1. Each frame was equipped with 9 measuring points,

each of which contained three sensors glued to three planes of a special profile. Rock deformations were recorded using strain gauge equipment. Based on the

measured principal stresses, their diagrams were constructed around the working, which served as the basis for assessing the weakening of the massif under the influence of mining operations (Fig. 2).

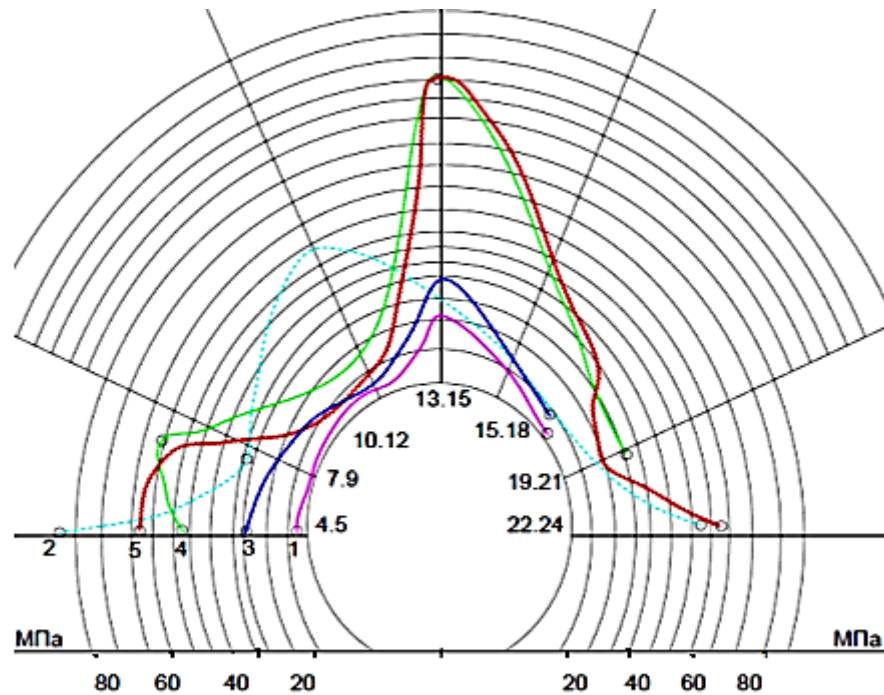


Fig. 2. Stress diagrams σ_z : 4-24-strain gauges; 1-5 – measurements

Based on measured deformations $\xi_{0,1}, \xi_{f1}, \xi_{f2}$ The main deformations were determined:

$$\xi_{1,2} = \frac{\xi_{f2} + \xi_{f1}}{2} \pm \frac{\sqrt{2}}{2} \sqrt{(\xi_{f2} - \xi_{f1})^2 + (\xi_0 - \xi_{f1})^2}, \quad (2)$$

and the angle φ between the directions $\xi_{0,1}$ and ξ_{f1} :

$$\operatorname{tg} \varphi_0 = \frac{\xi_{f1} - \xi_{f2}}{2\xi_0 - \xi_{f1} - \xi_{f2}} \cdot \operatorname{tg} \varphi_1, \quad (3)$$

Principal stresses at the point under study based on Hooke's law:

$$\sigma_1 = \frac{E}{1-\mu^2} (\xi_1 + \mu \xi_2), \quad \sigma_2 = \frac{E}{1-\mu^2} (\xi_2 + \mu \xi_1), \quad (4)$$

Where E - modulus of elasticity; μ - Poisson's ratio.

Principal normal stresses: σ_z and σ_x - respectively, vertical and horizontal: $\sigma_z = \sigma_1 \sin \alpha - \sigma_2 \sin \alpha$ and and $\sigma_x = \sigma_1 \sin \alpha - \sigma_2 \sin \alpha$. (5)

It was found that the deformations in the lining are activated after 3 months, steadily maintaining the trend of increase with time. This can be explained by

relaxation phenomena when pressure is perceived on the lining. The deformations increase starting from the 4th to 6th month and reach a maximum after 11th to 12th months. The first phase is the beginning of the development of the operational block. The deformations of the lining increased from 2 to 16 mm (Fig. 3).

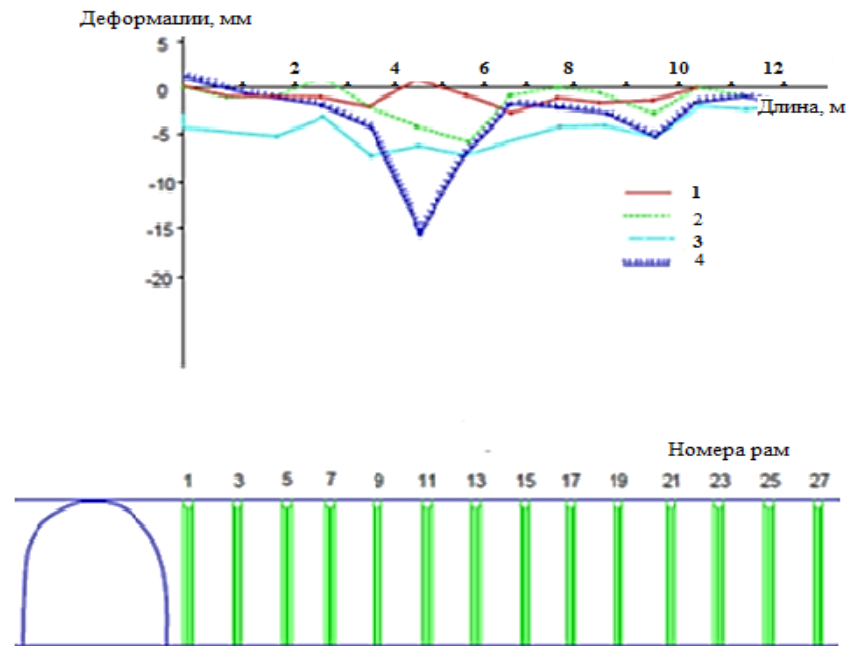


Fig. 3. Dependence of the deformation of the support lining on its length in the first phase: 1,2,3,4 - measurements, 1-27 – frames

It follows from Fig. 3 that the development of deformations is not monotonous. Thus, the greatest deformation of frame No. 11 was 19 mm, reflecting the influence of the fault. The second phase is the section of the ore body from the side of the hanging wall. The third phase is the development of deformations of the support during ore extraction, which is characterized by intensive deformation of the support. If outside the cleaning zone the deformations were insignificant, then during ore extraction the average deformations of 27 arches over 1, 2 and 3 months, according to sensor data, increased to 43, 119, 128 mm, respectively. The width of the workings at a height of 0.5 m from the ground decreased by 85 mm in the first month and by 175 mm in the second month. The maximum deformations of the metal arch support were noted at the frames located

close to the working face, and at frame No. 4 in the fault area. After 6 months, the deformations in the upper arch of frame No. 4 were 233 mm, and the width of the support at a distance of 0.5 m from the soil increased by 55 mm. At this time, frame No. 19 came apart at the locks and failed. The center of the upper arch of the frame dropped by 432 mm, the width at the locks increased by 312 mm. In the upper arch of frame No. 8, the deformations were 340 mm. The maximum deformations of the support in working No. 2 were observed at the frames close to the working face and at frame No. 4 in the fault area (see Fig. 3). Based on the results of the analysis of the practice of mining low-power flat and inclined intersecting ore bodies, variants of mining systems with selective ore extraction were developed (Fig. 4).

