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URBAN SQUARE IMPROVEMENT WITHIN THE FRAMEWORK OF THE GREEN INFRASTRUCTURE DEVELOPMENT CONCEPT OF THE IVANO-FRANKIVSK URBAN TERRITORIAL COMMUNITY

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БЛАГОУСТРІЙ СКВЕРІВ У РАМКАХ КОНЦЕПЦІЇ РОЗВИТКУ ЗЕЛЕНОЇ ІНФРАСТРУКТУРИ ІВАНО-ФРАНКІВСЬКОЇ МІСЬКОЇ ТЕРИТОРІАЛЬНОЇ ГРОМАДИ

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Abstract

The article examines contemporary approaches to the improvement of urban squares as components of the green infrastructure of territorial communities, using the Ivano-Frankivsk Urban Territorial Community as a case study. The relevance of the transition from traditional landscaping to the systematic management of green infrastructure is substantiated, as such an approach ensures the fulfilment of environmental, social, urban-planning, and climate-adaptation functions within the urban environment. The provisions of the Green Infrastructure Development Concept of the Ivano-Frankivsk Urban Territorial Community until 2035 are analysed, together with current scientific approaches to the organisation of public green spaces and Ukrainian and international practices of urban-square development.

The study employs systemic, comparative, urban-planning, and regulatory analysis, as well as methods for synthesising contemporary scientific sources and strategic documents in the field of spatial development. The principal concepts of modern urban-square improvement are identified. Priority is given to the creation of a barrier-free environment, the provision of pedestrian accessibility, biodiversity conservation, the implementation of nature-based solutions, the use of rain gardens and permeable surfaces, the introduction of locally adapted plant species, and the application of digital tools for the management of green spaces.

It is established that the development of an interconnected network of urban squares should be regarded as one of the key elements in implementing the Green Infrastructure Development Concept of the Ivano-Frankivsk Urban Territorial Community. This network should contribute to improving the environmental resilience of the urban environment, adapting the city to climate change, enhancing the quality of public spaces, and ensuring comfortable living conditions for the population. The main directions for improving urban squares are proposed, including the integration of local green spaces into a unified green-blue infrastructure system of the community, the development of ecological corridors, the creation of pocket parks, the application of contemporary principles of landscape architecture, and the digital monitoring of the condition of green spaces.

The practical significance of the obtained results lies in their potential application in the preparation of urban-planning documentation, municipal improvement programmes, projects for the reconstruction of existing squares and the creation of new ones, as well as in the implementation of strategic development documents of the Ivano-Frankivsk Urban Territorial Community.

Анотація

У статті досліджено сучасні підходи до благоустрою міських скверів як складових зеленої інфраструктури територіальних громад на прикладі Івано-Франківської міської територіальної громади. Обґрунтовано актуальність переходу від традиційного озеленення до системного управління зеленою інфраструктурою, що забезпечує виконання екологічних, соціальних, містобудівних та кліматоадаптаційних функцій міського середовища. Проаналізовано положення Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року, сучасні наукові підходи до організації громадських зелених просторів, а також вітчизняний і зарубіжний досвід формування скверів.

Дослідження виконано із застосуванням системного, порівняльного, містобудівного та нормативного аналізу, а також методів узагальнення сучасних наукових джерел і стратегічних документів у сфері просторового розвитку. Визначено основні принципи сучасного благоустрою скверів, серед яких пріоритетними є формування безбар'єрного середовища, забезпечення пішохідної доступності, збереження біорізноманіття, впровадження природоорієнтованих рішень, використання дощових садів, водопоглинаючих покриттів, локальних видів рослинності та цифрових інструментів управління зеленими насадженнями.

Встановлено, що розвиток мережі скверів необхідно розглядати як один із ключових елементів реалізації Концепції розвитку зеленої інфраструктури Івано-Франківської МТГ, спрямованої на підвищення екологічної стійкості міського середовища, адаптацію до змін клімату, покращення якості громадських

просторів та забезпечення комфортних умов проживання населення. Запропоновано основні напрями удосконалення благоустрою скверів, що передбачають інтеграцію локальних зелених просторів у єдину систему зелено-блакитної інфраструктури громади, розвиток екологічних коридорів, створення кишень-кових парків, застосування сучасних принципів ландшафтно́ї архітектури та цифрового моніторингу стану зелених насаджень.

Практичне значення отриманих результатів полягає у можливості їх використання під час розроблення містобудівної документації, програм благоустрою, проєктів реконструкції існуючих і створення нових скверів, а також реалізації стратегічних документів розвитку Івано-Франківської міської територіальної громади.

Keywords: green infrastructure; urban improvement; urban square; public space; landscape architecture; ecosystem services; nature-based solutions; sustainable development; Ivano-Frankivsk Urban Territorial Community; climate change adaptation.

Ключові слова: зелена інфраструктура; благоустрій; сквер; громадський простір; ландшафтна архітектура; екосистемні послуги; природоорієнтовані рішення; сталий розвиток; Івано-Франківська міська територіальна громада; адаптація до змін клімату.

Вступ

Сучасний етап розвитку українських міст характеризується посиленням урбанізаційного тиску, ущільненням забудови, скороченням площ озелених територій, зростанням інтенсивності транспортних потоків і підвищенням уразливості міського середовища до наслідків зміни клімату. Сукупна дія цих чинників зумовлює погіршення мікрокліматичних умов, підвищення температури в щільно забудованих районах, зниження здатності територій до природного регулювання поверхневого стоку, фрагментацію міських екосистем і нерівномірну доступність рекреаційних просторів. За таких умов благоустрій зелених територій уже не може розглядатися лише як сукупність декоративних або санітарно-технічних заходів, а має бути інтегрованою складовою просторового розвитку, кліматичної адаптації та підвищення якості життя населення.

Особливе місце у структурі міського озеленення належить скверам — відносно невеликим за площею відкритим просторам, розміщеним переважно в межах сформованої забудови та призначеним для короточасного відпочинку, транзитного руху, соціальної комунікації й покращення екологічного стану довкілля. На відміну від великих парків, сквери здатні інтегруватися у щільну міську тканину, заповнювати дефіцит локальних зелених зон і забезпечувати повсякденний контакт мешканців із природними елементами. Дослідження скверів Львова засвідчило, що значна частина таких просторів виконує одночасно транзитні та рекреаційні функції, а їх класифікація за площею, планувальною структурою, складом насаджень і функціональним призначенням є важливою передумовою ефективного управління міською зеленою зоною.

У сучасній науковій і проєктній практиці дедалі більшого поширення набуває поняття зеленої інфраструктури, під яким розуміють взаємопов'язану мережу природних, напівприродних та штучно створених зелених і блакитних просторів, що забезпечують екологічні, соціальні та економічні функції міста. Такий підхід принципово відрізняється від традиційного розуміння озеленення як локального благоустрою окремих ділянок. Зелена інфраструктура передбачає системну

взаємодію парків, скверів, бульварів, вуличного озеленення, водних об'єктів, дощових садів, зелених коридорів, приміських лісів та інших елементів, які спільно формують екологічний каркас території. У Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року наголошено, що така мережа має функціонувати як цілісна екосистема, забезпечуючи регулювання мікроклімату, очищення повітря, утримання дощових вод, підтримку біорізноманіття, рекреацію та відновлення фізичних і психологічних сил населення.

Актуальність дослідження благоустрою скверів у межах зазначеної Концепції зумовлена необхідністю переосмислення їх ролі у просторовій структурі Івано-Франківської міської територіальної громади. Івано-Франківськ є компактним обласним центром із високою інтенсивністю забудови, значним транспортним навантаженням та обмеженим резервом вільних земель у центральній і середній частинах міста. Водночас громада має розгалужену систему водних об'єктів, долин річок, міських і приміських зелених територій, що створює передумови для формування цілісної зелено-блакитної мережі. Концепція до 2035 року визначає п'ять стратегічних напрямів розвитку: удосконалення управління зеленою інфраструктурою, розвиток її мережі, належне утримання і відновлення, цифрову трансформацію, а також партнерство та просвітництво. У цьому контексті сквери можуть розглядатися як локальні вузли такої мережі, спроможні поєднувати рекреаційні, екологічні, соціальні, меморіальні та кліматотегульовальні функції.

Потреба в системному оновленні підходів до благоустрою скверів посилюється тим, що значна частина існуючих малих зелених просторів формувалася без урахування сучасних вимог до інклюзивності, біорізноманіття, адаптації до кліматичних змін, управління дощовими водами та цифрового обліку зелених насаджень. Практика благоустрою міських скверів в Україні свідчить, що їх ефективність залежить не лише від естетичних рішень, а й від якості функціонального зонування, зручності пішохідних зв'язків, стійкості рослинних композицій, водопроникності покриттів, доступ-

ності для різних груп населення та можливості довготривалого утримання. У дослідженні, виконаному на прикладі Одеси, сквери визначено як важливий інструмент підвищення якості міського середовища, здатний компенсувати дефіцит відкритих просторів, покращувати мікроклімат і підтримувати соціальну взаємодію.

Окремого значення набуває питання благоустрою скверів у період суспільних трансформацій, пов'язаних із повномасштабною війною, демографічними змінами та зростанням потреби у просторах психологічного відновлення. Сучасні сквери дедалі частіше поєднують традиційну рекреаційну функцію з меморіальною, терапевтичною, комунікативною та освітньою. Іноді створення скверу це шлях ревіталізації конфліктних або функціонально застарілих територій шляхом їх перетворення на відкриті громадські простори. Потрібно також наголосити на важливості забезпечення пішохідної доступності малих зелених зон, прозорого управління й участі громади у прийнятті проєктних рішень.

Отже, наукова проблема полягає у відсутності цілісного методичного підходу до благоустрою скверів Івано-Франківської МТГ як взаємопов'язаних елементів зеленої інфраструктури, а не як ізольованих об'єктів озеленення. Наявні дослідження здебільшого зосереджуються на окремих аспектах — класифікації скверів, їх функціональному зонуванні, дендрологічному складі, архітектурно-планувальних рішеннях або питаннях експлуатації. Водночас недостатньо опрацьованими залишаються питання їх мережевої взаємодії, просторової доступності, внеску в регулювання мікроклімату, управління дощовими водами, підтримки біорізноманіття, цифрової інвентаризації та інтеграції у стратегічні документи громади.

Метою дослідження є обґрунтування принципів і напрямів благоустрою міських скверів відповідно до положень Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року. Досягнення цієї мети передбачає аналіз теоретичних положень зеленої інфраструктури, визначення функціональної ролі скверів у структурі громади, систематизацію сучасних вимог до їх благоустрою, виявлення основних проблем існуючих малих зелених просторів і формулювання практичних рекомендацій щодо їх оновлення та інтеграції у єдину зелено-блакитну мережу.

Об'єктом дослідження є система міських скверів Івано-Франківської міської територіальної громади як складова її зеленої інфраструктури. Предмет дослідження становлять містобудівні, ландшафтно-планувальні, екологічні, функціональні та організаційні принципи благоустрою скверів відповідно до стратегічних положень Концепції до 2035 року.

Наукова новизна роботи полягає у розгляді благоустрою скверів на рівні територіальної громади як системного процесу, що поєднує просторове планування, надання екосистемних послуг, природоорієнтовані рішення, цифрове управління

зеленими насадженнями та соціальну участь. Практичне значення дослідження визначається можливістю використання його результатів під час підготовки місцевих програм благоустрою, завдань на проєктування нових і реконструкцію існуючих скверів, формування цифрового реєстру зелених насаджень, актуалізації містобудівної документації та реалізації дорожньої карти Концепції розвитку зеленої інфраструктури Івано-Франківської МТГ до 2035 року.

Аналіз останніх досліджень і публікацій

Концепція зеленої інфраструктури сформувалася на межі урбаністики, ландшафтно-архітектури, екології, просторового планування та теорії сталого розвитку. За останні три десятиліття дослідження у цій сфері еволюціонували від розгляду окремих зелених зон як елементів благоустрою до розуміння їх як взаємопов'язаної просторової системи, що забезпечує надання екосистемних послуг, підвищення стійкості міст до кліматичних змін та покращення якості життя населення. Значний внесок у формування сучасної теорії зеленої інфраструктури зробили зарубіжні дослідники Jan Gehl, Timothy Beatley, Peter Newman, Ian McHarg, Mark Benedict та Edward McMahon, праці яких заклали методологічні засади сучасного людиноцентричного містобудування.

Одним із найавторитетніших дослідників сучасної урбаністики є данський архітектор і містобудівник Jan Gehl, праці якого докорінно змінили підходи до проєктування міських просторів. У книгах *Life Between Buildings* (1971), *New City Spaces* (2001) та особливо *Cities for People* (2010) [33,34] автор обґрунтовує концепцію людиноцентричного міста, відповідно до якої першочерговим об'єктом проєктування повинна бути людина, а не транспортна чи інженерна інфраструктура.

На думку Я. Гейла, якість міського середовища визначається не масштабом забудови, а можливістю людини комфортно пересуватися, відпочивати, спілкуватися та взаємодіяти з навколишнім простором.

У своїх роботах Я. Гейл значну увагу приділяє громадським просторам, які розглядаються як місце формування соціального капіталу міста. Автор наголошує, що якісний громадський простір повинен бути:

- безпечним;
- відкритим;
- доступним;
- інклюзивним;
- комфортним для пішоходів;
- насиченим зеленими насадженнями.

Особливе місце у дослідженнях займає поняття *walkability* — здатність міського середовища стимулювати пересування пішки. На думку автора, саме комфортні пішохідні маршрути між скверами, площами та іншими громадськими просторами формують активне міське життя.

Основним висновком досліджень Я. Гейла є те, що навіть невеликі сквери можуть значно покращити

чувати якість міського середовища за умови їх інтеграції у систему громадських просторів та забезпечення високої пішохідної доступності.

Подальший розвиток теорії зеленої інфраструктури пов'язаний із працями американського професора Тімоті Бітлі [27,28], який є одним із провідних дослідників концепції зеленого урбанізму. Він розглядає зелену інфраструктуру як комплекс взаємопов'язаних природних і антропогенних елементів, що забезпечують екологічну стійкість урбанізованих територій.

На думку автора, зелена інфраструктура повинна забезпечувати широкий спектр екосистемних послуг, серед яких: очищення атмосферного повітря та регулювання мікроклімату, зниження ефекту міського теплового острова, психологічне відновлення населення.

Особливе значення Т. Бітлі надає розвитку біофільних міст, де природні компоненти інтегруються у всі рівні міського планування. Сквери, на його думку, є не окремими об'єктами благоустрою, а елементами єдиної зеленої мережі.

Висновки автора свідчать про необхідність переходу від локального озеленення до стратегічного управління зеленою інфраструктурою на рівні територіальної громади.

Австралійський учений Пітер Ньюман є одним із засновників сучасної концепції сталого міста. У фундаментальній праці *Cities as Sustainable Ecosystems* (2008) [36], написаній у співавторстві з І. Дженнінгсом, місто розглядається як складна екологічна система, функціонування якої повинно ґрунтуватися на принципах природних екосистем.

П. Ньюман одним із перших довів необхідність інтеграції зеленої інфраструктури у транспортне, містобудівне та екологічне планування. Він розглядає сквери як локальні екологічні вузли, що виконують одночасно природоохоронні, соціальні та рекреаційні функції.

Автор також пов'язує розвиток walkability із компактною моделлю міста, де зелені громадські простори повинні бути розташовані у межах пішохідної доступності від житлової забудови.

Праці П. Ньюмана стали теоретичною основою сучасних концепцій 15-хвилинного міста, сталого транспорту та зеленої мобільності.

Визначальне значення для розвитку екологічного містобудування має праця американського ландшафтного архітектора Ian McHarg *Design with Nature* (1969) [35], яка вважається одним із найвпливовіших наукових видань XX століття у сфері просторового планування.

Ян Мак-Харг уперше запропонував розглядати природні компоненти території як основу прийняття містобудівних рішень. Він сформував методу багатопланового аналізу території, що стала попередником сучасних геоінформаційних технологій (GIS).

Основний зміст цієї концепції полягає у тому, що розвиток міст має відбуватися відповідно до природного потенціалу території. Я. Мак-Харг наголошував, що зелені території повинні виконувати не декоративну, а екологічну функцію. Його методологія сьогодні широко застосовується під

час розроблення концепцій зеленої інфраструктури.