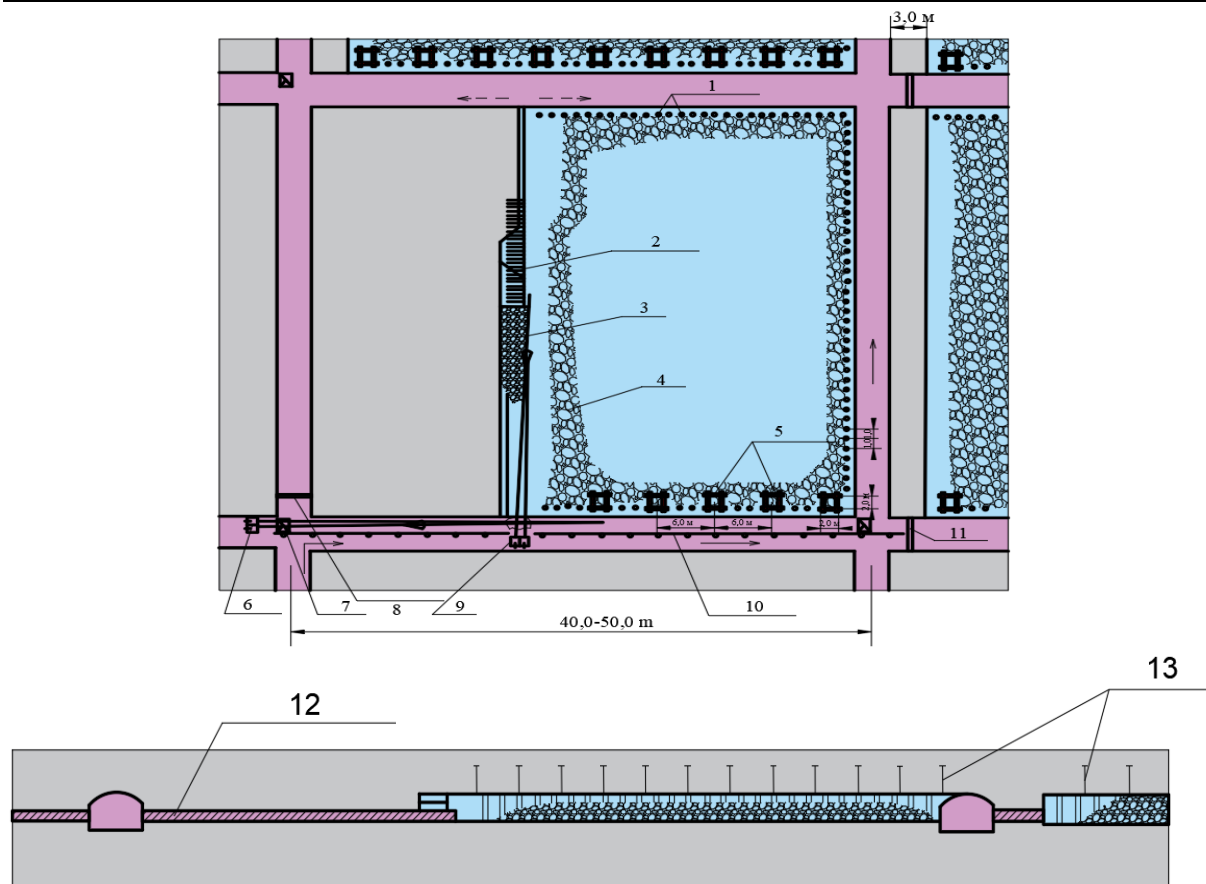


Fig. 4. Solid mining system with separate extraction of ore and rock: 1 - wooden racks; 2 - face; 3 - beaten ore; 4 - rock; 5 - fire support; 6 - scraper winch; 7 - ore intake; 8 - ventilation door; 9 - scraper winch; 10 - stitching of the running compartment; 11 - jumper; 12 - ore body; 13 - anchor support

The variant with selective extraction of ore bodies was tested on the section with the thickness from 0,3 to 1,3 m. The strike of the ore body from north to south, the dip is to the west at the angle of 23...43°. The ore is dense, finely fractured. The variant is applied for development of ore bodies with the thickness of 0,2...1,0 m with the dip angle from 0 to 40°. It provides separate breaking of host rocks and ore by hiding; when the compensation gap is formed, the rock is thrown by blast into the worked-out space, where it is left as a backfill, and the ore with minimal rock sticking is broken off on the compensation gap, delivered by scraper to the undercutting drift and along it to the ore pass. When choosing the height of the working space, the necessity of providing normal working conditions for the worker in the face and high technical and economic indicators of block development is taken into account [25, 26].

When extracting ore bodies with a thickness of 0.2...0.3 m, the height of the working space is taken to be 1.2...1.4 m, and for extracting ore bodies with a

thickness of 0.4...1.0 m, 1.8...2.0 m. To improve the quality indicators of mining, the face is given a stepped shape, which is maintained both at the stage of forming the compensation gap and at the stage of breaking the ore body, when the width of the step is minimal, but not less than the thickness of the ore body. To prevent the scattering of rock along the compensation gap when it is formed, a rock breaker is installed at a distance of up to 5-6 m from the face. The roof of the stope is supported by wooden spacers with a diameter of 0.2...0.3 m every 2.5...3.0 m or by metal rods 2.0 m long on a grid of 2.5 × 2.6 m. At the boundary of the stope and the undercut adit, as the stope works progress, fires measuring 2.0 × 2.0 m are laid out every 6.0 m. At the contact with the stope, the mine workings are supported by additional supports. In the variant of the continuous face development system, ore was extracted along the rise with subsequent expansion of the worked-out space by undermining the soil (Fig. 5).

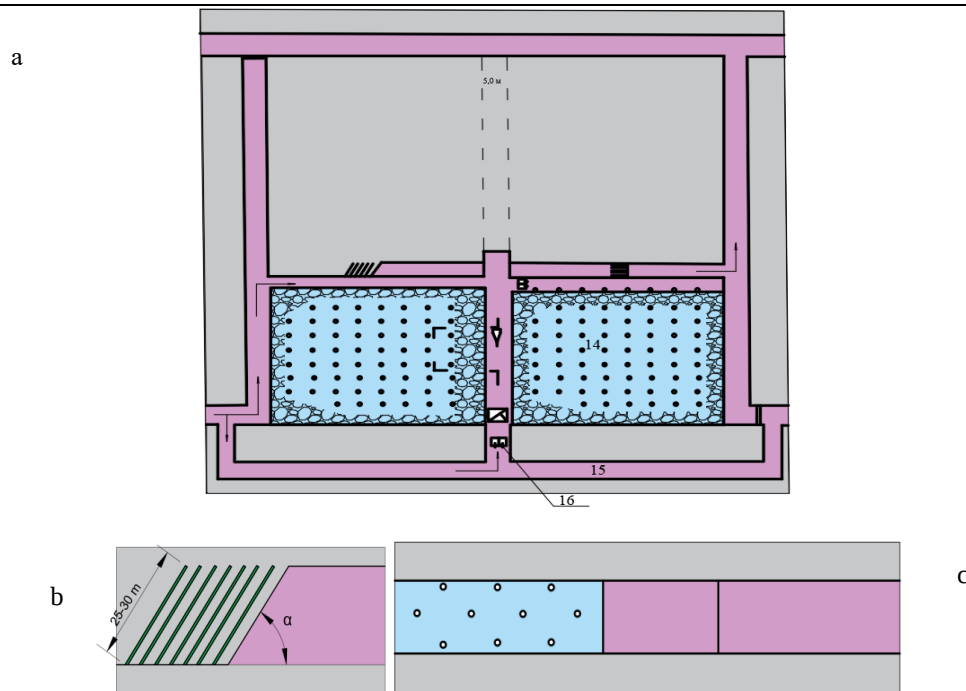


Fig. 5. Layered mining system with selective ore extraction: a - block projection on a vertical plane; b - ore stripping; c - rock blasting in the soil

To prevent ore from scattering into the mined-out space, spacer posts were installed along the cleaning belt and boards were used to line it. After breaking and removing two ore belts to a depth of 2.7 m with an extraction capacity determined by the ore body capacity, boreholes were drilled through the rock in the soil to expand the mined-out space. The broken rock, most of it, was moved into the mined-out space by the force of the blast and a scraper winch. This development system variant is used for mining ore bodies up to 1.2 m thick with a dip angle of 30° ... 60° . Ore is mined in ascending layers with selective breaking of the ore and the host rocks of the footwall. The block is prepared by driving the upper and lower horizon drifts, inclined raisers and a collector. A raiser for lifting loads is installed in the center of the block as the cleaning work progresses. An ore pass is made at the intersection of the load raiser and the ventilation drift of the lower horizon. The cleaning excavation begins with drilling the ore of the first layer above the ventilation drift.

The ore of the first layer is broken onto the ventilation drift and transferred to the ore pass. After the first layer ore is released, the rock bench of the first layer is formed. The mined-out space is fenced with wooden shields.

The ore of the second layer is broken onto the rock bench of the first layer and delivered by a scraper to the cargo raise. After the ore is released, the fence of the mined-out space is removed and the first bench of the second layer is formed. The rock is broken onto the mined-out space and used to fill technological voids. The ore is broken into boreholes 2.5...3.0 m long with an inclination towards the cleaning space of 55° ... 60° .

The rock bench is formed by blasting explosives in boreholes 1.8...2.5 m long drilled by telescopic perforators, located parallel to the cleaning space.

The bench width is selected equal to 1.5...2.5 m, the distance from the bench soil to the roof of the working space does not exceed 3 m. After the bench is formed, support posts with a diameter of 16...18 m are installed along the boundary of the bench with the mined-out space every 1.5...3.0 m, on which shields are attached, preventing the broken ore of the next layer from getting into the mined-out space. After unloading the broken ore in the layer, the shields are removed for use in the next layer, and the posts remain as a safety support.

To reduce ore losses on the bench soil, it is cleaned. As the block is mined, the sides of the ventilation and cargo risers are secured and lined with wood from the side of the working space. To improve the ventilation parameters, the lining is compacted with film or fabric. Ore is mined in ascending layers with selective breaking of the ore and host rocks of the footwall [27, 28].

3.2. Economic efficiency. Economic comparison of development technologies is carried out on the basis of an economic and mathematical model by comparing the values of the optimum points for the target functions and selecting the values of the parameters corresponding to the optimum point for the final product, taking into account the metal extraction according to the Golik-Lyashenko model [21]. The main indicators for cleaning extraction are adopted according to the data of reports and projects for deposit development:

$$\begin{aligned} \Pi_{\text{vTT}} = & \left[3_{\text{To}} \left(1 - \frac{Q'_n + Q'_g}{Q_6} \right) + \frac{3_{3K}}{\rho} \left(1 + \frac{Q''_n + Q'_n}{Q_6} \right) + 3_{\text{Th}} \frac{Q'_n + Q''_n}{Q_6} + 3_{\text{Tn}} \frac{Q'_n + Q''_n}{Q_6} \right] - \\ & - \Delta\gamma_T \Pi_{\text{T60T}} - \frac{R_s}{(1 - R_s)P} \left[\left(3_{\text{To}} + \frac{3_{3K}}{\rho} \right) + (1 - \Delta\gamma_T) Y_{\text{TRS}} \right] - \frac{1 - P}{P} \times \\ & \times \left[3_{\text{T6n}} - B \left(3_{\text{To}} + \frac{3_{3K}}{S} \right) \right] + \frac{(1 - P)(1 - B)(1 - \epsilon)}{P} (1 - \Delta\gamma_T) Y_{\text{TRP}}, \end{aligned} \quad (6)$$

Where Π_{T60T} – value of extracted balance ore, rub.; Π_{T60n} – value of lost ore with metal content αT , rub.; 3_{To} , 3_{Th} , 3_{Tn} , 3_{3K} – costs for breaking, releasing and transporting ore, for cutting, mining preparation and stowage work, respectively, rub.; Q_6 , Q_n , Q'_n , Q''_n – volumes of ore, rock and off-balance ore within the boundaries of the ore body, as well as cutting and mining preparatory work on ore and rock, respectively, m³; ρ – ore density, t/m³; 3_{T60n} – costs of extraction of balance ore, rub.; R_s – ore dilution, i.e.; P – ore losses, etc.; B – amount of diluting rocks, t; ϵ – metal content in diluting rocks, fractions of units.

The technical and economic indicators of mining with selective extraction of the ore body and the expected indicators of block mining with gross extraction of ore and rock at an extraction thickness of 1.2...1.3 m are presented in Table 2.