У праці Марка Бенедикта та Едварда Мак-Магона *Green Infrastructure: Linking Landscapes and Communities* (2006) [29] вперше системно обґрунтовано необхідність створення взаємопов'язаної мережі природних територій. На відміну від традиційного підходу до озеленення, автори розглядають сквери, парки, ліси, річки, бульвари, зелені коридори та інші природні елементи як єдину функціональну систему. Ці уявлення фактично стали основою сучасної європейської політики розвитку зеленої інфраструктури, положення якої сьогодні реалізуються у стратегічних документах Європейського Союзу та адаптуються в українській практиці просторового планування.

Український науковий доробок, пов'язаний зі скверами, міським озелененням і благоустроєм, доцільно поділяти на дві групи. До першої належать праці, у яких сквери або зелені насадження міста є безпосереднім об'єктом дослідження. До другої — фундаментальні містобудівні та ландшафтно-планувальні роботи, що формують методологічну основу для аналізу скверів як елементів просторової системи міста. Такий поділ є важливим, оскільки не всі автори зі сформованого переліку спеціально досліджували сквери, однак їхні концепції безпосередньо впливають на розуміння ролі малих зелених просторів у міській структурі.

Праці В. П. Кучерявого [17,18] становлять одну з найґрунтовніших в Україні теоретичних баз у сфері озеленення населених місць, урбоєкології та садово-паркового будівництва. У підручнику «Озеленення населених місць» систематизовано історичні, ландшафтно-типологічні, архітектурно-художні, дендрологічні та технологічні засади створення і функціонування міських зелених насаджень. Видання охоплює питання підбору рослинного матеріалу, формування композицій, створення та експлуатації об'єктів зеленого господарства.

Для дослідження скверів особливо важливим є розуміння автором міського озеленення як системи, у якій окремі об'єкти — парки, сквери, бульвари, насадження вулиць і житлових територій — мають виконувати взаємодоповнювальні санітарно-гігієнічні, кліматорегулювальні, рекреаційні та композиційні функції. Із положень праці випливає, що благоустрій скверу не може обмежуватися розташуванням доріжок, лав і декоративних насаджень. Він потребує врахування стійкості рослин до міських умов, ярусності композиції, сезонної декоративності, інсоляції, вітрового режиму, пилогазового навантаження та подальшого догляду.

Наукове значення підходу В. П. Кучерявого полягає у поєднанні ландшафтно-архітектурного та фітомеліоративного розуміння міських насаджень. Для сучасної тематики зеленої інфраструктури це означає, що сквер слід оцінювати не лише за естетичним результатом, але й за його фактичною екологічною ефективністю. Новіші дослідження за участю В. П. Кучерявого розвивають цей підхід у

напрямі оцінювання фітомеліоративної ефективності зеленої інфраструктури та екопросторових властивостей міських насаджень.

Найбільш безпосередньо до теми скверів належить спільна стаття Х. Ю. Гринь і Я. В. Геника [4]. Автори на основі натурних досліджень і картографічних матеріалів розробили багатокритеріальну класифікацію скверів за площею, формою, планувальною структурою, складом насаджень, місцем розташування, функціональним призначенням і часом створення.

Практична цінність цієї роботи полягає в переході від загального опису скверів до їх системного типологічного аналізу. Автори встановили, що у Львові переважають малі за площею сквери, а серед функцій найбільш поширеними є транзитна та відпочинкова. Також вони виокремили буферні, спортивні, лікарняні, декоративні та пам'ятні сквери.

Для теми благоустрою важливо, що функціональний тип скверу визначає вимоги до його планувальної організації. Транзитний сквер потребує чітких і безбар'єрних пішохідних зв'язків; відпочинковий — затінених місць перебування, достатньої кількості сидінь і захисту від вуличного шуму; буферний — щільної багаторівневої рослинності; пам'ятний — збалансованого поєднання меморіальної та повсякденної функцій.

Методика Гринь і Геника придатна як основа для інвентаризації скверів Івано-Франківська. Вона дозволяє створити не лише перелік об'єктів, а типологічну базу, за якою можна визначати пріоритети реконструкції та добирати відповідні засоби благоустрою.

Р. Б. Дудин досліджує переважно дендрологічний стан, видовий склад, вікову структуру та трансформацію паркових і скверних насаджень [12]. Автором сквер розглянуто як сформований садово-парковий фітоценоз, стан якого залежить від видового різноманіття, вікової структури деревостану та якості догляду.

У спільних роботах Р. Б. Дудина з іншими авторами аналізуються паркові насадження Хмельницького, їхній сучасний стан та напрями оптимізації. Наукова логіка цих досліджень полягає у тому, що реконструкція зелених просторів має спиратися на інвентаризацію, оцінку життєвого стану, виявлення аварійних і малоцінних рослин, визначення дефіциту вікових груп та прогнозування зміни структури насаджень.

Для благоустрою скверів це має принципове значення. Архітектурне оновлення без попереднього дендрологічного обстеження може призвести до втрати зрілих дерев, порушення просторової структури насаджень або висадження видів, непридатних до конкретних умов.

Т. Ф. Панченко досліджує архітектурно-ландшафтну організацію та планування ландшафтно-рекреаційних територій [19]. У публікації розглядаються державний, регіональний, місцевий і локальний рівні планування рекреаційних просторів, а також типологія ландшафтно-рекреаційних об'єктів.

Хоча ці роботи не зосереджені винятково на скверах, їхнє значення полягає у визначенні ієрархічного підходу до рекреаційних територій. Сквер у такій системі є локальним елементом, який повинен бути пов'язаний із більшими зеленими територіями, пішохідними маршрутами та громадськими центрами.

Особливо важливим є сформульований у працях Панченко екологічний підхід до архітектурно-ландшафтної організації території. Благоустрій при цьому має не лише забезпечувати зручність користування, а й покращувати стан довкілля, підтримувати природні компоненти та регулювати рекреаційне навантаження.

У навчальному посібнику О. С. Безлюбенко, О. В. Завального і Т. О. Черноусової систематизовано питання функціонально-планувальної організації територій, інженерної підготовки, вулично-дорожньої мережі, озеленення, малих архітектурних форм та благоустрою міського середовища [12]. Видання було рекомендоване для підготовки фахівців будівельного напрямку.

Цінність праці для дослідження скверів полягає у комплексному трактуванні благоустрою. Озеленення розглядається разом із вертикальним плануванням, водовідведенням, освітленням, покриттями, організацією пішохідного руху та обладнанням території. Саме такого інтегрованого підходу часто бракує під час реконструкції скверів, коли увага зосереджується лише на заміні покриття й встановленні меблів.

Монографія М. М. Габреля присвячена методології аналізу й розвитку містобудівних систем у динамічних умовах [5]. Автор розглядає місто як складну просторову систему, елементи якої взаємодіють через функціональні, комунікаційні, природні та соціальні зв'язки.

У контексті скверів особливо продуктивною є системна позиція автора: якість окремої території залежить не лише від її внутрішнього устрою, а від місця у загальноміській структурі, доступності, зв'язку з транспортними та пішохідними мережами, сусідніми функціями й природним каркасом.

Для аналізу благоустрою це означає, що ефективність скверу слід оцінювати не тільки за площею озеленення чи кількістю обладнання, а за його просторовою роллю: чи формує він вузол зеленої мережі, чи пов'язує громадські об'єкти, чи підтримує пішохідний маршрут, чи компенсує дефіцит зелені в конкретному районі.

М. М. Дьомін є одним із провідних представників української школи містобудування та дослідження містобудівних систем [13]. У межах теми скверів його доробок доцільно використовувати не як джерело спеціальних дендрологічних або ландшафтних рекомендацій, а як методологічну основу управління міським розвитком.

У сучасних працях за участю М. М. Дьоміна розглядаються теоретико-методичні засади ревіталізації та просторового розвитку, включно з поствоєнною трансформацією територій. Це важливо для дослідження скверів, що виникають на занедбаних, конфліктних або функціонально застарілих ділянках.

Із системного підходу Дьоміна випливає, що створення скверу має бути пов'язане з містобудівною документацією, функціональним зонуванням, планувальними обмеженнями, демографічними потребами та сценаріями довгострокового розвитку міста. Отже, сквер є не лише локальним проектом благоустрою, але й інструментом ревіталізації та коригування просторової структури.

Ю. М. Білоконь у власній монографії досліджує питання планувальної організації територій на регіональному та міжпоселенському рівнях [2]. Його праця не є спеціальним дослідженням скверів, однак важлива для розуміння масштабної ієрархії зелених територій. Міські сквери мають розглядатися як найнижчий, повсякденний рівень зеленої системи, пов'язаний із міськими парками, приміськими лісами, річковими долинами й елементами регіональної екологічної мережі.

Методика дослідження

Методологічною основою дослідження є комплексний міждисциплінарний підхід, який поєднує положення сучасної теорії містобудування, ландшафтно-архітектури, урбоєкології, просторового планування та концепції зеленої інфраструктури. Дослідження виконано з використанням загальнонаукових і спеціальних методів, що забезпечують всебічне оцінювання сучасного стану скверів Івано-Франківська, визначення основних проблем їх функціонування та обґрунтування напрямів удосконалення благоустрою відповідно до Концепції розвитку зеленої інфраструктури Івано-Франківської МТГ до 2035 року.

Основним методологічним підходом став системний аналіз, який дав змогу розглядати міські сквери не як окремі елементи благоустрою, а як взаємопов'язані компоненти зеленої інфраструктури територіальної громади. У межах цього підходу досліджувалася структура зеленої мережі, функціональні зв'язки між скверами, парками, бульварами, вуличним озелененням, прибережними територіями та іншими природними компонентами міського середовища. Системний аналіз дозволив оцінити роль скверів у формуванні екологічного каркаса міста, забезпеченні просторової безперервності зелених територій та наданні екосистемних послуг населенню.

Для оцінювання просторової організації міського середовища застосовано містобудівний аналіз, який охоплював вивчення сучасної функціонально-планувальної структури Івано-Франківської міської територіальної громади, особливостей розміщення існуючих скверів, їх транспортної та пішохідної доступності, взаємозв'язків із громадськими просторами, житловою забудовою, закладами освіти, охорони здоров'я, культури та іншими центрами тяжіння населення. Аналіз здійснювався з урахуванням положень Закону України «Про регулювання містобудівної діяльності», ДБН Б.2.2-12:2019 «Планування та забудова територій», ДБН Б.2.2-5:2011 «Благоустрій територій», а також Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року.

З метою визначення сучасних тенденцій розвитку міських зелених просторів використано порівняльний аналіз, який передбачав зіставлення наукових підходів українських і зарубіжних дослідників щодо організації громадських просторів, зеленої інфраструктури, благоустрою скверів, walkability та природоорієнтованих рішень. Крім теоретичних аспектів, порівнювалися практичні підходи до реконструкції та функціонального оновлення скверів у містах України (Львів, Одеса, Київ, Вінниця) та європейських містах, що дозволило визначити можливості адаптації успішних практик до умов Івано-Франківська.

Важливим етапом роботи став картографічний аналіз, який полягав у вивченні картографічних матеріалів, генерального плану міста, матеріалів комплексного плану просторового розвитку території громади, схем озеленення, відкритих геопросторових ресурсів та супутникових знімків. За результатами аналізу визначалися просторовий розподіл скверів, забезпеченість окремих районів зеленими територіями, наявність зелених коридорів, фрагментованість зеленої мережі та потенційні території для створення нових громадських просторів.

Одним із ключових методів дослідження стало польове обстеження існуючих скверів. Натурні дослідження передбачали безпосереднє обстеження територій із визначенням їх функціонального призначення, рівня благоустрою, санітарного стану, дендрологічних характеристик, ступеня рекреаційного навантаження, інтенсивності використання населенням, рівня інклюзивності та безбар'єрності. Особлива увага приділялася аналізу структури насаджень, стану деревної та чагарникової рослинності, якості газонів, малих архітектурних форм, покриттів, освітлення, систем водовідведення та елементів візуальної навігації.

Результати польових досліджень документувалися методом фотофіксації, що забезпечило об'єктивну оцінку сучасного стану скверів та можливість подальшого порівняльного аналізу. Фотофіксація використовувалася для документування композиційної структури територій, стану зелених насаджень, рівня благоустрою, інженерного обладнання, доступності для маломобільних груп населення, а також для виявлення дефектів, що потребують усунення під час реконструкції.

Окремим напрямом дослідження став нормативний аналіз, спрямований на вивчення сучасної нормативно-правової бази у сфері містобудування, благоустрою та озеленення територій. У процесі роботи проаналізовано положення Закону України «Про благоустрій населених пунктів», Закону України «Про регулювання містобудівної діяльності», Закону України «Про природно-заповідний фонд України», Закону України «Про оцінку впливу на довкілля», а також чинних державних будівельних норм, серед яких ДБН Б.2.2-12:2019 «Планування та забудова територій», ДБН Б.2.2-5:2011 «Благоустрій територій», ДБН В.2.2-40:2018 «Інклюзивність будівель і споруд» (зі змінами), ДБН В.2.3-5:2018 «Вулиці та дороги населених пунктів» та інші нормативні документи,

чинні станом на 2026 рік. Додатково враховано положення Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року, яка визначає стратегічні напрями формування зелено-блакитної інфраструктури громади.

Застосування наведеного комплексу взаємодоповнювальних методів забезпечило всебічне дослідження сучасного стану скверів Івано-Франківської міської територіальної громади, дозволило оцінити їх просторову організацію, екологічну ефективність, функціональну структуру, відповідність сучасним нормативним вимогам і принципам зеленої інфраструктури, а також сформувати науково обґрунтовані рекомендації щодо вдосконалення благоустрою міських скверів із використанням людиноцентричних підходів, природоорієнтованих рішень та сучасних методів управління зеленими територіями.

Концепція розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року є стратегічним документом, у якому закладено перехід від фрагментарного озеленення окремих міських територій до формування цілісної, просторово пов'язаної та керованої зелено-блакитної мережі. Документ розроблено в межах проекту «Нова економіка Івано-Франківська», що реалізується за підтримки Європейського Союзу, і орієнтовано на довгострокове збереження, відновлення та розвиток зелених просторів громади. У Концепції зелену інфраструктуру визначено не як декоративне доповнення до забудови, а як цінну міську систему, співмірну за значенням із транспортною, інженерною та соціальною інфраструктурою.

Для проблематики благоустрою скверів значення цього документа полягає насамперед у зміні масштабу їх осмислення. Сквер у межах Концепції доцільно розглядати не як автономну озеленену ділянку, а як локальний вузол зеленої інфраструктури, який має підтримувати екологічні процеси, забезпечувати повсякденну рекреацію, сприяти пішохідній мобільності, покращувати мікроклімат і формувати просторові зв'язки між більшими природними та громадськими територіями. Такий підхід принципово відрізняється від традиційної практики благоустрою, коли проектування обмежувалося заміною покриттів, встановленням лав, освітленням і висадженням декоративних рослин.

Головною метою Концепції є формування збалансованої, екологічно стійкої та соціально орієнтованої системи зелених просторів громади. Документ орієнтується на підвищення якості життя мешканців, адаптацію міського середовища до зміни клімату, збереження біорізноманіття, покращення якості повітря, регулювання поверхневого стоку та створення доступних рекреаційних просторів. У візії громади зелена інфраструктура постає як взаємопов'язана екосистема, де окремі елементи — від вікових дерев і міських парків до приміських лісів, річкових долин, кишенькових парків та вуличного озеленення — виконують різні, але взаємодоповнювальні функції.

У контексті розвитку скверів це означає, що їхня цінність визначається не лише площею або естетичним станом, а здатністю забезпечувати певний набір суспільно корисних функцій. Сквер повинен одночасно бути доступним місцем короткочасного відпочинку, елементом пішохідної мережі, локальним осередком біорізноманіття, кліматичним регулятором і простором соціальної взаємодії. Необхідними стають єдині критерії оцінювання стану скверів, визначення пріоритетності реконструкції, регламенти догляду за насадженнями, правила компенсаційного озеленення та механізми громадського контролю. Адже тепер сквери виконують роль проміжних вузлів, які скорочують просторові розриви між великими парками, річковими долинами, вуличним озелененням і житловими районами. Щодо них має бути застосована практика утримання та розвитку, цифрової трансформації та партисипативного проєктування, проведення відкритих архітектурних конкурсів, громадських консультацій, освітніх кампаній і спільних ініціатив з догляду за зеленими територіями.