The efficiency of mining production can be determined by comparing the options for developing deposits (including man-made ones) taking into account the costs at all stages. In this case, it is necessary to take into account the costs of protecting the population (including the costs of environmental protection, rehabilitation of contaminated and disturbed areas, human health, etc.) living in the zone of influence of mining facilities according to the proposed analytical model:

$$\Pi = \sum_{i=1}^n \left[\left(U_{AP} - C_{AP} \pm (Y + Z_{\mu}) \right) \right] \frac{1}{1 + E^{t-1}} \cong \max, \quad (7)$$

Where Π – profit from obtaining final products from metal-containing ores, monetary units;

U_{op} – total extractable value of the final product from metal-containing ores, monetary units;

C_{op} – total costs of extraction and obtaining final products, monetary units;

V – total damage (economic consequences) caused (-) to the environment or prevented (+) taking into account the costs of protecting the population living in the zone of influence of mining enterprises (3μ), monetary units;

E – cost and profit discount factor over time t of application of the technology being evaluated, units.

Table 2.

Indicators of solid system development

Indicators	Recess option	
	Selective	Gross
Angle of incidence, degree	31	31
Ore Square, m ²	1024	1024
Ore body capacity, m	0,04	0,64
Balance sheet stocks, m ³	650	650
Area of recaptured ores, m ²	1024	1024
Dredging ore capacity, m	0,86	1,20
Height of the cleaning space, m	2,0	1,25
Recaptured ore mass, m ³	081	1280
Repulsed rocks for expansion, m ³	1167	-
Ore content before sorting, %	60	51
Commercial ore after sorting, m ³	677	740
Output of off-balance sheet ore, m ³	198	490
Metal content in commercial ore, %	66	55
Dilution in commercial ore, %	40	45
Dilution of the breed from the outside, %	25,6	40,0
Dilution by the breed in the block, %	3,3	45,0
Total metal losses, %	13,2	37,0
Metal losses in off-balance sheet ore, %	9,8	34,0
Metal loss in voids, %	3,4	3,0
Productivity of the downhole worker, m ³ /person cm	3,2	4,0

The obtained results correspond with the conclusions of specialists in this area of mining in Ukraine, the Republic of Kazakhstan, Canada and other developed mining countries of the world [29, 30]. The research results are of interest to related industries of the mining industry, in particular, ferrous metallurgy [31, 32].

Further research. As an alternative to the trend of developing mining production by intensifying underground mining of deposits with an increase in the size of ore fields and the use of high-performance equipment, there remains the direction of increasing the efficiency of mining by reducing the amount of ore dilution by implementing reserves in the organization of work during the extraction and processing of ores.

In our opinion, the following new scientific and methodological provisions:

Since the middle of the last century, the practice of mining ores with backfilling of mined-out spaces with hardening mixtures of various compositions and strengths has been improved. The correlation of ore dilution by backfilling on the parameters of breaking has been determined, the direction of reducing dilution by activating and coarsening the components of the mixture has been substantiated, methods for optimizing the compositions of hardening mixtures in activators have been developed, increasing the indicators of the completeness of subsoil use and the quality of the mined ore [33].

Observations of the state of the rock mass indicate an insignificant increase in deformations and stresses during the first three months of mining operations. Stresses in the rock mass increase more slowly than in the ore. Upon completion of mining operations, stresses and deformations in the massif stabilize. The area where the preparatory and production works junction occurs is characterized by the formation of a weakened rock zone with the following dimensions:

- length, depending on the angle of inclination of the thick ore body and the location of tectonic structures, approximately 30 m or more in the footwall and about 10 m in the hanging wall;
- width: when mining across the strike of the ore body - the width of the stope section, when mining along the strike - the extracted thickness of the ore body;
- height: the vertical distance to the boundaries of the forming arch of natural rock equilibrium.

Rock collapse within the junction zone can be prevented by supporting the workings, the parameters of which are determined by the interaction of the rocks within the arch:

- if the thrust force of the jammed rocks in the roof of the working is sufficient, lightweight support can be used;
- if the thrust force is insufficient, the support of the workings must be calculated based on the condition of maintaining a column of rocks up to the daylight surface or the formation of a new arch of natural equilibrium. The possibility of increasing the quality of mineral resources, mining and environmental safety of the development of gently dipping thin ore deposits by reducing the amount of ore dilution is confirmed by an industrial experiment using reliable geological and

mine surveying control. Of interest is also the introduction of engineering forecasting using special programs such as Edu Net (Phoenix Contact), Power Chute Network Shutdown (PCNS) and Network Management Card (NMC) (Schneider Electric), SITRAIN (Siemens), GIS K-MINE® ("KAI Scientific and Industrial Enterprise" LLC, Ukraine), VENTSIM and others for the training of mining engineers [34].

The prospects for the use of continuous development with gross ore extraction are confirmed by the results of dilution in the variants of continuous development by rise with selective and gross extraction of ore and rock. Variants of two-stage selective development with breaking from boreholes can be an alternative to gross extraction and can be in demand at enterprises in various industries, including mining and metallurgy [35].

4. Conclusions.

It was found that deformations in the lining are activated after 3 months, steadily maintaining the trend of increase with time. Deformations increase starting from the 4th - 6th month and reach a maximum after 11 - 12 months. The distribution of the main stresses with all the spread of values obeys the general pattern and the curves of the graph are close in shape. It was determined that the development of deformations is not monotonous. The greatest deformation of frame No. 11 was 19 mm, reflecting the influence of the fault. It is shown that the increase in load in the stress concentration zone is 15-20% of the gravitational component, or 39 MPa, which is less than the compressive strength of rocks - 54-75 MPa.

4.1. Prospective studies. Further studies aimed at establishing the patterns of development of the massif's SSS in the zone of its weakening (geomechanical monitoring) are recommended. This will allow adjusting the development parameters with the receipt of an economic effect due to the reduction of ore dilution, while ensuring the improvement of mining and environmental safety, as well as the labor of underground workers.

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APPLICATION OF IMPRECISE MODELS IN ANALYSIS OF RISK MANAGEMENT OF SOFTWARE SYSTEMS**Alexeiev O.***Private aviation expert**Kamenna 8435/14D, Zilina, 01001, Slovakia*<https://doi.org/10.5281/zenodo.14236039>**Abstract**

The analysis of functional completeness for existing detection systems was conducted. It made it possible to define information systems with a similar feature set, to assess the degree of similarity and the matching degree of the means from the "standard" model of risk management system, that considers the recommended ICAO practices and standards on aviation safety, to justify the advisability of decision-making support system creation, using imprecise model and imprecise logic for risk analysis at aviation activities.

Keywords: risks, decision making, Bayesian networks, risk factors, cause-and-effect relationships.

1. Introduction

A decision maker usually assesses the situation in a limited and imprecise information environment, and implementation processes are characterized by uncertainty, which significantly affects the quality of the decisions that are made. The reliability increasing of such decisions can be achieved by creating a methodology that considers this uncertainty. The probabilistic approach is based on statistical processing, the evaluation of which is insufficient due to insufficient sample size. It is known that the minimising approach allows decisions to be made based on the best/worst integral assessments that is inefficient, the expert methods are difficult to apply at the operational assessment of uncertainty and risks; in addition, it is difficult to combine quantitative and qualitative factors in one model.

The imprecise math machine usage is an option in those cases, where classical methods do not give an appropriate result, and allow doing formalization and transformation of quantitative and qualitative imprecise concepts. Imprecise models [1] have a number of features regarding the possibility of taking into account the experts' intuition and experience, the possibility of more adequate flight safety management processes modelling and obtaining the accurate decisions that correlate with the initial data; support for the rapid development of a safety management system with its further functionality complexity increase; their hardware and software implementation in control systems and decision making is less sophisticated in comparison with classical algorithms.

2. Analysis of recent research and publications.

Various aspects of risk management in socio-economic systems are considered in [8-10], on these studies the nature of risks appearance is investigated, their classification and various methods of qualitative and quantitative assessment, proposed recommendations on

the of risk management and decision-making conduction under conditions of uncertainty. There are approaches described for economic and mathematical methods usage at different stages of risk management in studies [11-12].

Analysis of current scientific studies represented that assessments of the risks is most commonly used with statistical techniques today, including Bayesian networks, which are effective graphical tools for representation of cause-and-effect relationships between multiple variables. At the same time, existing and applied in practice methods and tools of risk management does not fully allow to record different types of information uncertainties and to analyse quantitative and qualitative risk specialties and, consequently, to assess and to manage risk, taking the enterprise state and characteristics of internal and external environment into account.

3. Formulating of the article purpose.

To develop risk management tools that arise in the process of aviation activity, for analysis and assessment of these risks, using a combination of Bayesian imprecise models to determine the possibility of occurrence of undesirable events of various types and imprecise-logic procedures, to predict the risks damage to enhance the validity of managerial decisions to ensure a guaranteed level of safety.

4. Main body.

Systems that are based on imprecise logic link the dynamic processes between input and output by a set of imprecise rules, using linguistic variables, instead of complicated dynamic models. The figure 1 shows the overall structure of the imprecise model of decision-making.

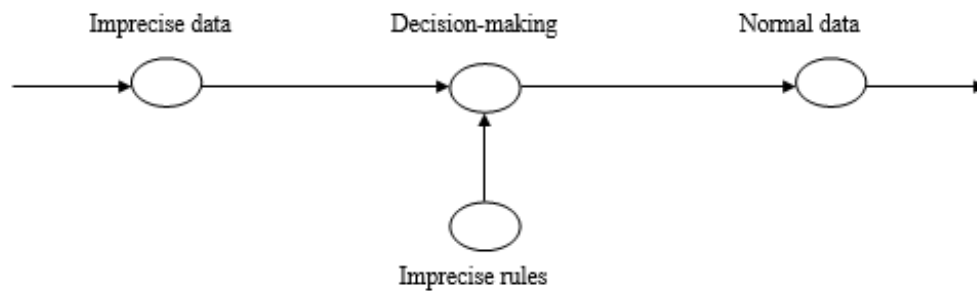


Figure 1 – Imprecise decision-making model graph

The principle of the linguistic approach applying at decision-making in the process of analysis and management of flights safety is carried out by the terms "low risk", "permissible risk" and "high risk", however, it is difficult for the person making the decision to give an objective evaluation and to describe it using a mathematical language. The application of methods, imprecise logic models for risk assessments obtaining allows getting the comprehensive accounting of various factors, and there is a possibility for constructing models of subject areas that are characterized by uncertainty

using imprecise numbers, plural and linguistic variables [2].

Automation of identification processes, qualitative and quantitative risks analysis through the support system for decision-making on safety management, significantly improves the efficiency of the decision maker.

Figure 2 shows the functional requirements of the "standard" model of the RMSS risks management, which integrates the accounting of qualitative and quantitative factors in risk assessment [5].

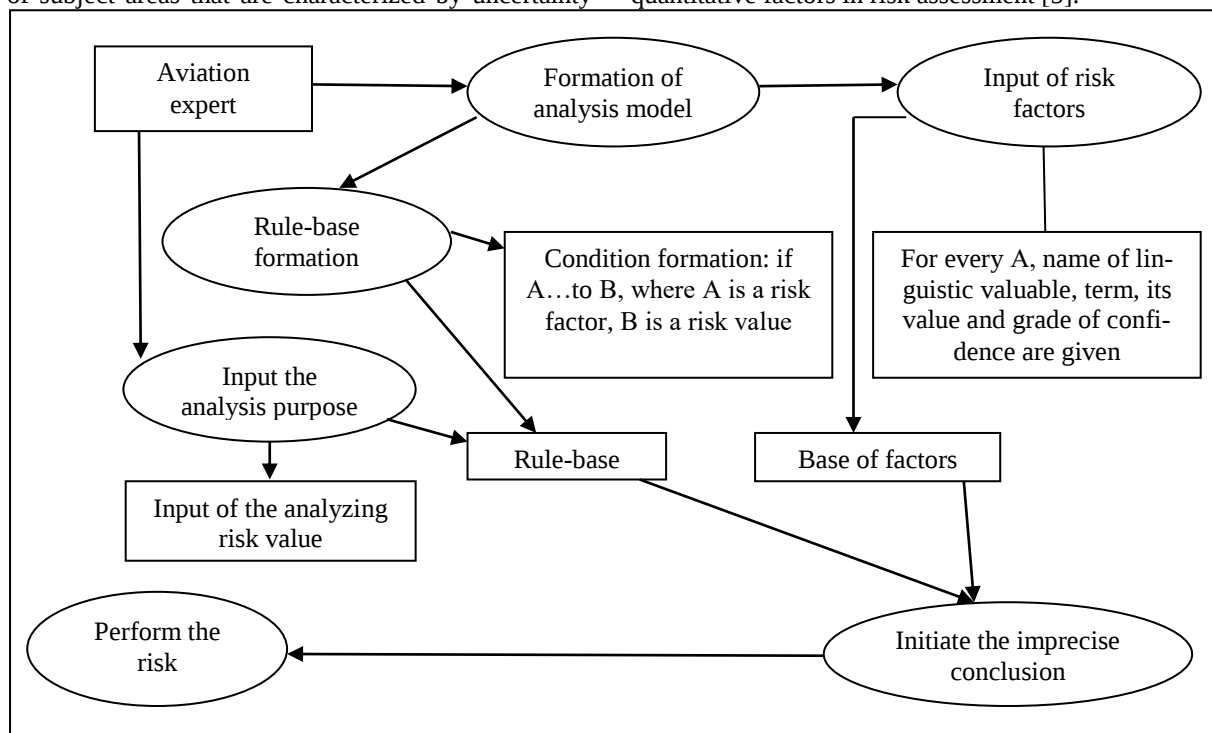


Fig.2. Functional requirements to «Standard» RMSS model

Development of the high quality RMSS depends on the structural decisions taken in the design process [3,4,5,6].