Одним із концептуальних положень документа є трактування зелених територій як постачальників екосистемних послуг. Стосовно міських скверів ці послуги можна систематизувати за чотирма групами. Регульовальні послуги охоплюють затінення території, зниження локальної температури, поглинання пилу, послаблення шуму та затримання опадів. Підтримувальні послуги пов'язані зі створенням середовища існування для птахів, комах-запилювачів та інших видів. Культурні послуги включають відпочинок, естетичне сприйняття, меморіальні практики, соціальну комунікацію та формування локальної ідентичності. Соціально-оздоровчі послуги проявляються у підтримці фізичної активності, психологічному відновленні та зниженні стресу.

Для скверів природоорієнтований підхід означає скорочення площі суцільного мощення, утримання дощової води безпосередньо на території, застосування локально адаптованих видів рослин і створення багаторівневої структури насаджень. Такі рішення одночасно зменшують навантаження на дощову каналізацію, покращують мікроклімат і підвищують біологічну цінність простору. Сквери можуть виконувати функцію локальних «перехідних ланок» між водними та зеленими територіями. Якщо вони розміщені вздовж пішохідних маршрутів, вулиць або поблизу водотоків, їх благоустрій доцільно узгоджувати з формуванням безперервних зелених маршрутів, системою затримання дощових вод та екологічними коридорами. Розвиток скверів має супроводжуватися благоустроєм підходів до них, вуличним озелененням і створенням безперервних затінених маршрутів. Для системи скверів такі «зелені коридори» мають подвійне значення. По-перше, вони забезпечують екологічну зв'язність і зменшують фрагментацію зелених територій. По-друге, формують комфортні пішохідні маршрути між житловими районами, громадськими установами та рекреаційними об'єктами

У сучасній теорії містобудування та ландшафтно-архітектури сквер розглядається не лише як невелика озеленена територія загального користування, а як багатофункціональний структурний елемент зеленої інфраструктури міста, який забезпечує виконання комплексу екологічних, соціальних, економічних, кліматичних та просторових функцій. Такий підхід відповідає сучасній європейській концепції Green Infrastructure, відповідно до якої всі зелені та блакитні простори формують єдину взаємопов'язану систему, здатну підтримувати функціонування міських екосистем, забезпечувати населення екосистемними послугами та підвищувати стійкість міст до антропогенних і кліматичних викликів.

У структурі зеленої інфраструктури Івано-Франківської міської територіальної громади сквери виконують роль локальних природних осередків, що поєднують житлові райони, громадські простори, транспортні вузли, парки, бульвари, набережні та інші озеленені території. Їх розташування у сформованій міській забудові забезпечує безпосередню доступність зелених просторів для населення та створює умови для повсякденного контакту людини з природним середовищем. Саме тому сучасний благоустрій скверів повинен розглядатися не як окремий архітектурний або ландшафтний проєкт, а як складова комплексного розвитку зеленої інфраструктури територіальної громади.

Екологічна функція є однією з базових характеристик сучасного міського скверу. Незважаючи на порівняно невеликі площі, сквери беруть активну участь у підтриманні екологічної рівноваги урбанізованих територій. Зелені насадження здійснюють поглинання вуглекислого газу, виділення кисню, фільтрацію атмосферного повітря від пилу та газоподібних забруднювачів, акумуляцію важких металів, зниження рівня шумового навантаження та формування сприятливого мікроклімату.

Особливого значення набуває роль скверів у підтриманні біорізноманіття міста. Дерева, чагарники, квітникові композиції та лучна рослинність створюють середовище існування для численних видів птахів, комах-запилювачів, дрібних ссавців та ґрунтових організмів. Таким чином навіть невеликі за площею сквери можуть виконувати функцію локальних осередків біологічного різноманіття та бути складовою міської екологічної мережі.

У Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади екологічна функція зелених територій визначається як одна з ключових, оскільки саме вона забезпечує стійкість міського середовища до антропогенних навантажень та кліматичних змін. Сквери розглядаються як елементи природного каркаса міста, здатні підтримувати екологічні процеси на локальному рівні та забезпечувати безперервність зелено-блакитної інфраструктури.

Сквери є важливими громадськими просторами, що забезпечують щоденну соціальну взаємодію населення. На відміну від великих парків, вони розташовані безпосередньо у житловій

збудові, поблизу навчальних закладів, адміністративних установ, медичних центрів, торговельних об'єктів і транспортних вузлів, що робить їх доступними для широкого кола користувачів.

Соціальна функція скверів проявляється у створенні комфортного середовища для відпочинку, спілкування, короточасного перебування, проведення громадських заходів, культурних подій та неформальної комунікації мешканців. Саме у таких просторах формується локальна міська спільнота, зміцнюються соціальні зв'язки та підвищується рівень громадської активності.

Важливою складовою сучасного благоустрою є забезпечення принципів універсального дизайну та безбар'єрності. Сквер повинен бути доступним для всіх категорій населення незалежно від віку, фізичних можливостей чи соціального статусу. Це передбачає застосування вимог ДБН В.2.2-40:2018 «Інклюзивність будівель і споруд», облаштування безбар'єрних маршрутів, тактильних елементів, достатньої кількості місць для сидіння, якісного освітлення та зрозумілої навігації.

Сквери формують архітектурно-художній образ міста та суттєво впливають на його композиційну виразність. Зелені насадження пом'якшують сприйняття щільної забудови, створюють природні доміканти, формують перспективи вулиць і площ, забезпечують сезонну зміну ландшафтних композицій та підвищують естетичну якість громадського простору.

Архітектурно-планувальна композиція скверу повинна ґрунтуватися на принципах гармонійного поєднання природних компонентів, малих архітектурних форм, покриттів, освітлення та елементів міського дизайну. Особливого значення набуває використання місцевих видів рослин, характерних для природного ландшафту Прикарпаття, що дозволяє зберігати регіональну ідентичність міського середовища.

Сучасний підхід до благоустрою передбачає відмову від надмірної декоративності на користь природних композицій, багаторусних насаджень, сезонної мінливості рослинності та екологічно обґрунтованих ландшафтних рішень.

З позицій містобудування сквери є структурними елементами системи відкритих просторів міста. Вони забезпечують просторову організацію забудови, формують композиційні вузли, створюють буферні зони між різними функціональними територіями та підтримують безперервність зеленої інфраструктури.

У сучасній практиці містобудування сквери дедалі частіше виконують роль локальних центрів громадського життя, інтегрованих у мережу пішохідних маршрутів, велосипедної інфраструктури та громадських просторів. Їх ефективність значною мірою визначається рівнем пішохідної доступності. Згідно із сучасними урбаністичними концепціями, зокрема принципами walkability та 15-хвилинного міста, мешканці повинні мати можливість дістатися найближчого скверу протягом 5–10 хвилин пішки.

Для Івано-Франківської міської територіальної громади сквери можуть стати ключовими вузлами зелено-блакитної мережі, що поєднуюватиме міські

парки, бульвари, долини річок Бистриці Надвірнянської та Бистриці Солотвинської, міське озеро та інші рекреаційні території.

Економічна цінність скверів традиційно недооцінювалася, однак сучасні дослідження доводять їх значний внесок у розвиток міського господарства. Якісно облаштовані зелені простори сприяють підвищенню інвестиційної привабливості територій, збільшенню вартості нерухомості, розвитку малого підприємництва, туристичної активності та сфери послуг.

Крім прямих економічних ефектів, сквери забезпечують значні непрямі вигоди. Завдяки покращенню якості повітря, зменшенню теплового навантаження та підтриманню фізичного й психічного здоров'я населення скорочуються витрати на охорону здоров'я та експлуатацію інженерної інфраструктури. Використання природоорієнтованих рішень, зокрема дощових садів і водопроникних покриттів, дозволяє зменшити навантаження на системи дощової каналізації та витрати на ліквідацію наслідків підтоплень.

У контексті сучасних кліматичних змін роль міських скверів істотно зростає. Урбанізовані території характеризуються ефектом міського теплового острова, що проявляється у підвищенні температури повітря внаслідок значної площі штучних покриттів, недостатнього озеленення та високої концентрації джерел тепла.

Деревна рослинність скверів забезпечує затінення територій, випаровування вологи, зниження температури повітря, покращення вентиляції міського середовища та накопичення атмосферної вологи. Водночас використання водопроникних покриттів, дощових садів, біоретенційних зон і зелених інфільтраційних смуг сприяє природному регулюванню поверхневого стоку та адаптації міста до інтенсивних опадів.

Саме тому сучасні сквери розглядаються як важливі елементи кліматичної адаптації міст і складові природоорієнтованих рішень, які активно впроваджуються в європейській практиці просторового розвитку.

Останніми роками психологічна роль зелених просторів набуває особливої актуальності. Наукові дослідження у сфері екологічної психології підтверджують, що регулярний контакт людини з природним середовищем сприяє зниженню рівня стресу, покращенню емоційного стану, концентрації уваги та когнітивних функцій.

Сквери виконують функцію просторів психологічного відновлення, особливо в умовах інтенсивного міського середовища, інформаційного навантаження та тривалого психоемоційного напруження. Для України, яка переживає наслідки повномасштабної війни, ця функція набуває додаткового значення. Зелені громадські простори можуть слугувати місцями тихого відпочинку, соціальної підтримки, психологічної реабілітації та відновлення емоційної рівноваги населення.

Формування комфортного акустичного середовища, використання природних матеріалів, вод-

них елементів, багаторівневої рослинності та достатньої кількості затінених зон підвищує терапевтичний потенціал міських скверів.

У сучасних українських містах дедалі більшого значення набуває меморіальна функція скверів. Унаслідок російської збройної агресії виникла потреба у створенні нових просторів пам'яті, присвячених загиблим військовослужбовцям, цивільним жертвам війни та визначним історичним подіям. Сквери стають місцями колективної пам'яті, суспільного діалогу та формування історичної ідентичності громади.

На відміну від традиційних меморіальних комплексів сучасні меморіальні сквери поєднують функції вшанування пам'яті, повсякденного відпочинку та громадської активності. Їх благоустрій має забезпечувати делікатний баланс між урочистістю меморіального простору та його відкритістю для повсякденного використання. Це вимагає ретельного добору ландшафтних композицій, малих архітектурних форм, символічних елементів і місць для тихого споглядання.

Для Івано-Франківської міської територіальної громади розвиток меморіальних скверів може стати одним із напрямів реалізації Концепції розвитку зеленої інфраструктури, поєднуючи збереження історичної пам'яті з формуванням якісного та комфортного міського середовища.

Сучасні принципи благоустрою скверів

Розвиток сучасних міст супроводжується зміною підходів до проєктування та експлуатації громадських просторів. Якщо традиційно благоустрій скверів зосереджувався переважно на декоративному озелененні, облаштуванні пішохідних доріжок та встановленні малих архітектурних форм, то сучасна практика базується на концепції сталого розвитку, зеленої інфраструктури та природоорієнтованих рішень. Такий підхід передбачає комплексне поєднання екологічних, соціальних, економічних, кліматичних і містобудівних аспектів, що забезпечують довготривалу ефективність функціонування громадських просторів.

В Україні ці принципи набувають особливої актуальності у зв'язку з необхідністю адаптації міст до наслідків зміни клімату, підвищення якості життя населення, впровадження європейських стандартів сталого розвитку та реалізації положень Закону України «Про благоустрій населених пунктів», Закону України «Про регулювання містобудівної діяльності», ДБН Б.2.2-12:2019 «Планування та забудова територій», ДБН В.2.2-40:2018 «Інклюзивність будівель і споруд», а також Концепції розвитку зеленої інфраструктури Івано-Франківської міської територіальної громади до 2035 року. Саме тому сучасний благоустрій скверів повинен ґрунтуватися на комплексній інтеграції природних процесів, інноваційних технологій та людиноцентричного підходу до формування міського середовища.

Інклюзивність та універсальний дизайн

Одним із визначальних принципів сучасного благоустрою є забезпечення рівного доступу до громадських просторів для всіх категорій населення. Сучасний сквер повинен бути комфортним

для дітей, людей похилого віку, осіб з інвалідністю, батьків із дитячими візками, військовослужбовців, які проходять реабілітацію, та інших маломобільних груп населення.

Принцип універсального дизайну передбачає створення простору, який не потребує додаткової адаптації для різних користувачів. Це означає застосування безбар'єрних маршрутів, пандусів із нормативними ухилами, тактильних смуг, контрастного маркування, понижених бордюрів, достатньої ширини пішохідних доріжок, ергономічних лав різної висоти, зон відпочинку через визначені інтервали, інтуїтивно зрозумілої навігації та якісного освітлення.

Особливої актуальності принцип інклюзивності набув після початку повномасштабної війни, коли кількість маломобільних користувачів громадських просторів суттєво зросла. Тому сучасний благоустрій скверів повинен враховувати не лише фізичну доступність території, але й психологічний комфорт, безпечність пересування та можливість повноцінної соціальної інтеграції всіх категорій населення.

Збереження та підтримка біорізноманіття

Сучасний благоустрій дедалі більше орієнтується на збереження природних екосистем у межах міста. Якщо раніше перевага надавалася декоративним композиціям із невеликої кількості інтродукованих рослин, то сучасна практика передбачає формування стійких багаторусних рослинних угруповань, максимально наближених до природних.

Біорізноманіття розглядається як одна з ключових характеристик зеленої інфраструктури, що забезпечує стабільність екосистем, підтримання природних трофічних зв'язків та стійкість зелених насаджень до кліматичних змін і антропогенних навантажень.

У проєктах благоустрою сучасних скверів рекомендується:

- максимально зберігати існуючі дорослі дерева;
- використовувати багаторусні посадки дерев, чагарників і трав'яної рослинності;
- створювати природні квітникові композиції;
- впроваджувати лучні газони;
- облаштовувати середовище для запилювачів;
- зберігати окремі природні мікробіотопи.

Такий підхід забезпечує значно вищу екологічну ефективність території порівняно з традиційними декоративними газонами.

Водопроникні покриття

Однією з головних проблем сучасних міст є значна площа водонепроникних покриттів, які порушують природний водний баланс території та спричиняють перевантаження систем дощової каналізації.

Тому сучасне благоустрій скверів передбачає максимальне використання водопроникних покриттів. До них належать:

- екологічна тротуарна плитка із відкритими швами;
- водопроникний бетон;
- гравійні покриття;
- стабілізовані відсів;
- деревна мульча;
- георешітки із трав'яним покриттям;
- комбіновані природні покриття.

Їх використання дозволяє зменшити поверхневий стік, забезпечити природне інфільтрування атмосферних опадів, покращити живлення кореневої системи дерев та запобігти локальним підтопленням.

Особливо актуальним це є для Івано-Франківської громади, де через збільшення інтенсивності короточасних злив навантаження на систему дощової каналізації постійно зростає.

Дощові сади як елемент управління поверхневими водами

Одним із найбільш перспективних природоорієнтованих рішень є використання дощових садів (Rain Gardens).

Дощовий сад являє собою спеціально спроектовану заглиблену озеленену ділянку, яка тимчасово акумулює дощові води, забезпечує їх природне очищення та поступове проникнення у ґрунт.

На відміну від традиційної дощової каналізації дощові сади:

- затримують поверхневий стік;
- очищують воду від завислих речовин;
- зменшують навантаження на інженерні мережі;
- покращують живлення рослин;
- формують додаткові біотопи для комах і птахів;
- підвищують декоративність території.

У структурі скверів вони можуть інтегруватися вздовж доріжок, у пониженнях рельєфу, біля водостічних труб або на межі із вуличною мережею.

Використання місцевих видів рослин

Одним із сучасних напрямів розвитку ландшафтної архітектури є відмова від надмірного використання екзотичних декоративних видів на користь рослин місцевої флори.

Використання автохтонних рослин має низку переваг:

- кращу адаптацію до місцевого клімату;
- вищу морозо- та посухостійкість;
- менші витрати на догляд;
- підтримання місцевого біорізноманіття;
- стійкість до шкідників;
- формування природного ландшафтного образу.

Для Івано-Франківської області доцільним є використання дуба звичайного, липи серцелистої, граба звичайного, клена польового, явора, горобини, черемхи, калини, дерену, ліщини, глоду, шипшини, різноманітних лучних багаторічників та декоративних злаків.

Такі рослинні композиції краще відповідають природним умовам Прикарпаття та забезпечують значно вищу екологічну стійкість насаджень.

Природоорієнтовані рішення

Концепція Nature-based Solutions сьогодні є однією з провідних у розвитку міських громадських просторів.

Її основною ідеєю є використання природних процесів замість суто інженерних методів.

У благоустрої скверів це проявляється через:

- багаторівневе озеленення;
- зелені інфільтраційні смуги;
- природне очищення дощових вод;
- мінімізацію суцільного мощення;
- використання природного рельєфу;
- створення природних середовищ

існування;

- максимальне збереження існуючих дерев;
- використання лугових газонів;
- біоретенційні системи;
- зелені буферні смуги.

Такі рішення одночасно покращують екологічний стан території, підвищують її стійкість до кліматичних змін та зменшують експлуатаційні витрати.

Енергоефективне освітлення

Сучасне освітлення скверів виконує не лише функцію забезпечення безпеки, але й є важливою складовою комфортного громадського простору.

Сучасні тенденції передбачають використання:

- LED-світильників;
- світильників із керуванням інтенсивністю;
- датчиків руху;
- сонячних автономних опор;
- систем автоматичного регулювання

освітленості;

- спрямованого світла без світлового забруднення.

Такі рішення дозволяють скоротити споживання електроенергії на 50–70 %, підвищити безпеку території та мінімізувати негативний вплив на нічну фауну.

Однією із сучасних тенденцій є автоматизація догляду за зеленими насадженнями.

Прикладом слугують смарт-системи поливу, які використовують:

- датчики вологості ґрунту;
- метеостанції;
- погодні прогнози;
- дистанційне керування;
- зональне регулювання витрат води.

Такі системи дозволяють зменшити витрати водних ресурсів на 30–50 %, забезпечити рівномірне зволоження рослин та скоротити експлуатаційні витрати.

Особливо актуальним їх використання є в умовах збільшення літніх посушливих періодів.

Одним із найбільш інноваційних напрямів розвитку зеленої інфраструктури є цифровізація управління зеленими насадженнями.

Сучасні міста переходять до використання GIS-технологій, цифрових паспортів дерев та систем дистанційного моніторингу.

Інтеграція таких даних у геоінформаційні системи забезпечує обґрунтоване планування заходів із благоустрою та дозволяє оперативно контролювати стан зеленої інфраструктури громади.

Використання екологічних матеріалів

Сучасний благоустрій передбачає використання матеріалів із мінімальним екологічним слідом протягом усього життєвого циклу. Перевага надається матеріалам, що є довговічними, придатними до повторного використання або перероблення, безпечними для довкілля та користувачів. До них належать сертифікована деревина, природний камінь місцевого походження, бетон із пониженим вмістом клінкеру, перероблена сталь, вторинні полімерні композити, гумові покриття з переробленої сировини та інші матеріали, які відповідають принципам циркулярної економіки.

Під час реконструкції скверів також доцільно максимально використовувати існуючі конструктивні елементи та матеріали після їхньої відповідної підготовки. Такий підхід зменшує обсяги будівельних відходів, скорочує споживання природних ресурсів і знижує вуглецевий слід будівельних робіт.

Аналіз сучасного стану скверів Івано-Франківської міської територіальної громади

Оцінювання сучасного стану скверів Івано-Франківська здійснено не лише як інвентаризацію окремих озелених ділянок, а як аналіз просторової, функціональної та екологічної підсистеми міської зеленої інфраструктури. Такий підхід відповідає положенням Концепції розвитку зеленої інфраструктури Івано-Франківської МТГ до 2035 року, у якій зелені й водні території розглядаються як взаємопов'язана мережа, що забезпечує екосистемні послуги, кліматичну адаптацію, рекреацію, підтримку біорізноманіття та підвищення якості життя населення.

В Івано-Франківську нараховується 112 скверів, 7 парків і 8 територій природно-заповідного фонду. Сумарна площа скверів згідно нормативних документів становить орієнтовно 58,4 га. Ці показники свідчать про кількісно розвинену мережу малих зелених територій, однак сам факт надання земельній ділянці статусу скверу ще не означає її повного благоустрою, сформованості насаджень або належної експлуатаційної якості. Тому кількість юридично визначених скверів необхідно відрізняти від кількості фактично облаштованих і повноцінно функціонуючих громадських просторів.

У березні 2026 року було повідомлено про рішення щодо створення ще чотирьох скверів: на вул. Галицькій біля будинку № 134, у районі вулиць Молодіжної та Проктної, на вул. Івана Павла II біля будинку № 20 і на вул. 24 Серпня. Ці території доцільно трактувати як заплановані або юридично визначені зелені зони, а не автоматично як завершені об'єкти благоустрою, оскільки між рішенням про створення скверу та його фактичним облаштуванням існують етапи землевпорядкування, проєктування, фінансування, виконання робіт і прийняття в експлуатацію.

Просторове розміщення скверів у структурі Івано-Франківська є нерівномірним. Найбільш упізнавані та історично сформовані об'єкти зосереджені у центральній і прилеглий до центру частинах міста, де вони інтегровані у мережу площ, вулиць, громадських закладів і пішохідних маршрутів. До таких просторів належать Меморіальний сквер, малі озеленені ділянки біля громадських та культових будівель, транспортних вузлів і житлових кварталів. Меморіальний сквер при цьому виконує не лише рекреаційну, а й виразну комеморативну функцію, залишаючись місцем офіційних церемоній і громадського вшанування загиблих.

У периферійних житлових районах і нових масивах забудови озеленені території часто мають фрагментарний характер. Частина з них сформована як невеликі внутрішньоквартальні або придорожні зелені ділянки, які можуть мати статус скверу, але не завжди містять повний комплекс елементів благоустрою. В умовах інтенсивного житлового будівництва особливо актуальним є резервування ділянок під нові локальні зелені простори до початку освоєння території, оскільки після формування щільної забудови створення повноцінного скверу стає значно складнішим і дорожчим.

Концепція зеленої інфраструктури вказує на необхідність формування взаємопов'язаної мережі, до якої мають входити не лише парки та великі природні території, але й сквери, кишенькові парки, вуличне озеленення, річкові долини, дощові сади та зелені коридори. Для Івано-Франківська особливе значення має просторовий зв'язок малих зелених територій із долинами Бистриці Надвірнянської та Бистриці Солотвинської, системою малих водотоків, міським озером, парком імені Тараса Шевченка та озеленими вулицями.

Таким чином, основною проблемою є не лише кількість скверів, а ступінь їх зв'язності. Ізольований сквер може забезпечувати локальний відпочинок, однак його екологічний і кліматорегулювальний ефект значно зростає, коли він включений у безперервний або дискретно пов'язаний зелений маршрут.

Пішохідна доступність є одним із ключових критеріїв ефективності мережі малих зелених просторів. Для її аналізу доцільно використовувати не прості радіуси навколо скверів, а ізохрони руху фактичною вулично-пішохідною мережею. Базовим орієнтиром може бути зона 5–10-хвилинної ходьби, що приблизно відповідає 300–800 м залежно від віку користувачів, якості маршруту, рельєфу, наявності переходів і фізичних бар'єрів.

Попереднє картографічне зіставлення структури забудови з розташуванням відомих зелених просторів дає підстави припускати кращу забезпеченість центральної частини міста та окремих історично сформованих районів. Водночас у нових житлових масивах, периферійних кварталах і частині приєднаних населених пунктів громади доступність може бути нижчою або залежати від невеликих неформалізованих зелених ділянок.

Стан благоустрою скверів є неоднорідним. Окремі центральні та репрезентативні простори мають сформовану доріжкову мережу, освітлення,

місця для сидіння, меморіальні або декоративні елементи та регулярне утримання. Інші території виконують переважно транзитну або буферну функцію і характеризуються мінімальним предметним наповненням.

Особливо важливо розрізняти декоративно відремонтований простір і функціонально стійкий сквер. Значна площа нового мощення або велика кількість малих архітектурних форм не обов'язково свідчать про високу якість, якщо при цьому зменшено площу ґрунту, погіршено умови росту дерев, не забезпечено затінення або відсутня доступність.

Озеленення скверів Івано-Франківська сформоване переважно деревною рослинністю, газонами, фрагментарними чагарниковими й квітниковими композиціями. У старих скверах основну екологічну і просторову цінність становлять зрілі дерева, які забезпечують затінення, акумуляцію вуглецю, фільтрацію пилу та формування характерного образу місця. У новіших або реконструйованих просторах часто переважають молоді насадження, екологічний ефект яких стане значним лише через тривалий час.

Головним завданням має бути не формальне збільшення кількості висаджених рослин, а збереження життєздатного деревного полог, покращення ґрунтових умов і формування багаторівневої структури. Концепція розвитку зеленої інфраструктури передбачає збереження біорізноманіття, багаторівневе озеленення, застосування ґрунтопокривних рослин, різнотравних луків і природоорієнтованих рішень.

Отже, сучасний стан скверів Івано-Франківська можна охарактеризувати як кількісно розвинений, але нерівномірний за просторовою доступністю, функціональною сформованістю, якістю благоустрою та станом озеленення.

Напрями удосконалення благоустрою скверів Івано-Франківської міської територіальної громади

Удосконалення благоустрою скверів Івано-Франківської міської територіальної громади доцільно здійснювати не як сукупність локальних ремонтних заходів, а як складову цілісної політики розвитку зеленої інфраструктури. Такий підхід передбачає одночасне вирішення просторових, екологічних, соціальних, управлінських та технологічних завдань. Відповідно до положень Концепції розвитку зеленої інфраструктури Івано-Франківської МТГ до 2035 року, окремі зелені території мають функціонувати як взаємопов'язані елементи єдиної зелено-блакитної мережі, що забезпечує екосистемні послуги, адаптацію до зміни клімату, підтримання біорізноманіття та підвищення якості життя населення.

Формування мережі кишенькових парків

Одним із найбільш перспективних напрямів є розвиток мережі малих зелених просторів типу «кишенькових парків». Їх створення є особливо доцільним у щільно забудованих районах, де відсутні резерви для формування великих парків або повноцінних рекреаційних комплексів. Такі простори можуть розміщуватися на занедбаних ділянках, територіях після демонтажу тимчасових споруд, у

міжквартальних розривах, біля громадських будівель, транспортних зупинок або в місцях локальної концентрації пішохідних потоків.

Кишенькові парки доцільно розглядати як найнижчий, але найчастіше використовуваний рівень зеленої інфраструктури. Їх основною перевагою є наближеність до повсякденних маршрутів мешканців. Навіть за невеликої площі такий простір може забезпечувати короточасний відпочинок, затінення, локальне зниження температури, підвищення естетичної якості середовища та формування місця соціальної взаємодії. Для Івано-Франківська пріоритетними є райони нової житлової забудови та території з дефіцитом зелених просторів у межах 5–10-хвилинної пішохідної доступності.

Розвиток зелених коридорів

Другим стратегічним напрямом має стати формування зелених коридорів, які забезпечують просторовий і екологічний зв'язок між скверами, парками, вуличним озелененням, річковими долинами, міським озером та приміськими природними територіями. У міському середовищі такими коридорами можуть бути озеленені вулиці, бульвари, велосипедно-пішохідні маршрути, прибережні смуги та лінійні насадження вздовж транспортних магістралей.

Для Івано-Франківської МТГ важливим є включення скверів до мережі, пов'язаної з долинами Бистриці Надвірнянської та Бистриці Солотвинської, системою малих водотоків і Міським озером. У такій моделі сквери виконуватимуть функцію локальних вузлів, а вуличне озеленення і пішохідні маршрути — функцію сполучних елементів. Це дозволить зменшити фрагментацію зеленої системи, покращити міграцію видів, підвищити комфорт пішохідного пересування та сформувати безперервні затінені маршрути.

Створення скверів пам'яті

У сучасних умовах окремого значення набуває розвиток скверів пам'яті. Вони мають поєднувати меморіальну, рекреаційну, психологічну та соціальну функції. Такий простір не повинен бути лише місцем встановлення пам'ятного знака; він має формувати середовище для тихого споглядання, громадського вшанування, повсякденного перебування та діалогу між різними поколіннями.

Проектування меморіальних скверів потребує особливо делікатного підходу до композиції, добору рослин, освітлення, матеріалів і символічних елементів. Надмірна монументальність може знизити відкритість простору, тоді як недостатня виразність — послабити меморіальний зміст. Тому доцільним є поєднання стриманої ландшафтної композиції, місць для сидіння, тінєвих зон, інтерактивних інформаційних елементів та природних матеріалів. Прикладом такого напрямку є ініціативи ревіталізації конфліктних територій у центральній частині Івано-Франківська через створення відкритих громадських просторів.

Підвищення біорізноманіття

Наступним напрямом має бути відмова від спрощених декоративних схем озеленення на користь екологічно стійких багаторусних рослинних

композицій. У скверах доцільно поєднувати дерева, чагарники, ґрунтопокривні види, лучні трави та рослини для запилювачів. Перевагу слід надавати автохтонним або добре адаптованим видам, які відповідають кліматичним умовам Прикарпаття та потребують менших витрат на догляд.

Важливим є збереження зрілих дерев як найбільш цінного елементу міської зеленої інфраструктури. Під час реконструкції необхідно уникати пошкодження кореневих систем, надмірного мощення, підняття рівня ґрунту біля стовбурів та заміни сформованих дерев молодими саджанцями без об'єктивної необхідності. Підвищення біорізноманіття має бути одним із критеріїв якості проектного рішення, а не другорядним декоративним завданням.

Впровадження дощових садів

В умовах збільшення інтенсивності короточасних опадів важливим напрямом є використання дощових садів та інших елементів локального управління поверхневим стоком. Дощові сади можуть бути інтегровані у пониження рельєфу, уздовж доріжок, на межі скверу з вуличною мережею або в місцях відведення води з покриттів.

Такі рішення дозволяють тимчасово затримувати опади, зменшувати навантаження на дощову каналізацію, очищувати воду від завислих речовин та підтримувати вологість ґрунту. Крім інженерної функції, дощові сади підвищують ландшафтну виразність простору та створюють нові оселища для комах, птахів і вологолюбної рослинності. Для Івано-Франківська їх застосування є доцільним у скверах, розташованих у зонах локальних підтоплень або поблизу інтенсивно замошених територій.

Участь громади

Удосконалення скверів повинно здійснюватися з активним залученням мешканців. Партисипативний підхід дає змогу враховувати реальні сценарії використання простору, потреби різних вікових груп, локальні конфлікти та особливості місцевої ідентичності.

Участь громади може відбуватися через опитування, воркшопи, публічні обговорення, архітектурні конкурси, тестове облаштування тимчасових елементів та спільне оцінювання проектних рішень. Водночас громадське залучення не повинно підміняти професійне проектування. Найбільш ефективною є модель, у якій мешканці формують потреби й сценарії, а фахівці переводять їх у просторові, ландшафтні та інженерні рішення.

Особливе значення участь громади має для скверів пам'яті, де проектно рішення безпосередньо пов'язане з колективною пам'яттю, емоційною чутливістю та суспільною довірою.

Оцінювання екосистемних послуг

Для підвищення обґрунтованості управлінських рішень доцільно запровадити оцінювання екосистемних послуг, які надає кожен сквер. Йдеться про затінення, зниження температури, поглинання пилу, утримання дощових вод, підтримання біорізноманіття, рекреаційне використання, психологічне відновлення та культурну цінність.

Таке оцінювання дозволить відійти від формального підходу, за якого якість скверу визначається лише кількістю лав, площею мощення або вартістю реконструкції. Натомість об'єкт оцінюватиметься за реальним внеском у стійкість міського середовища. Для практичного застосування доцільно використовувати систему індикаторів: частка території під кронами дерев, площа водопроникних покриттів, обсяг затриманого поверхневого стоку, видовий склад насаджень, кількість користувачів, рівень пішохідної доступності та інтенсивність рекреаційного використання.