Figure 3 represents the general scheme on the RMSS structure.

The decision maker, in the process of risk analysis, takes the option of using "Forming Analysis Model", which includes the option of using «Input of risk factors» and "Formation of the rule-base". Next sends a message that activates the use of the Input the analysis purpose. The chosen purpose of the analysis indicates which input risk factors and the manager to implement imprecise modelling must fill in the rule-base. A work

area that consists of rule-bases and fact databases, determines whether it is possible to execute the "Initiate Imprecise Conclusion" option, which calculates the appropriacy of the function for the output linguistic variable that characterizes the risk parameter. At the final stage, the decision maker uses "Perform a risk assessment", which, in its turn, causes the use of the "Initiate Imprecise Conclusion".

The interface management system provides a simple communication between the user, the subsystem of

data and the subsystem of models, and provides conduction of problem analysis and modelling for assistance in making management decisions [7].

Application of the specified method in the tasks of choosing a support system for decision-making on risk management will allow: to highlight the main functions of information systems; to determine groups of similar systems; to rank systems according to functional completeness; to determine systems that outperform others; to compare systems with the requirements of the "standard" model of RMSS.

Let us take $S = \{S_i\}$, ($i = 1, n$) to implement various analysed IS risks assessments –

«Systems-expectants».

Let us define the set that makes up the vocabulary of functions implemented by the IS, in the following form

$$F = \{F_j\}, (j = 1, m)$$

The total number of analysed functions (Table 2) for the IS was - 35, i.e.; $j = 35$.

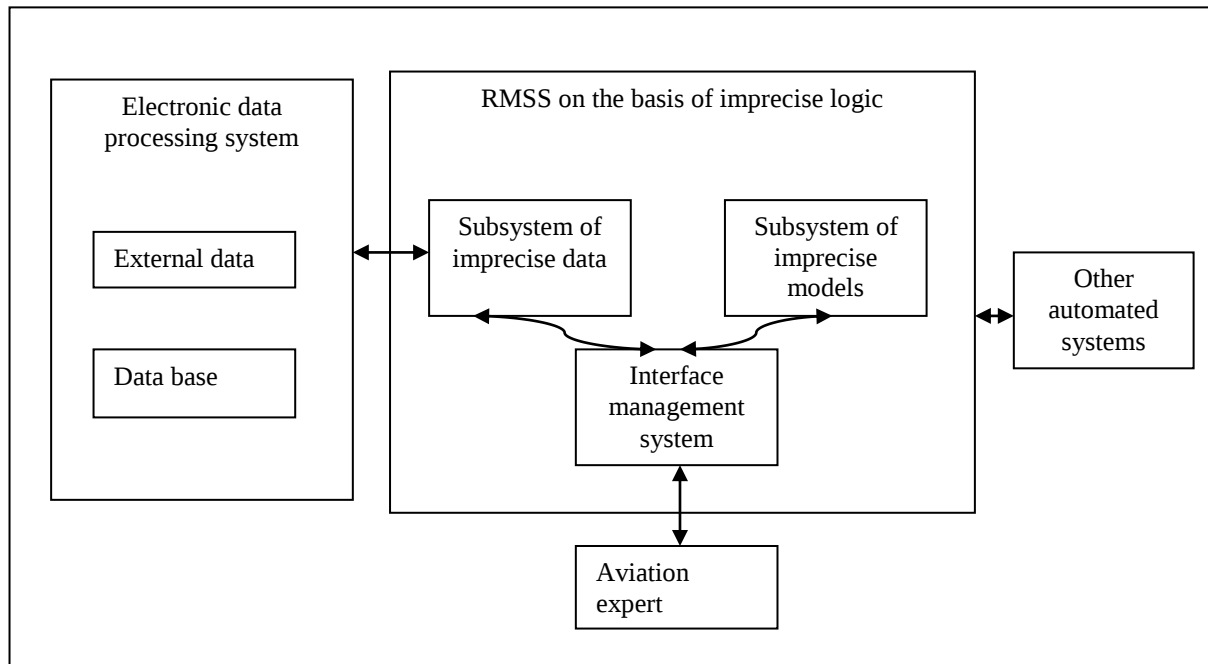


Fig.3. General scheme on RMSS structure

Table 2

Analysed IS functions

Code Function name	
Group of functions «Risk management at aviation activity»	
F1	Support of users' mode
F2	New project design
F3	Set project properties
F4	Export/Results saving
F5	Import/Results downloading
Group of functions «Risk management»	
F6	Risks adding
F7	Risks editing
F8	Risks deleting
F9	Designing of rule-base for risks model
F10	Identification of risks
F11	Risks volume editing
F12	Choice of risks influence domain
F13	Help with risks form fulfilling
F14	Control parameters of risks identification
F15	Risks description
F16	Choice of risks factors
F17	Choice of analysed groups of risks
F18	Qualitative assessment
F19	Quantitative assessment
F20	Integral qualitative and quantitative assessment
F21	Choice of editing method at database support
F22	Accounting of completed projects
F23	Support of different types distribution

F24	Reference to additional sources of risks occurrence
F25	Addition of comments to the give type of risk
Group of functions «Accounting»	
F26	Printing of report
F27	Saving of report
F28	Publication in HTML form
F29	Displaying of the analysis results for the entire observation time
Group of functions «Additional possibilities»	
F30	Risks functions graphical form
F31	Client-server support
F32	Web-access to data
F33	Support OLE
F34	Access to methodologies and databases assignments
F35	Assignment of database right

Then, let us represent information in the form of a matrix X (Table 3), elements of which were determined

in the following way: $x_{ij} = 1$, if j-function is implemented i-m PC $x_{ij} = 0$, if it is not implemented.

Table 1.5

Matrix X elements

Code	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
F1	0	1	1	1	1	1	0	1	1	0
F2	1	1	0	1	1	1	1	1	1	1
F3	1	0	1	0	0	1	1	1	1	1
F4	1	1	0	1	1	1	1	1	1	1
F5	1	1	0	1	1	1	1	1	1	1
F6	1	1	1	1	1	1	1	1	1	1
F7	1	1	0	1	1	0	1	1	1	1
F8	1	1	0	1	1	0	1	1	1	1
F9	0	0	0	0	0	0	0	0	0	1
F10	1	1	0	1	0	0	0	1	1	1
F11	1	0	0	1	0	0	0	1	1	1
F12	1	1	0	1	1	1	1	1	1	0
F13	0	0	0	0	1	0	0	0	1	0
F14	0	1	0	1	1	1	1	1	0	0
F15	0	1	0	1	1	1	1	1	1	1
F16	0	1	0	1	1	1	1	1	1	1
F17	0	1	0	0	0	1	1	0	1	1
F18	1	1	1	1	1	1	1	0	0	0
F19	1	1	1	1	1	1	0	1	1	0
F20	0	0	0	0	0	0	0	0	0	1
F21	1	1	0	1	1	1	1	1	1	1
F22	1	1	0	0	1	1	1	1	1	0
F23	1	1	1	0	0	0	0	1	0	0
F24	1	0	1	0	0	0	1	0	0	0
F25	1	0	1	0	1	1	1	1	0	1
F26	1	1	1	1	1	1	0	1	1	1
F27	0	1	1	1	1	1	0	1	0	1
F28	0	1	1	1	0	1	1	1	0	0
F29	0	0	0	1	1	0	0	1	0	1
F30	1	1	1	1	0	1	1	1	1	1
F31	0	1	1	1	1	1	1	1	1	0
F32	0	0	1	1	0	0	0	1	0	0
F33	1	1	1	0	1	0	0	1	1	1
F34	1	0	0	1	0	1	1	1	0	0
F35	0	1	1	1	1	1	0	1	1	0

To determine the absolute estimate of superiority functions AESF of one system over another, the matrix has been made $P^{10} = \|P_{ik}^{10}\|$, where elements P_{ik}^{10} correspond to the number of functions, conducted by system S_i but not used in the system S_k ,

where $i, k = 1, n$. Element P_{ik}^{10} is the capacity of difference of sets Z_i and Z_k , i.e. $P_{ik}^{10} = |F_i / F_k|$. Matrix $P^{10} = \|P_{ik}^{10}\|$ AESF of one system over another is given in the table 1.6.

Table 1.6

Matric of the absolute functional superiority

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S1	0	9	6	10	9	9	6	10	7	7
S2	5	0	4	4	3	3	3	6	3	6
S3	11	13	0	14	13	11	11	15	14	14
S4	6	4	5	0	4	4	4	5	5	6
S5	7	5	6	6	0	5	5	8	5	7
S6	7	5	4	6	5	0	3	8	6	8
S7	9	10	9	11	10	8	0	14	11	11
S8	2	2	2	1	2	2	3	0	2	3
S9	5	5	7	7	5	6	6	8	0	5
S10	7	10	9	10	9	10	8	11	7	0

Relative estimate of the system S_k absorption range regarding system S_i was found by means of the matrix $h = \|h_{ik}\|$, which elements h_{ik} were determined in the following way:

$$h_{ik} = \frac{P_{ik}^{11}}{P_{ik}^{10} + P_{ik}^{10}}, (0 \leq h_{ik} \leq 1)$$

Matrix $H = \|h_{ik}\|$ that gives characteristics to the relative correlation of the programming tools (table 1.7) in the part of duplicated functions there

Table 1.7

Matrix of the relative correlation of programming tools

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S1	1	0,762	0,476	0,714	0,667	0,667	0,571	0,905	0,762	0,667
S2	0,640	1	0,480	0,840	0,800	0,800	0,600	0,920	0,800	0,600
S3	0,625	0,750	1	0,688	0,625	0,750	0,438	0,875	0,563	0,438
S4	0,600	0,840	0,440	1	0,760	0,760	0,560	0,960	0,720	0,600
S5	0,609	0,870	0,435	0,826	1	0,783	0,565	0,913	0,783	0,609
S6	0,609	0,870	0,522	0,826	0,783	1	0,652	0,913	0,739	0,565
S7	0,667	0,833	0,389	0,778	0,722	0,833	1	0,833	0,667	0,556
S8	0,655	0,793	0,483	0,828	0,724	0,724	0,517	1	0,724	0,621
S9	0,696	0,870	0,391	0,783	0,783	0,739	0,522	0,913	1	0,696
S10	0,667	0,714	0,333	0,714	0,667	0,619	0,476	0,857	0,762	1

Relative esteem of the similarity degree of systems S_i and S_k is described with the matrix $G = \|g_{ik}\|$ elements of which g_{ik} are determined as:

$$g_{ik} = \frac{P_{ik}^{11}}{P_{ik}^{00}}, (0 \leq g_{ik} \leq 1)$$

Matrix $G = \|g_{ik}\|$ represents relative correlations of the program environment is given in the table

Relative esteem of the similarity degree of systems S_i and S_k is described with the matrix $G = \|g_{ik}\|$ elements of which $\|g_{ik}\|$ are determined as:

$$g_{ik} = \frac{p_{ik}^{11}}{p_{ik}^{00}}, (0 \leq g_{ik} \leq 1$$

Matrix $G = \|g_{ik}\|$ represents relative correlations of the program environment is given in the table 1.8.

Table 1.8

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S1	1	0,533	0,370	0,484	0,467	0,467	0,444	0,613	0,571	0,500
S2	0,533	1	0,414	0,724	0,714	0,714	0,536	0,742	0,714	0,484
S3	0,370	0,414	1	0,367	0,345	0,444	0,259	0,452	0,300	0,233
S4	0,484	0,724	0,367	1	0,655	0,655	0,483	0,800	0,600	0,484
S5	0,467	0,714	0,345	0,655	1	0,643	0,464	0,677	0,643	0,467
S6	0,467	0,714	0,444	0,655	0,643	1	0,577	0,677	0,586	0,419
S7	0,444	0,536	0,259	0,483	0,464	0,577	1	0,469	0,414	0,345
S8	0,613	0,742	0,452	0,800	0,677	0,677	0,469	1	0,677	0,563
S9	0,571	0,714	0,300	0,600	0,643	0,586	0,414	0,677	1	0,571
S10	0,500	0,484	0,233	0,484	0,467	0,419	0,345	0,563	0,571	1

Then we build logical matrices of superiority $P_o = \|p_{ik}^o\|$, of similarity $G_o = \|g_{ik}^o\|$ and of exception $H_o = \|h_{ik}^o\|$ on the basis of matrices P , H and G . Elements of matrices P_o are calculated according to the following formula:

$$p_{ik}^o = \begin{cases} 1, & \text{if } (p_{ik} \leq \varepsilon_p) \cap (i \neq k) \\ 0, & \text{if } p_{ik} < \varepsilon_p \cup (i = k) \end{cases}$$

Elements of matrix H_o :

$$h_{ik}^o = \begin{cases} 1, & \text{if } (h_{ik} \leq \varepsilon_h) \cap (i \neq k) \\ 0, & \text{if } h_{ik} < \varepsilon_h \cup (i = k) \end{cases}$$