Висновки

У результаті проведеного дослідження встановлено, що сквери Івано-Франківської міської територіальної громади доцільно розглядати не як ізольовані об'єкти благоустрою, а як повноцінні структурні елементи зеленої інфраструктури. Їх значення визначається сукупністю екологічних, соціальних, містобудівних, кліматичних, психологічних, естетичних, економічних і меморіальних функцій. Саме багатофункціональність скверів обумовлює необхідність переходу від локальних ремонтних заходів до комплексного управління їх просторовим розвитком, благоустроєм, озелененням і подальшим утриманням.

Аналіз наукових підходів і практик показав, що сучасний сквер має забезпечувати не лише рекреаційне використання, але й надання екосистемних послуг: регулювання мікроклімату, затримання поверхневого стоку, зниження рівня запиленості й шуму, підтримання біорізноманіття, створення умов для щоденної соціальної взаємодії та психологічного відновлення населення. Відповідно, якість благоустрою слід оцінювати не лише за кількістю малих архітектурних форм або площею нового мощення, а за фактичним внеском скверу у стійкість міського середовища та комфорт користувачів.

Встановлено, що Концепція розвитку зеленої інфраструктури Івано-Франківської МТГ до 2035 року загалом відповідає сучасним європейським принципам просторового розвитку. У ній зелена інфраструктура розглядається як взаємопов'язана зелено-блакитна мережа, що поєднує природні, напівприродні та штучно створені елементи й виконує екологічні, соціальні та економічні функції. Документ узгоджується з підходами сталого розвитку, кліматичної адаптації, збереження біорізноманіття, природоорієнтованого управління дощовими водами, цифровізації обліку насаджень і залучення громадськості до прийняття рішень. У цьому контексті сквери мають розглядатися як локальні вузли мережі, що доповнюють парки, річкові долини, вуличне озеленення, зелені коридори та кишенькові парки.

Проведений аналіз також засвідчив необхідність переходу до мережевої моделі розвитку зелених просторів. Кількісне збільшення числа скверів саме по собі не гарантує належної якості міського середовища. Вирішальне значення мають їх просторовий розподіл, пішохідна доступність, функціональна типологія, екологічна зв'язність, стан насаджень і взаємодія з іншими елементами

зеленої інфраструктури. Тому перспективним є формування системи взаємопов'язаних скверів і кишенькових парків, інтегрованих у зелені коридори та пішохідні маршрути, особливо у районах щільної забудови й територіях із дефіцитом громадських зелених просторів.

До основних практичних напрямів удосконалення благоустрою скверів віднесено створення мережі малих локальних зелених просторів, розвиток зелених коридорів, формування скверів пам'яті, підвищення біорізноманіття, збереження зрілих дерев, застосування місцевих і кліматично стійких видів рослин, впровадження дощових садів, водопроникних покриттів та інших природоорієнтованих рішень. Окремого значення набуває створення GIS-реєстру, цифрових паспортів скверів і системи регулярного моніторингу їхнього стану.

Перспективи впровадження природоорієнтованих рішень у благоустрій скверів Івано-Франківська є значними. Дощові сади, біоретенційні смуги, багатоярусне озеленення, різнотравні луки, водопроникні покриття та локальне утримання опадів можуть одночасно зменшувати навантаження на дощову каналізацію, покращувати мікроклімат, підтримувати біорізноманіття та знижувати експлуатаційні витрати. Їх ефективність буде найвищою за умови інтеграції у загальну систему просторового планування громади та поєднання з цифровим моніторингом і належним доглядом.

Отже, подальший розвиток скверів Івано-Франківська має ґрунтуватися на системному, людиноцентричному та екологічно орієнтованому підході. Реалізація положень Концепції до 2035 року створює передумови для переходу від фрагментарного благоустрою до цілісного управління зеленою інфраструктурою. Це дозволить підвищити просторову доступність зелених зон, посилити кліматичну стійкість міського середовища, покращити якість громадських просторів і сформувати більш комфортну, безпечну та екологічно збалансовану міську територію.

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ARTS

CONSTRUCTIVE-TEXTURAL FORM GENERATION IN FASHION DESIGN: INTEGRATION OF TECHNOLOGICAL PROCESSES, STYLE FORMATION, MARKETING TECHNOLOGIES, AND BRAND MANAGEMENT

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КОНСТРУКТИВНО-ФАКТУРНЕ ФОРМОУТВОРЕННЯ В ДИЗАЙНІ ОДЯГУ: ІНТЕГРАЦІЯ ТЕХНОЛОГІЧНИХ ПРОЦЕСІВ, ФОРМУВАННЯ СТИЛЮ, МАРКЕТИНГОВИХ ТЕХНОЛОГІЙ ТА БРЕНД-МЕНЕДЖМЕНТУ

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Abstract

The article investigates the peculiarities of constructive-textural form generation in fashion design within the context of integrating modern technological processes, style formation, marketing technologies, and brand management. The relevance of the research is determined by the need for a comprehensive approach to clothing design that combines artistic, aesthetic, technological, and marketing aspects to create competitive fashion products.

Анотація.

У статті досліджено особливості конструктивно-фактурного формоутворення в дизайні одягу в контексті інтеграції сучасних технологічних процесів, формування стилю, маркетингових технологій та бренд-менеджменту. Актуальність дослідження зумовлена необхідністю комплексного підходу до проєктування сучасного одягу, що поєднує художньо-естетичні, конструктивно-технологічні та комунікаційно-маркетингові аспекти створення конкурентоспроможного дизайнерського продукту.

Keywords: constructive-textural form generation; fashion design; technological processes; style formation; advertising and marketing technologies in fashion design; fashion and stylistics; brand management; fashion marketing; image design.

Ключові слова: конструктивно-фактурне формоутворення; дизайн одягу; технологічні процеси; формування стилю; реклама і маркетингові технології в дизайні одягу; мода і стилістика; бренд-менеджмент; маркетинг у сфері моди; імідж-дизайн.

Сучасна індустрія моди функціонує в умовах стрімкого розвитку цифрових технологій, глобалізації ринку, зміни споживчих пріоритетів та посилення конкуренції між виробниками дизайнерської продукції. За цих умов дизайн одягу виходить за межі виключно художньо-проектної діяльності й перетворюється на комплексну систему, що охоплює творчі, технологічні, економічні та маркетингові складові. Конкурентоспроможність сучасного

дизайнерського продукту визначається не лише його естетичними та функціональними характеристиками, а й здатністю відповідати актуальним тенденціям моди, формувати впізнаваний стиль бренду та ефективно комунікувати зі споживачем [10].

Одним із ключових напрямів сучасного проєктування одягу є конструктивно-фактурне формо-

утворення, яке забезпечує створення нових художньо-образних рішень шляхом поєднання конструктивних особливостей виробу з різноманітними фактурними ефектами матеріалів. Застосування інноваційних конструктивних прийомів, сучасних текстильних технологій, цифрового моделювання, автоматизованого проектування та експериментальних способів обробки матеріалів розширює можливості дизайнерів у створенні унікальних моделей одягу, здатних відповідати вимогам сучасного ринку [8].

Конструктивно-фактурне формоутворення дедалі частіше розглядається не лише як засіб художньої виразності, а й як інструмент формування стилістичної концепції колекції, візуальної ідентичності бренду та його ринкового позиціонування.

У сучасній індустрії моди успішність дизайнерського продукту значною мірою залежить від інтеграції проєктної діяльності з маркетинговими технологіями, рекламними комунікаціями, бренд-менеджментом та імідж-дизайном. Саме синергія творчого задуму, технологічних інновацій і стратегічного управління брендом забезпечує формування цілісного образу модного продукту та підвищує його конкурентоспроможність на національному й міжнародному ринках [5].

Актуальність дослідження зумовлена необхідністю наукового осмислення взаємозв'язку між конструктивно-фактурним формоутворенням, технологічними процесами виготовлення одягу, формуванням стилю, маркетинговими комунікаціями та бренд-менеджментом у контексті розвитку сучасної модної індустрії. Незважаючи на значну кількість наукових праць, присвячених окремим аспектам дизайну одягу, технології швейного виробництва, маркетингу моди та брендингу, комплексне дослідження інтеграції зазначених складових залишається недостатньо висвітленим, що визначає наукову доцільність цього дослідження [9].

Метою статті є дослідження особливостей конструктивно-фактурного формоутворення в дизайні одягу та обґрунтування його ролі в інтеграції сучасних технологічних процесів, формуванні стилю, застосуванні маркетингових технологій, бренд-менеджменту й імідж-дизайну для створення конкурентоспроможного дизайнерського продукту [8].

Основа дослідження становлять загальнонаукові та спеціальні методи, серед яких аналіз і синтез наукових джерел, системний, структурно-функціональний, порівняльний та проєктний методи, що дали змогу комплексно дослідити процес конструктивно-фактурного формоутворення в контексті сучасної індустрії моди [10].

Проблематика конструктивно-фактурного формоутворення в дизайні одягу є предметом досліджень українських і зарубіжних науковців у галузях дизайну, легкої промисловості, мистецтвознавства та маркетингу. Сучасні наукові праці присвячені питанням художньо-композиційних засад формоутворення, використання інноваційних матеріалів і технологій, цифрового проектування, розвитку бренд-менеджменту, маркетингових комунікацій та формування конкурентоспроможності дизайнерського продукту [3, с.92].

Значна частина досліджень розкриває особливості конструктивного та морфологічного формоутворення одягу. У сучасних публікаціях увагу зосереджено на закономірностях побудови об'ємно-просторової форми виробу, морфологічній класифікації конструктивних елементів, застосуванні геометричного моделювання та новітніх методів проектування, що сприяють удосконаленню процесів створення сучасного одягу [9].

Окремий напрям досліджень стосується конструктивно-фактурного формоутворення як засобу художньої виразності. Науковці аналізують способи створення фактурних поверхонь, використання нетрадиційних матеріалів, прийомів пластичного моделювання, деконструкції, параметричного проектування та інших інноваційних підходів до формування сучасного костюма. Такі дослідження доводять, що фактура сьогодні виконує не лише декоративну функцію, а є важливим елементом художнього образу, стилістичної концепції та дизайнерської ідентичності виробу [3, с. 73].

У сучасній науковій літературі дедалі більше уваги приділяється цифровізації процесів проектування одягу. Використання тривимірного моделювання, параметричного дизайну, засобів візуалізації, цифрових платформ і технологій штучного інтелекту відкриває нові можливості для створення інноваційних конструктивних і фактурних рішень, оптимізації технологічних процесів та скорочення часу розроблення нових колекцій [6].

Водночас розвиток індустрії моди обумовив активізацію досліджень у сфері маркетингу, брендингу та управління модними брендами. У наукових працях обґрунтовується, що сучасний дизайнерський продукт повинен поєднувати високий рівень художнього проектування із системою маркетингових комунікацій, реклами, позиціонування бренду та формування його візуальної ідентичності. Успішність бренду визначається не лише якістю виробу, а й ефективністю бренд-менеджменту, імідж-дизайну та комунікації зі споживачами [9].

Попри значну кількість досліджень, більшість із них висвітлює окремі аспекти конструктивно-фактурного формоутворення, технології виготовлення одягу, цифрового проектування або маркетингової діяльності підприємств модної індустрії. Водночас недостатньо дослідженими залишаються питання комплексної інтеграції конструктивно-фактурного формоутворення, сучасних технологічних процесів, формування стилю, маркетингових технологій, бренд-менеджменту та імідж-дизайну як взаємопов'язаних складових створення конкурентоспроможного дизайнерського продукту [6].

Саме необхідність комплексного дослідження взаємодії художньо-проєктних, технологічних та маркетингових чинників у процесі створення сучасного одягу визначає актуальність цієї статті, її наукову новизну та практичну значущість. Мета статті полягає у комплексному дослідженні конструктивно-фактурного формоутворення в дизайні одягу та обґрунтуванні його ролі в інтеграції сучасних технологічних процесів, формуванні стилю,

застосуванні маркетингових технологій, бренд-менеджменту та імідж-дизайну для створення конкурентоспроможного дизайнерського продукту в умовах розвитку сучасної індустрії моди [2].

Методологічну основу дослідження становить сукупність загальнонаукових і спеціальних методів, що забезпечили комплексне вивчення проблематики. Застосовано аналіз і синтез для опрацювання наукової літератури та систематизації сучасних підходів до конструктивно-фактурного формоутворення; системний метод – для дослідження взаємозв'язку між художньо-проектними, технологічними та маркетинговими складовими дизайну одягу; структурно-функціональний метод – для визначення ролі конструктивних і фактурних елементів у формуванні стилістичної концепції виробу; порівняльний метод – для зіставлення традиційних та інноваційних підходів до проектування одягу; проектний метод – для обґрунтування практичних аспектів створення дизайнерських колекцій із використанням сучасних технологій і принципів бренд-орієнтованого проектування [7].

Крім того, використано комплексний міждисциплінарний підхід, який поєднує положення теорії дизайну, матеріалознавства, технології швейного виробництва, маркетингу, бренд-менеджменту та іміджології. Це дало змогу розглянути конструктивно-фактурне формоутворення не лише як художньо-технологічний процес, а й як ефективний інструмент формування конкурентних переваг дизайнерського продукту та розвитку модного бренду [1, с. 115].

Застосування зазначених методів забезпечило всебічне дослідження конструктивно-фактурного формоутворення в системі сучасного дизайну одягу та стало підґрунтям для обґрунтування практичних рекомендацій щодо інтеграції технологічних, стилістичних і маркетингових рішень у процесі розроблення конкурентоспроможних модних колекцій.

Конструктивно-фактурне формоутворення є одним із визначальних напрямів сучасного дизайну одягу, що забезпечує гармонійне поєднання конструктивної побудови виробу, пластичних властивостей матеріалів і художньо-естетичних засобів виразності[9].

На відміну від традиційного конструювання, орієнтованого переважно на забезпечення функціональності та ергономічності виробу, конструктивно-фактурне формоутворення передбачає комплексне проектування, у якому конструкція, фактура, силует, колір і декоративні елементи формують єдину художньо-композиційну систему [8].

У сучасній практиці дизайну одягу конструктивно-фактурне формоутворення розглядається як багаторівневий процес, що інтегрує художнє проектування, технології виготовлення виробів, матеріалознавство та цифрові засоби моделювання. Такий підхід дає змогу створювати вироби з високим рівнем індивідуалізації, які відповідають сучасним естетичним, функціональним і комерційним вимогам [10].

Форма одягу виникає внаслідок взаємодії кількох взаємопов'язаних чинників: конструктивної побудови виробу, фізико-механічних властивостей текстильних матеріалів, технології обробки деталей, композиційних принципів та творчої концепції дизайнера. При цьому фактура матеріалу перестає виконувати лише декоративну функцію і стає активним засобом художньої виразності, який визначає характер силуету, пластичність форми, особливості світлотіньового сприйняття та емоційний образ виробу.

Особливого значення конструктивно-фактурне формоутворення набуває в умовах розвитку цифрових технологій. Використання систем автоматизованого проектування (CAD), тривимірного моделювання, цифрового друку на текстильних матеріалах, лазерного різання, ультразвукового виробництва тканин і технологій адитивного виробництва істотно розширює можливості дизайнерів щодо створення складних просторових конструкцій та нових фактурних рішень. Завдяки цьому дизайн одягу переходить від традиційного моделювання до інноваційного проектування, де конструкція та фактура створюються одночасно як взаємозалежні елементи єдиної композиції [5].

Важливою особливістю сучасного конструктивно-фактурного формоутворення є його орієнтація на індивідуалізацію дизайнерського продукту. В умовах високої конкуренції саме оригінальні конструктивні рішення та авторські фактури формують унікальність колекції, підкреслюють творчу концепцію дизайнера та сприяють створенню впізнаваної візуальної мови бренду. Це дозволяє не лише підвищити художню цінність виробу, а й сформувати його конкурентні переваги на ринку модної індустрії [4, с. 118].