Elements of matrix G_o ::

$$g_{ik}^o = \begin{cases} 1, & \text{if } (g_{ik} \leq \varepsilon_g) \cap (i \neq k) \\ 0, & \text{if } g_{ik} < \varepsilon_g \cup (i = k) \end{cases}$$

Where, $\varepsilon_p, \varepsilon_h, \varepsilon_g$ liminal values of superiority P_o, H_o, G_o

The logical matrix of superiority $P_o = \|p_{ik}^o\|$ for liminal value $\varepsilon_p = 10$ is shown in the table

Logical matrix of superiority

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S1	0	1	1	1	1	1	1	1	1	1
S2	1	0	1	1	1	1	1	1	1	1
S3	0	0	0	0	0	0	0	0	0	0
S4	1	1	1	0	1	1	1	1	1	1
S5	1	1	1	1	0	1	1	1	1	1
S6	1	1	1	1	1	0	1	1	1	1
S7	1	1	1	0	1	1	0	0	0	0
S8	1	1	1	1	1	1	1	0	1	1
S9	1	1	1	1	1	1	1	1	0	1
S10	1	1	1	1	1	1	1	0	1	0

Logical matrix of similarity $G_o = \|g_{ik}^o\|$ for liminal value $\varepsilon_g = 0,5$ is given in the table 1.10.

Table1.10

Logical matrix of similarity

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S1	0	1	0	0	0	0	0	1	1	1
S2	1	0	0	1	1	1	1	1	1	0
S3	0	0	0	0	0	0	0	0	0	0
S4	0	1	0	0	1	1	0	1	1	0
S5	0	1	0	1	0	1	0	1	1	0
S6	0	1	0	1	1	0	1	1	1	0
S7	0	1	0	0	0	1	0	0	0	0
S8	1	1	0	1	1	1	0	0	1	1
S9	1	1	0	1	1	1	0	1	0	1
S10	1	0	0	0	0	0	0	1	1	0

Logical matrix of functionality for information systems exception $H_o = \|h_{ik}^o\|$ for the level $\varepsilon_g = 0,8$ is given in the table 1.11.

Table 1.11

Logical matrix of functionality for information systems exception

	S1I	S2	S3	S4	S5	S6	S7	S8	S9	SIO
S1	0	0	0	0	0	0	0	1	0	0
S2	0	0	0	1	1	1	0	1	1	0
S3	0	0	0	0	0	0	0	1	0	0
S4	0	1	0	0	0	0	0	1	0	0
S5	0	1	0	1	0	0	0	1	0	0
S6	0	1	0	1	0	0	0	1	0	0
S7	0	1	0	0	0	1	0	1	0	0
S8	0	0	0	1	0	0	0	0	0	0
S9	0	1	0	0	0	0	0	1	0	0
S10	0	0	0	0	0	0	0	1	0	0

On the basis of logic matrix of exception $P_o = \|p_{ik}^o\|$, of similarity $G_o = \|g_{ik}^o\|$ and exception $H_o = \|h_{ik}^o\|$ the graphs of advantage (fig. 4), similarity (fig. 5) and exception (fig. 1.6) of the system.

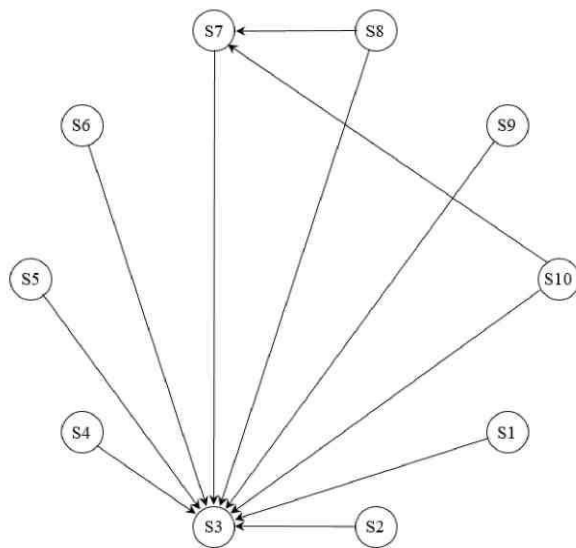


Fig. 4 - Graph of system advantage at = 10

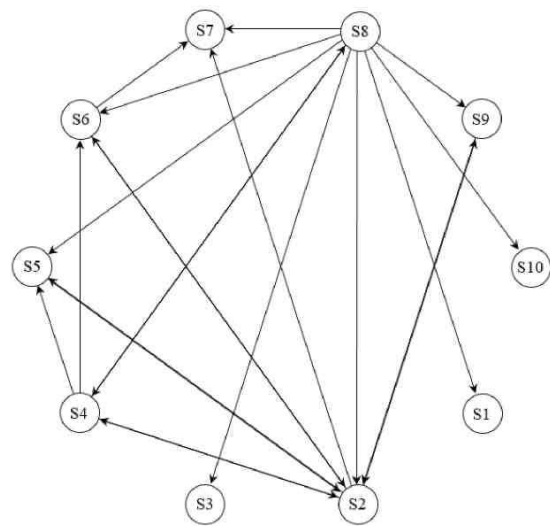


Fig.5 - Graph of system similarity at = 0,6:

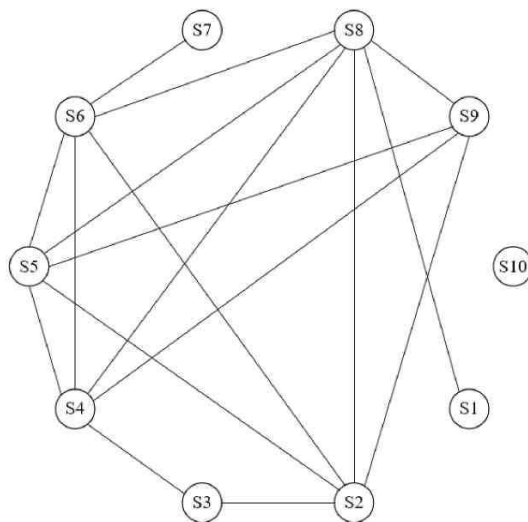


Fig. 1.6 - Graph of system exception at = 0,8

5. Conclusions.

All the systems take an advantage over S3, but systems S8 and S10 have also an advantage over the system S7. Practically all systems have similar functions with S2, S8 and S9, and the lack of connections with S10 can be explained by the presence of unique risk assessment functions; S2 is absorbed by many systems, but in some cases, there is a mutual absorption present, and S8 absorbs all of them.

According to everything written above, one can say that to increase the effectiveness of risk management we need of risk management formalization and automation at different stages. Such a task can be solved by developing a support system for risk management decision. RMSS should be based on modern methods of information processing at conditions of material uncertainty and allow to conduct risk analysis, production, evaluation and effective decision-making. To provide this, the system should use models that integrate qualitative and quantitative factors that determine aviation risks at any stage of the activity.

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