Таким чином, конструктивно-фактурне формоутворення доцільно розглядати як інтегровану систему, що поєднує художньо-проектні, конструктивно-технологічні та естетичні принципи створення одягу. Ефективність цього процесу визначається здатністю дизайнера гармонійно поєднати функціональні властивості виробу, інноваційні технології, композиційні закономірності та сучасні тенденції моди. Саме такий комплексний підхід створює підґрунтя для формування конкурентоспроможного дизайнерського продукту та розвитку сучасних модних брендів. У результаті проведеного дослідження встановлено, що конструктивно-фактурне формоутворення є одним із визначальних чинників розвитку сучасного дизайну одягу, оскільки забезпечує інтеграцію художньо-композиційних, конструктивно-технологічних і маркетингових складових процесу проектування. На відміну від традиційного підходу, сучасне конструктивно-фактурне формоутворення розглядається як комплексна система, у якій конструкція, фактура, матеріал, технологія та дизайнерська концепція взаємодіють для створення конкурентоспроможного модного продукту.

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BIOLOGICAL SCIENCES

COMPARATIVE ASSESSMENT OF THE PHYTOTOXIC AND ZOOTOXIC ACTIVITIES OF ENDOGENOUS AND EXOGENOUS METABOLITES PRODUCED BY FUNGI ISOLATED FROM DIFFERENT ECOSYSTEMS OF AZERBAIJAN

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Abstract

This study evaluated the phytotoxic activity of endogenous and exogenous metabolites produced by fungi isolated from different ecosystems in Azerbaijan. A total of 46 fungal species belonging to the phyla Ascomycota, Basidiomycota, and Mucormycota were investigated to determine the toxicity of their metabolites. The results revealed considerable variation in phytotoxic activity among the studied fungi. Of all species examined, 26.7% exhibited strong phytotoxic activity, 56.6% moderate activity, 10.0% weak activity, while 6.7% showed no detectable phytotoxic effect. All fungi with strong phytotoxic activity belonged to the phylum Ascomycota. In contrast, none of the Basidiomycota species demonstrated either strong or moderate phytotoxicity; 50% exhibited weak activity, whereas the remaining species showed no phytotoxic effects. All representatives of the phylum Mucormycota displayed weak phytotoxic activity. Comparative analysis further demonstrated that exogenous metabolites generally exhibited higher phytotoxicity than endogenous metabolites. The observed differences among taxonomic groups appear to reflect their ecological adaptations and competitive strategies in natural habitats. Xylotrophic macromycetes, which colonize relatively stable woody substrates with lower levels of biological competition, exhibited substantially lower phytotoxic activity than soil- and plant-associated micromycetes. These findings provide new insights into the ecological significance of fungal metabolites and demonstrate that phytotoxicity is closely associated with fungal taxonomy, ecological niche, and adaptive strategies.

Keywords: fungi, endogenous metabolites, exogenous metabolites, phytotoxic activity, ecological adaptation, Azerbaijan

Introduction

Fungi constitute one of the most diverse and ecologically important groups of organisms on Earth, playing indispensable roles in ecosystem functioning. As major components of the heterotrophic compartment of terrestrial and aquatic ecosystems, fungi contribute to the decomposition of organic matter, nutrient cycling, soil formation, and the regulation of ecological processes. Although approximately 120,000 fungal species have been formally described, recent estimates suggest that their global diversity may reach 2.2–3.8 million species, highlighting the vast extent of undescribed fungal biodiversity¹. In addition to their ecological significance, fungi synthesize a wide range of primary and secondary metabolites that influence interactions with other organisms and determine their adaptation to diverse environmental conditions (22–27).

Among fungal secondary metabolites, mycotoxins represent one of the most intensively studied groups because of their ecological and biological significance. These compounds enhance fungal competitiveness by inhibiting the growth of competing microorganisms and plants while also contributing to successful colonization of ecological niches. However, many mycotoxins are harmful to animals and humans due to their mutagenic, carcinogenic, hepatotoxic, nephrotoxic, and immunotoxic properties. Consequently, evaluating the toxic potential of fungal metabolites has become an important research area in environmental microbiology, mycology, agriculture, and food safety.

The Republic of Azerbaijan is characterized by diverse climatic zones and ecosystems that support a rich and insufficiently explored fungal diversity. Previous investigations have documented numerous toxigenic fungal species in soils, freshwater habitats, and plant-associated communities across different regions of the country^{5–7}. Nevertheless, current knowledge remains limited regarding the comparative phytotoxic activity of endogenous and exogenous metabolites produced by fungi belonging to different taxonomic groups and ecological habitats. Moreover, the influence of ecological adaptation and habitat characteristics on fungal phytotoxicity has received relatively little attention.

Differences in environmental conditions, substrate availability, and biological competition are expected to affect both the qualitative and quantitative composition of fungal metabolites. Consequently, fungi occupying different ecological niches may exhibit distinct levels of phytotoxic activity, reflecting their adaptive strategies and ecological functions. Comparative investigations of metabolite toxicity among fungi from different habitats therefore provide valuable insights into fungal ecology and the biological significance of secondary metabolites.

The present study aimed to evaluate and compare the phytotoxic activity of endogenous and exogenous metabolites produced by fungi isolated from soil, water, and plant ecosystems of Azerbaijan and to determine how phytotoxicity varies among different taxonomic groups in relation to their ecological adaptation.

MATERIALS AND METHODS

Fungal isolation and identification

The study was conducted during 2024–2025 using fungal isolates obtained from soil, water, and plant samples collected in different regions of the Greater Caucasus, including the Guba–Khachmaz and Absheron Economic Regions of Azerbaijan. Fungal isolation, purification, species identification, and the assessment of their suitability for bioconversion were performed using standard microbiological, mycological, and biotechnological methods described previously (15–16, 42–44).

Preparation of endogenous and exogenous metabolites

The phytotoxic and zootoxic activities of fungal metabolites were evaluated using both exogenous and endogenous metabolites. Exogenous metabolites were represented by culture filtrates (CF) obtained after cultivating fungal isolates for five days in liquid Czapek or glucose–peptone medium. Endogenous metabolites were obtained from the fungal biomass (vegetative mycelium, VM).

Following cultivation, the fungal biomass was separated from the culture filtrate and washed several times with neutral phosphate buffer (pH 7.0). Subsequently, 50 mL of phosphate buffer was added to the biomass, after which the cells were disrupted using a tissue grinder. The homogenate was centrifuged three times at 5,000 rpm for 10 min, and the resulting supernatant was collected as the source of endogenous metabolites.

Evaluation of phytotoxic and zootoxic activity

Phytotoxic activity was assessed by determining the effects of fungal metabolites on the germination of wheat (*Triticum aestivum* L.) and pea (*Pisum sativum* L.) seeds using established bioassay methods. Zootoxic activity was evaluated using the ciliate *Paramecium caudatum* Ehrenberg as the test organism following standard protocols reported in previous studies.

Each experiment was performed in at least four independent replicates. The obtained data were statistically analyzed, and the results are presented as mean values. Statistical significance was evaluated using appropriate statistical methods at a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Approximately 500 soil, water, and plant samples were collected from different locations within the study area during 2024–2025. From these samples, 76 pure fungal isolates were obtained, including 60 micromycetes and 16 macromycetes. Based on their cultural and morphological characteristics, these isolates were identified as belonging to 46 fungal species. Of the identified species, 65.2% belonged to the phylum Ascomycota, 26.1% to Basidiomycota, and 8.7% to Mucoromycota.

The phytotoxic activity of fungal metabolites varied considerably among the investigated taxa. Strong phytotoxic activity, defined as more than 40% inhibition of seed germination, was observed exclusively among micromycetes. Moderate phytotoxic activity (20–40% inhibition) was also recorded primarily in species belonging to Ascomycota, whereas Basidiomycota species did not exhibit either strong or moderate phytotoxic effects. Weak phytotoxic activity (less than

20% inhibition) was detected in several representatives of Basidiomycota and all representatives of Mucoromycota.

Overall, 26.7% of the Ascomycota species exhibited strong phytotoxic activity, 56.6% moderate activity, 10.0% weak activity, and only 6.7% showed no detectable phytotoxic effect. In contrast, none of the Basidiomycota species demonstrated strong or moderate phytotoxicity; half of the species exhibited weak activity, whereas the remaining species showed no phytotoxic effects. All Mucoromycota species exhibited weak phytotoxic activity.

Interestingly, culture filtrates obtained from the xylophilic fungi *Cerrena unicolor*, *Pleurotus ostreatus*, and *Laetiporus sulphureus* did not inhibit seed germination. Instead, they stimulated wheat seed germination by approximately 4–7% compared with the untreated control, suggesting the presence of metabolites with growth-promoting properties.

Comparison of endogenous and exogenous metabolites demonstrated that exogenous metabolites consistently exhibited higher phytotoxic activity. The number of fungal species showing strong phytotoxicity decreased from eight to six when endogenous metabolites were evaluated. Likewise, the overall phytotoxicity index decreased from 44.4–59.7% for exogenous metabolites to 40.4–54.4% for endogenous metabolites, indicating that extracellular metabolites contribute more substantially to fungal phytotoxicity. Similar findings have been reported for fungal secondary metabolites by Keller (18) and Vasilenko et al. (5).

Evaluation of zootoxic activity using *Paramecium caudatum* revealed a pattern similar to that observed for phytotoxicity. Exogenous metabolites from fungi exhibiting strong or moderate phytotoxicity reduced the viability of the test organism by approximately 1.2–2.0-fold relative to the control, whereas endogenous metabolites reduced viability by 1.05–1.65-fold. In contrast, metabolites produced by fungi with weak phytotoxic activity had little or no adverse effect on the survival of *P. caudatum*. Furthermore, metabolites produced by xylophilic macromycetes frequently stimulated the growth of the protozoan rather than inhibiting it.

The observed differences in phytotoxic and zootoxic activities among fungal taxa are likely associated with their ecological adaptation and competitive strategies (6,18). Soil- and water-associated micromycetes inhabit environments characterized by intense competition for nutrients and space, favouring the production of biologically active secondary metabolites that enhance competitive ability (2,6). In contrast, xylophilic macromycetes colonize relatively stable woody substrates where interspecific competition is generally less intense. Consequently, these fungi appear to invest less in the production of toxic metabolites, which explains their comparatively low phytotoxic activity.

The consistently higher toxicity of exogenous metabolites further supports the ecological role of extracellular secondary metabolites in mediating interactions between fungi and other organisms (5,6,18). These metabolites may suppress competing microorganisms and influence surrounding biota, whereas endogenous metabolites primarily participate in intracellular metabolic processes necessary for fungal growth

and development. Similar ecological functions of fungal secondary metabolites have been widely reported in previous studies (5,6,18), supporting the findings of the present investigation.

CONCLUSION

This study demonstrated that endogenous and exogenous metabolites produced by fungi isolated from different ecosystems of Azerbaijan differ significantly in their phytotoxic and zootoxic activities. Exogenous metabolites consistently exhibited stronger biological activity than endogenous metabolites, indicating that extracellular secondary metabolites play a more important role in fungal interactions with other organisms.

The results also revealed that phytotoxic activity varied among fungal taxonomic groups. Species belonging to the phylum Ascomycota showed the highest phytotoxic activity, whereas Basidiomycota and Mucoromycota exhibited predominantly weak or no phytotoxic effects. In particular, xylotrophic macromycetes displayed substantially lower toxicity than micromycetes.

The observed differences are likely associated with ecological adaptation and habitat-specific competitive strategies. Fungi inhabiting soil and water environments experience stronger competition for resources, which may promote the production of biologically active secondary metabolites. In contrast, xylotrophic macromycetes colonize relatively stable woody substrates and therefore exhibit lower levels of phytotoxic activity.

Overall, the findings improve our understanding of the ecological functions of fungal metabolites and demonstrate that metabolite toxicity is closely related to fungal taxonomy, ecological niche, and adaptive strategies. These results provide a useful basis for future studies on fungal secondary metabolites and their potential applications in biotechnology, agriculture, and environmental management.

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ECONOMIC SCIENCES

CYBERSECURITY IN FINANCIAL MARKETS: CURRENT STATE, RISKS, AND STRATEGIC CHALLENGES

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Abstract

The rapid digitalization of financial markets has elevated cyber risks to a core systemic threat, placing the impact of cyberattacks on financial stability at the forefront of the global regulatory agenda. However, a significant research gap remains regarding the cybersecurity landscape of financial markets in developing economies, including Azerbaijan. This study provides a comprehensive analysis of the current state of cybersecurity in the financial sector, examining attack typologies, international regulatory mechanisms, and global trends from 2020 to 2025 to derive strategic recommendations for Azerbaijan. Employing a mixed-methods approach—including quantitative-qualitative analysis, comparative country assessments, and a systematic literature review—this research utilizes empirical data from the IMF, ENISA, IBM Security, the World Economic Forum, and the BIS. The findings reveal that the financial sector accounted for 20% of all global cyber incidents in 2024, with the average cost of a data breach reaching USD 6.08 million 22% above the global cross-industry average. Ransomware, data breaches, AI-driven social engineering, and supply chain vulnerabilities constitute the primary risk categories. While international frameworks like the EU's DORA, US NIST standards, and the FS-ISAC model offer robust pathways for enhancing resilience, Azerbaijan requires tailored interventions. Consequently, this study recommends establishing a unified national cybersecurity coordination platform, deploying AI-based real-time monitoring systems, integrating mandatory stress-testing mechanisms into the regulatory framework, and accelerating human capital development within the financial sector.

Keywords: cybersecurity, financial markets, cyber risk, digital transformation, financial stability, artificial intelligence, regulatory frameworks, Azerbaijan.

Introduction

The digital transformation of the global economy has fundamentally altered the operational paradigms of financial markets in the contemporary era. Advances in information and communication technologies (ICT), the expansion of electronic commerce, the mass adoption of digital payment systems, and the proliferation of online financial service platforms have generated unprecedented opportunities for the sector. However, alongside these advancements, financial markets have increasingly become primary targets for sophisticated cybersecurity threats. The escalating frequency and complexity of cyberattacks targeting financial institutions, payment systems, and capital markets in recent years underscore the urgent need for systematic research in this domain [34].

The digital transformation of financial markets has accelerated significantly over the past decade. Digital banking, mobile payment systems, electronic wallets, open banking platforms, cloud computing, and AI-driven financial services have become foundational components of the sector. Notably, the proliferation of FinTech enterprises has not only enhanced the velocity and accessibility of financial transactions but has also fundamentally reshaped the cyber risk landscape. Consequently, the escalating reliance of financial systems on digital infrastructure has intensified systemic vulnerabilities, rendering the sector more susceptible to digital threats [20].

Cybersecurity plays a pivotal role in safeguarding financial stability, as cyberattacks targeting financial

institutions can inflict severe repercussions not merely on individual firms, but on the systemic integrity of the financial architecture and the confidence of market participants. Prototypical threats—such as data breaches, the disruption of electronic payment systems, ransomware, and denial-of-service attacks—not only heighten operational risk but also serve as catalysts for systemic financial crises. Consequently, cybersecurity should transcend its traditional classification as a purely technical matter, being repositioned instead as a strategic dimension of financial stability, macro-economic security, and sustainable development [10]. The accelerating trajectory of digital transformation within the financial sector of Azerbaijan has concurrently brought these cybersecurity challenges to the forefront. The expanding volume of digital payments, the proliferation of internet and mobile banking services, and the growth of e-commerce collectively expose the sector to emerging categories of risk. While the Cybersecurity Strategy for Financial Markets for 2023–2026, formulated by the Central Bank of the Republic of Azerbaijan, establishes a robust institutional framework, the rapid pace of technological evolution necessitates its continuous iteration [5].

The primary objective of this study is to critically evaluate the contemporary state of cybersecurity in financial markets, delineate existing structural vulnerabilities, examine international regulatory frameworks, and formulate actionable policy recommendations tailored to Azerbaijan. To achieve this overarching aim, the following specific objectives have been established:

to analyze current trends in the digitalization of financial markets; to map the prevailing cyber-threat landscape within the financial sector; to quantify the impact of cybersecurity on financial stability; to execute a comparative analysis of international regulatory mechanisms; and to synthesize scientifically grounded, practice-oriented recommendations for Azerbaijan."

Literature Review

The foundational macroeconomic analysis of cybersecurity challenges within financial markets originates from the seminal study conducted by Kopp, Kaffenberger, and Wilson for the IMF [23]. The authors conceptualized cyber risk not merely as a technological anomaly, but as an economic risk capable of inducing market failures, demonstrating that capital allocations by financial institutions toward cybersecurity systematically fall short of the socially optimal threshold. This framework established the conceptual groundwork for integrating cyber risk into the broader paradigm of systemic financial risk. The International Monetary Fund has consistently reinforced this position in its subsequent literature. Notably, the IMF's 2024 Global Financial Stability Report highlighted the exponential increase in cyber incidents targeting financial institutions, emphasizing that the escalating interconnectedness of contemporary financial networks amplifies the risk of cross-institutional contagion [19].

From a microeconomic perspective, Gordon, Loeb, and Zhou examined the firm-level implications of information security breaches. Their empirical findings indicate that direct financial losses constitute merely a fraction of the total economic damage; conversely, reputational degradation, declines in market capitalization, erosion of consumer trust, and consequential legal liabilities represent the predominant share of the aggregate economic impact [16].

Corroborating this view, Romanosky independently concluded that governance frameworks and strategic management systems exert a more critical influence on risk mitigation than isolated technical defense mechanisms [30].

Regarding sector-specific dynamics in banking, the analysis compiled by Aldasoro, Gambacorta, Giudici, and Leach for the BIS merits particular attention. Their study identified a positive correlation between bank size and cyber risk exposure, while concurrently demonstrating that, unlike credit or market risks, cyber risk exhibits significantly lower statistical predictability [1].

Concurrently, ENISA's Threat Landscape reports dedicated to the financial sector provide a robust empirical foundation. According to these assessments, phishing campaigns, ransomware, social engineering, data breaches, and DDoS attacks account for the vast majority of sector-specific incidents; furthermore, a substantial proportion of these breaches is attributable to human factors rather than inherent technical vulnerabilities [11].

In the domain of capital markets, IOSCO's research underscores the vulnerability of trading platforms, clearing houses, and settlement systems to cyber disruptions, delineating how cyber incidents in securities markets adversely affect market liquidity, price discovery mechanisms, and investor behavior [21]. The

cyber-resilience guidelines jointly formulated by CPMI and IOSCO have established a benchmark international regulatory reference point in this regard; this framework operationalizes cyber resilience not merely through prevention capabilities, but through the capacity to detect, respond to, and recover from operational disruptions [6].

Concerning FinTech architectures, reports from the World Economic Forum indicate that open banking APIs, cloud-based configurations, and artificial intelligence models have introduced novel risk vectors, thereby elevating third-party risk to the core of regulatory oversight [34].

Biener, Eling, and Wirfs elucidated the challenges of underwriting cyber risks through traditional insurance models, demonstrating that these risks constitute an anomalous category due to their extreme uncertainty and systemic nature [3]. Research executed by the US Federal Reserve on the macroeconomic repercussions of cyber risk similarly validates that attacks targeting systemic nodes can trigger widespread financial contagion. Furthermore, a report by the Carnegie Endowment for International Peace underscores the imperative of strengthening multilateral cooperation mechanisms to counter cyber threats to the global financial architecture [4].

A critical synthesis of the existing literature reveals that, while researchers universally acknowledge the strategic salience of cybersecurity for financial stability, several structural gaps persist [7]. Primarily, contemporary literature is heavily concentrated on the financial ecosystems of advanced economies—specifically the United States, the United Kingdom, and the European Union [33]. Furthermore, the banking sector, capital markets, payment infrastructures, and FinTech platforms are predominantly analyzed in isolation, resulting in insufficient exploration of their systemic interdependencies [9]. Empirical investigations assessing the cybersecurity posture within the financial markets of developing economies, including Azerbaijan, remain remarkably scarce. Rectifying this empirical deficit is essential from both a theoretical and a policy-oriented standpoint.

Cybersecurity Posture and Regulatory Mechanisms in Financial Markets:

International Practice

The pervasive digital transformation of the global financial architecture has exponentially heightened systemic cybersecurity risks. Over the past decade, the widespread proliferation of Omni channel banking ecosystems, electronic payment infrastructures, digital investment platforms, and FinTech architectures has fundamentally intensified the financial sector's structural reliance on information technology networks. According to empirical estimates by the IMF, direct financial losses stemming from systemic cyber incidents within the financial sector over the trailing two decades have surpassed 12 billion US dollars, with cumulative indirect economic repercussions and institutional reputational degradation amplifying this aggregate figure multi-fold [20]. Correspondingly, research by the BIS on the evolution of the FinTech sector validates that digital transformation introduces not only operational efficiencies but also novel supervisory burdens for

macroprudential banking oversight [2]. Furthermore, a World Bank assessment indicates that balancing the expansion of financial inclusion with the preservation of robust cybersecurity frameworks presents a critical pol-

icy trilemma for developing economies [33]. The empirical matrix below delineates a comparative analysis of cybersecurity preparedness across selected jurisdictions.

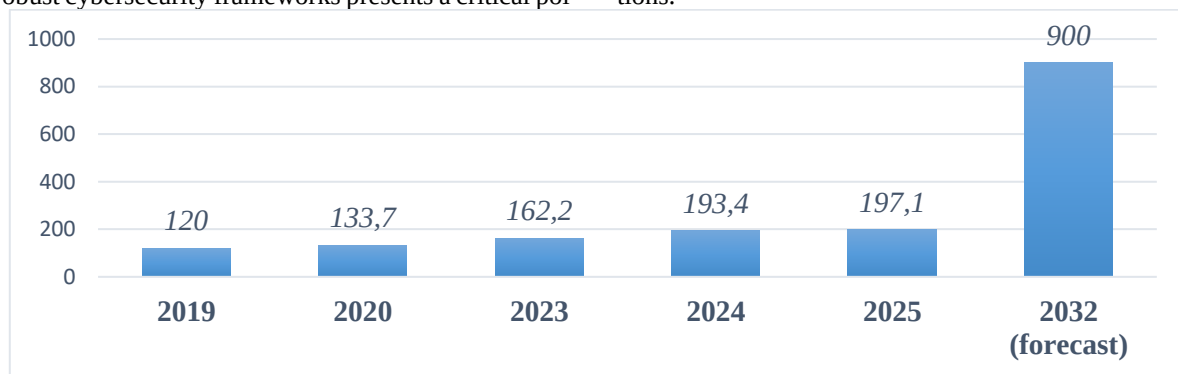


Figure 1. The volume of the global cybersecurity market in recent years (billion USD)

Source: <https://www.fortunebusinessinsights.com/industry-reports/cyber-security-market-101165>

The analysis conducted shows that a significant increase has been observed in the volume of the global cybersecurity market in recent years. For instance, while the total market volume in this field was 120 billion USD in 2019, this figure increased to 193.4 billion

USD in 2024 and reached 248.28 billion USD in 2026. According to the economic analyses conducted, this indicator is projected to rise to 699.39 billion USD in 2034 (Figure 1).

Table 1.

Comparative Indicators of Cybersecurity Posture by Selected Jurisdiction (2024)

Country	GCI Index	NCSI Index	Share of Cyberattacks in Financial Sector (%)
United States	100	94.8	22
United Kingdom	99.5	92.2	19
Singapore	99.8	91.4	17
Germany	98.7	89.6	18
Estonia	98.1	100	14

Source: Compiled by the author based on [22]; [26].

As delineated in Table 1, jurisdictions exhibiting advanced cybersecurity postures concurrently lead the development of digital financial services (Table 1). This positive correlation implies that sustaining the socio-economic dividends generated by digital transformation necessitates the synchronized evolution of cybersecurity frameworks. Absent such alignment, cyber disruptions targeting the core digital infrastructure of the financial architecture may function as a primary

transmission mechanism for systemic risk. Concurrently, the structural composition of international cyber threats targeting the financial sector has undergone a paradigm shift over recent years [34]. Although data breaches aimed at expropriating personal information historically predominated, operational disruptions designed to compromise the systemic functionality of financial networks have increasingly migrated to the forefront [8].

Table 2.

Structural Composition of Primary Cyber Threats within the Financial Sector (2024)

Type of Cyber Threat	Share of Total Incidents (%)
Ransomware attacks	35
Data theft and breaches	27
Social engineering (phishing)	18
DDoS attacks	12
Supply chain attacks	8

Source: Compiled by the author based on [8]; [17].

As illustrated in Table 2, the most pervasive risk vector within the financial sector is attributable to ransomware campaigns (Table 2). The primary objective of these exploits is to extract financial leverage by freezing or severely disrupting the operational continuity of financial institutions. Furthermore, the escalating structural reliance on third-party service providers introduces critical systemic vulnerabilities, thereby facilitating the propagation of these risks [12]. To mitigate these threats, robust regulatory frameworks have been

formulated at the international level to fortify organizational cyber resilience. The Digital Operational Resilience Act (DORA), enacted by the European Union in 2022, mandates stringent obligations for financial institutions concerning cyber risk management, incident disclosure protocols, mandatory resilience stress testing [27], and the oversight of third-party dependencies. In the United States, the NIST Cybersecurity Framework 2.0 and the FS-ISAC operational model serve as the premier benchmarks for sector-specific risk mitigation

[13]. Concurrently, the Financial Stability Board’s recommendations on cyber incident reporting function as a cornerstone strategic document aimed at enhancing multilateral coordination [14]. Similarly, the Technology Risk Management Guidelines enforced by the Monetary Authority of Singapore (MAS) have played a pivotal role in establishing unified cybersecurity standards across the Asia-Pacific financial architecture [25].

Concurrently, the COVID-19 pandemic catalyzed a mass migration of banking and payment infrastructures to digital channels, significantly expanding the financial sector's threat surface [20]. Empirical estimates by the IMF indicate that the frequency of cyberattacks approximately doubled post-2020 relative to the pre-pandemic baseline, with roughly twenty percent of globally documented cyber incidents targeting financial entities. The empirical matrix in Table 3 delineates the trajectory of key indicators during this timeframe [26].

Table 3.

Major Cybersecurity Trends in the Financial Sector (2020–2025)				
Indicator	2020–2021	2022–2023	2024	2025
Share of financial sector (total incidents)	~15%	~18%	~20%	~20%+
Global average cost of a data breach (USD mln)	3.86 / 4.24	4.35 / 4.45	4.88	4.44
Average cost in financial sector (USD mln)	~5.0+	High	6.08	~5.56
Ransomware encryption rate	Rising	Continuing	70%	50%
AI-driven social engineering	Early stage	Rising	Expanding	High risk

Source: Compiled by the author based on [17]; [18]; [31]; [34].

"According to IBM Security’s 2024 report, the global average financial impact of a single data breach reached 4.88 million US dollars, whereas within the financial sector, this metric escalated to 6.08 million US dollars—marking a 22% premium over the global baseline [17]. Although the subsequent contraction of the

global average to 4.44 million US dollars in 2025 indicated a heightened efficacy in AI-driven detection mechanisms, the financial sector concurrently maintained its classification as a critically high-risk domain [18]."

Table 4.

Comparison of Average Data Breach Costs, 2020–2025 (USD million)			
Year	Global Average	Financial Sector	Key Notes
2020	3.86	~5.0+	Pandemic-era risks
2021	4.24	High	Hybrid work models
2022	4.35	High	Supply chain attacks
2023	4.45	High	Rising compliance costs
2024	4.88	6.08	Financial sector 22% above average
2025	4.44	~5.56	AI detection shortened response time; sector still high-risk

Source: Compiled by the author based on [17]; [18].

"According to Sophos’s 2025 report, the encryption efficacy rate within ransomware campaigns declined from 70% in 2024 to 50% in 2025 [31]. Although this contraction reflects advancements in robust defense frameworks, it does not imply a mitigation of the overall ransomware threat landscape (Table 4). Over this period, threat actors systematically pivoted from traditional encryption protocols toward data exfiltration, double-extortion architectures, and reputational leverage tactics [30].

Concurrently, the World Economic Forum’s 2025 report underscores that generative artificial intelligence has augmented the sophistication, cost-efficiency, and scalability of phishing, vishing, deepfake, and social

engineering exploits. This technological evolution poses an existential vulnerability for the financial sector, wherein core operational pillars—such as banking transactions, KYC (Know Your Customer) identification protocols, and payment authorization mechanisms—are structurally predicated on institutional trust. Regarding capital allocation, global cybersecurity expenditures expanded from approximately 260 billion US dollars in 2021 to 454 billion US dollars in 2025 [35]. Ultimately, given that aggregate global annualized cyber losses reached an estimated 10.5 trillion US dollars by 2025, it is evident that cyber risk has permanently transitioned into a critical macroeconomic hazard. (Table 5)

Table 5.

Key Indicators of Cybersecurity Spending and AI-Related Risks			
Indicator	2020–2021	2024	2025
Global cybersecurity spending	\$260 billion	Continued growth	\$454 billion
Projected global annual cyber losses	Growth phase	Trillions	\$10.5 trillion
AI-driven social engineering	Limited	GenAI phishing	Deepfake, vishing
Defense model in financial sector	Traditional	Risk monitoring	AI analytics

Source: Compiled by the author based on [35]; [15].

Mitigating Cybersecurity Risks in Financial Markets via AI-Driven Solutions

As the digital transformation of financial markets accelerates, conventional cybersecurity mechanisms exhibit diminishing efficacy in countering sophisticated contemporary exploits. Within this paradigm, embedding innovative architectures—specifically artificial intelligence—into the defensive infrastructure of

the financial sector has emerged as a strategic imperative [1]. By executing real-time behavioral analytics, AI-driven technologies possess the capability to identify emerging threat vectors that legacy signature-based systems fail to detect (Table 6). According to empirical findings by Deloitte, the deployment of cognitive technologies has compressed the mean time to detect (MTTD) security incidents in financial institutions by 40% to 60% [34].

Table 6.

Key Applications of AI-Based Cybersecurity Solutions in the Financial Sector		
Area of Application	Main Objective	Expected Outcome
Fraud detection	Identifying suspicious transactions	Reduction in financial losses
Behavioral analytics	Detecting anomalous activity	Early-warning capability
Real-time risk monitoring	Dynamic risk tracking	Faster decision-making
Automated response systems	Rapid reaction to attacks	40–60% reduction in response time
Biometric authentication	User identity verification	Strengthened account security

Source: Compiled by the author based on [28]; [8].

"Global payment conglomerates, such as Visa and Mastercard, systematically leverage AI-driven architectures [32]. to process and analyze multi-million transaction streams daily, thereby mitigating potential risk vectors in real time. Concurrently, blockchain technology is increasingly recognized as a viable complementary framework; by introducing immutable ledger systems that impede data tampering, it enhances transactional transparency and curtails fraudulent exploits [24]. Accounting for the idiosyncratic characteristics of Azerbaijan’s digital financial ecosystem, the operationalization of the following five strategic pillars carries paramount significance:

- Strategic Pillar I: Institutionalization of a Unified Cyber-Resilience Coordination Platform. Inter-institutional information sharing across the national financial sector is currently constrained [20]. Establishing a national financial cybersecurity infrastructure modeled after the global FS-ISAC framework would fortify cross-sectoral synergy and proactive threat intelligence sharing [29].
- Strategic Pillar II: Pervasive Deployment of Cognitive Monitoring Architectures. Within the banking sector, the institutionalization of AI-driven real-time behavioral diagnostics, automated anomaly detection, and algorithmic fraud mitigation would substantially elevate the aggregate cybersecurity posture.
- Strategic Pillar III: Implementation of Mandatory Cyber-Resilience Stress Testing Frameworks. Adopting international benchmarks—specifically the European Union’s DORA framework—enables the empirical evaluation of systemic resilience under simulated crisis conditions [18]. Consequently, the Central Bank of Azerbaijan should mandate comparable macroprudential regulatory stress-testing requirements for systemically important financial institutions (SIFIs).
- Strategic Pillar IV: Optimization and Cultivation of Human Capital. Empirical evidence demonstrates that a critical proportion of cyber breaches originates from human errors rather than inherent infrastructure vulnerabilities. Accordingly, embedding a comprehensive cybersecurity governance culture

within financial entities, supported by continuous pedagogical training, is essential to minimize operational risk vectors [9].

- Strategic Pillar V [2]: Advanced Risk Governance of Third-Party Dependencies. As the integration of FinTech architectures accelerates, the continuous mapping, assessment, and oversight of risk transmission channels introduced by external vendor networks and third-party service providers remain vital for systemic stability .

Conclusion

This study has provided a comprehensive investigation into the contemporary posture of cybersecurity within financial markets, delineating prevalent global trajectories and formulating strategic dimensions tailored to the Azerbaijani context. The critical synthesis of the empirical and qualitative findings yields several pivotal conclusions.

Primarily, the analysis confirms that cybersecurity has transcended its traditional classification as an isolated technical issue, emerging instead as a foundational strategic determinant of macroeconomic financial stability. Direct capital losses stemming from systemic cyber incidents within the global financial architecture have surpassed 12 billion US dollars over the trailing decade. Furthermore, the empirical evidence that the mean financial impact of a data breach within the financial domain in 2024 (6.08 million US dollars) exhibited a 22% premium over the global baseline validates that this sector possesses an inherently distinct and elevated risk profile.

Secondly, the structural composition of the cyber-threat landscape has undergone a significant paradigm shift. A highly sophisticated defense challenge has materialized, characterized by the convergence of ransomware campaigns, data breaches, AI-driven social engineering exploits, and supply-chain vulnerabilities. The proliferation of generative artificial intelligence models has markedly optimized the cost-efficiency and scalability of executing malicious campaigns, thereby intensifying systemic fragility.

Thirdly, the comparative evaluation of international regulatory practices demonstrates that robust cyber-resilience frameworks cannot rely exclusively on

technological deployment; rather, they must encompass tightly integrated regulatory, institutional, and human-capital dimensions. Frameworks such as the European Union's DORA, the NIST Cybersecurity Framework, the global FS-ISAC model, and the MAS Technology Risk Management Guidelines stand as premier benchmarks that effectively institutionalize this multi-dimensional coordination requirement.

For the digital economy of Azerbaijan, these findings carry profound policy and practical implications [17]. While the Cybersecurity Strategy for Financial Markets for 2023–2026, formulated by the Central Bank of Azerbaijan, establishes an important institutional foundation, the rapidly evolving digital ecosystem necessitates the continuous iteration of this framework. This includes the integration of cognitive AI-driven defense mechanisms, the institutionalization of intra-sectoral threat intelligence sharing platforms, and enhanced capital allocation toward human capital development. Finally, a recognized limitation of this study is the empirical scarcity of localized, sector-specific cyber incident statistics within Azerbaijan. Consequently, future research trajectories should be predicated on direct empirical surveys and quantitative incident analysis executed in closer alignment with local financial institutions.

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HISTORICAL SCIENCES

THE STRUCTURE AND FUNCTIONING OF EDITORIAL OFFICES IN TWENTIETH-CENTURY JOURNALISM: THE CASE OF *DEBRECZEN*

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Abstract

This study examines the organizational structure and operation of editorial offices in twentieth-century Hungarian journalism through the example of the *Debreczen* daily newspaper. It explores the internal organization of newspaper editorial offices, focusing on the roles of editors-in-chief, managing editors, assistant editors, section editors, and reporters, as well as the everyday processes involved in newspaper production. Particular attention is devoted to the career of József Pálffy, the newspaper's long-serving editor, and to the activities of other members of the editorial staff. The study also analyzes different forms of reportage and their appearance in the pages of *Debreczen*, while providing an overview of the newspaper's technical production process and the significance of advertising in its economic operation. The research highlights how local newspaper editorial offices adapted to the professionalization of journalism, changing market demands, and the evolving political environment during the interwar and early post-war periods.

Keywords: Debreczen, editorial history, József Pálffy, reportage, provincial daily newspapers, interwar Hungary, press history

The press is a reflection of the society in which it exists.¹

Introduction

In the first third of the 20th century, journalists viewed themselves as representatives of public opinion. Through the routine operation of newsrooms, work processes were divided, and newspapers became distributed products in accordance with the principles of the news trade. Journalists adapted to readers' demands; their role took shape as a fast-paced, high-output "journalistic wage laborer", whose performance was rewarded with a fee rather than being viewed as a community leader. The greatest challenge for journalists was to strike a balance between providing the public with credible information and serving business interests.² As the role of the press changed, so did the composition of newsrooms. The increased size of newspapers and the accelerating pace of news delivery led newsrooms to employ more and more people, who divided various tasks into smaller categories, and a broader hierarchy also emerged.³ The size of the editorial staff depended on several factors, such as the publication's position in the market. The spectrum ranges

from a one-person editorial office handling multiple journals to a professionally structured editorial department.⁴

The editor-in-chief and the managing editor

Every publication had a responsible leader: this was the editor-in-chief or the managing editor. In some publications, where the scale of the operation required it, both roles were present: both an editor-in-chief and an editor-in-charge, or a deputy editor-in-chief appeared in the masthead instead of the editor-in-charge. Additionally, an editorial board was involved in the editorial work of certain media outlets.⁵

Initially, a daily newspaper such as *Debreczen* employed a maximum of three staff members in addition to the "gatekeeper," i.e., the editor, for both the weekday and Sunday editions.⁶ Later, for a 4–8-page issue, it employed 10–12, and even up to 16 staff members.⁷ The editorial staff changed frequently, but the editor-in-chief⁸ remained in his position almost until the end of the paper's operation.⁹

József Pálffy

József Pálffy served as the editor-in-chief of *Debreczen* for 25 years, from the newspaper's launch on March 15, 1924, until August 1, 1949.¹⁰ József Pálffy

¹ Lajos Biró: On the Psychology of the Press. 30.

² Journalism sought to meet both the demands of the press market and society's need for information about public life, which required constant adaptation on the part of editorial staff and publishers. Balázs Sipos: The Press and Power in the Horthy Era. 200.

³ Cs. L. The Provincial Press, No. 7. 1–6.

⁴ Claudia Mast: The ABC of Journalism. An Introduction to Editorial Work. 56.

⁵ Pál Gombó: Introduction to Media Studies. 122.

⁶ Pálffy Papers – Wage Conditions. 2.

⁷ In "the old days," each newspaper had only 2–3 "official" staff members; the rest were merely "friends of the paper" or "freelancers." Pálffy Papers – The Editorial Staff. 6.

⁸ The managing editor is the direct supervisor of editorial work at the newspaper. At local newspapers, this role is usually filled by the editor-in-chief. Dániel Lovas: The ABC of the Local Press. 166.

⁹ At the time when the Trans-Tisza Book and Newspaper Publishing Joint-Stock Company was publishing two daily and two weekly newspapers, it employed a total of 10–12 staff members in the editorial office.

¹⁰ On March 7, 1924, the mayor of Debrecen issued a resolution announcing the Trans-Tisza Book and Newspaper Publishing Joint-Stock Company's declaration that it would launch a political daily newspaper titled *Debreczen*. Journalist József Pálffy was appointed as editor-in-chief. Pálffy Papers – The First Ten Years. 1.

was born on April 20, 1888, in Debrecen. He began his career in commerce, but even as a young man, at the age of 16–17, he wrote articles on economic topics for Debrecen newspapers; then, in August 1906, the daily newspaper *Szabadság* [Freedom] hired him as a journalist.¹¹ The following year, after *Szabadság* ceased publication, he joined the old *Debreczen*, which was then edited by Zoltán Szathmáry, and later Pál Móricz took over the position. In 1909, he was drafted into the army; as a result of a penalty imposed on him in a press lawsuit, he lost his right to volunteer and had to serve for three years; he was eventually discharged as a sergeant. At that time, in October 1912, Gyula Than, the editor and owner of *Debreczeni Ujság* [Debrecen Newspaper], hired him. Pálffy handled the police and society columns, just as he had at his previous papers. The World War that broke out in the summer of 1914 called him back to uniform, and until October 1918 he performed military service partly on the battlefield and partly in the rear. After returning to Debrecen, he became a member of the Soldiers' Council and also returned to the editorial staff of *Debreczeni Ujság*, which, following the proclamation of the Soviet Republic, was renamed *Népakarát* [The Will of the People].¹²

When the Romanian army marched in, *Népakarát* ceased publication, and the newspaper reverted to its former title and returned to its original owner, Gyula Than. It was at this time that the daily newspaper *Egyetértés* [Consensus] was launched by the City Printing House, following the political line of Bishop Baltazár. Pálffy was then lured to the editorial staff of the newly launched paper with a higher salary. He worked at this paper until February 1921, when he became the managing editor of the newly launched *Tiszántúli Hírlap* [Trans-Tisza Gazette], and then, from March 15, 1924, to August 1, 1949, the editor of *Debreczen*.¹³ When he signed his contract with *Tiszántúli Hírlap*, he agreed with the newspaper company's director, Gyula Szigethy, that they would gradually phase out the paper's extreme counterrevolutionary and "awakening" spirit and steer the paper toward more liberal waters.¹⁴ This is exactly what happened; in fact, when the publishing company's morning paper, *Debreczen*, began publication, it struck a liberal and "moderately" democratic note right from its inaugural issue and maintained this tone throughout the German occupation, until it was banned in May 1944; after liberation, it served the political agenda of the Independent Smallholders' Party.

In June and July 1944, Pálffy was unemployed as a result of the newspaper's ban; in August, he signed a contract with *Magyar Lapok* [Hungarian Papers], published in Nagyvárad, with the mandate to tone down the paper's extreme stance and steer it in a more moderate direction. He had little time for this, however, as the newspaper's publishing company ceased publication as the Soviet army approached. He moved from Nagyvárad to the village of Tahi near Budapest.¹⁵ From there, he was only able to return to Debrecen in mid-March 1945, at which point he resumed editing *Debreczen*.¹⁶ As an explicitly party-affiliated newspaper, it had to strictly follow the party's instructions, which were conveyed more specifically by Gyula Szigethy, the director of the publishing company,¹⁷ and the representative for Hajdú County during his two terms. The party's shifting policies were reflected in the newspaper's columns, from Ferenc Nagy to István Dobi, ranging from the advocacy of bourgeois democracy to the policies of the People's Front. The role of the editor-in-chief ceased to exist during this period; the paper had to be edited strictly according to the party's instructions. In July 1949, publication of the paper was taken over by the State Newspaper Publishing House. At that time, the party's press department urged Pálffy, in view of his advanced age, to request retirement based on the decision of the interministerial meeting. This is exactly what happened. The Journalists' Pension Fund, of which he had been a member for twenty years, placed Pálffy on the retired list starting in August 1949.¹⁸

As an editor, Pálffy initially received a monthly salary of 300 pengő, then 400 pengő, between 1926 and 1938. An exception to this was the inflationary years following the First World War, when his monthly income first reached the thousands and then the hundreds of thousands. Due to inflation during the years of the Second World War, his salary rose again, reaching as much as 800 pengő per month at that time. In the inflationary period following liberation, his salary fluctuated again, rising to 600 and then 800 forints per month after the introduction of the Hungarian forint. When the collective multiplier system was applied to journalists' salaries as well, the editor-in-chief's salary jumped to 2,300 forints.¹⁹

In addition to journalism, Pálffy also wrote literary works, primarily novels. In his younger years, he wrote the youth novel *Bandika naplója* [Bandika's Diary] for the *Debreceni Ujság*, the war novel *Hideg a vasút, de meleg a szív (katonadolog)* [The Railroad Is Cold, but

¹¹ The actual editor of this paper was Imre Gáspár, one of the well-known poets of his time; the nominal editor was József László, the paper's publisher and owner.

¹² József Pálffy: The History of the *Debreczen Keletmagyarországi Napló*. Members of the *Debreczen* Editorial Staff. Ms 11/1:3 (hereinafter: Pálffy Papers – The Editorial Staff). 1.

¹³ In March 1921, the *Tiszántúli Hírlap* was published, operating at that time as an afternoon paper. In addition to its publication, plans were also made to launch a larger morning paper, as they saw greater business potential in this than in an afternoon newspaper with a more limited circulation. At the same time, strengthening his rural positions was an important part of Bethlen's increasingly agile press policy, which offered an opportunity to establish a pro-Bethlen press organ in Debrecen.

¹⁴ Although many considered the shift between newspapers of different political leanings to be a mere change of allegiance, it was common in those days for a professional journalist to move from a pro-government paper to an opposition one and vice versa. Pálffy Papers – The Editorial Staff. 2.

¹⁵ He worked as a farm manager in the garden of the son-in-law of Ernő Dezső, a newspaper reporter and staff member of *Magyar Nemzet*.

¹⁶ The paper had actually been able to launch earlier, on February 18, as the press organ of the Smallholders' Party.

¹⁷ Pálffy Papers – The History of *Debreczen*. 2–3.

¹⁸ The Journalists' Pension Fund set his monthly pension at 335 forints starting in August 1949. Pálffy Papers – The Editorial Staff. 3.

¹⁹ Pálffy Papers – The Editorial Staff. 4.

the Heart Is Warm (A Soldier's Tale)] for *Debreczen*, and later other novels, such as *Száz kéz nyúl egy leány után* [A Hundred Hands Reach for a Girl] or *Csalfa délibáb* [Deceptive Mirage], and a couple of other shorter novels. These appeared in serial form in the newspapers and were later published in book form. These are not particularly ambitious works, nor do they possess great literary value, but at the time they captured the public's interest.²⁰

At *Debreczen*, he almost always wrote the editorials, which were generally published anonymously. In addition, he wrote or reviewed the newspaper's political section. He was forced to read every manuscript, making changes to them or omitting parts, since the editor-in-chief was held accountable before the courts and the authorities. He often spent 12–14 hours a day on a single piece, and it was not uncommon for him to write on various topics, such as a police reportage or city hall news, whenever a colleague was absent, filling in whatever was missing. Since *Debreczen* was a morning paper, editing often lasted until 2 or 3 a.m., as they had to wait for the latest news and ensure the paper did not “miss out” on any particularly interesting stories.

On June 1, 1949, the publishing rights of *Debreczen* were transferred to the Smallholders' Party. The party then sent István Bolgár, an employee of the Hungarian Telegraph Agency (and a member of the National Assembly at the time), to Debrecen to oversee the newspaper's financial and editorial operations. Although István Bolgár had his name listed as editor-in-chief on the paper, he never actually performed any active editorial work. His appointment ended two months later when the State Newspaper Publishing House took over the paper; at that time, the paper's longtime staff member, István Kiss, became the editor-in-chief. István Kiss held the editorial position until October 1950, when he was transferred to the *Friss Ujság* [Fresh Newspaper] in Budapest. Following István Kiss's departure, the party appointed Antal Koncz, who had previously worked for the party's newspaper in Szeged, as editor-in-chief. He was the paper's last editor-in-chief; his name appeared in the masthead until the paper's closure in March 1951.²¹

Editorial Boards, Assistant Editors

Some newspapers had editorial boards to assist the editor-in-chief. These boards can be classified into two types. The first group consisted of editorial board members who served as permanent staff, continuously participating in shaping the newspaper's profile and in the

day-to-day development of its content. Their responsibilities included specific columns, their management, and representation at editorial meetings. The other type were advisory editorial boards composed of external public figures, which met only occasionally, and their tasks were limited primarily to matters of editorial principles, profile-shaping, and thematic issues.²²

Within the editorial staff, there were also assistant editors, who essentially handled smaller tasks. They reviewed every manuscript, but they could also rewrite articles, make cuts, request additions, and even change titles and subtitles. They were often involved in the final layout of the paper, maintaining direct contact with the layout editor, with whom they collaborated to make the final adjustments before the daily's publication.

In the case of *Debreczen*, Andor Székely was one of those who filled this role. Andor Székely had been a staff member of *Debreczen* from the very beginning. He moved to Debrecen from Arad; he first worked as a stenographer at the Debrecen branch of the Hungarian Telegraph Agency, and later joined *Debreczen*. Thanks to his outstanding stenography skills, he provided significant assistance to the editorial staff, particularly in the accurate recording and reporting of meetings and interviews. It was precisely through these abilities that he became involved in the disciplinary cases initiated in 1934 against Mayor Vásáry and the city's senior officials, as he also assisted in documenting their trials and hearings.²³ Until early 1944, he headed the city hall and Reformed Church sections, and for an extended period, he was also responsible for editing the county news section. At that time, due to the prohibitions of the anti-Jewish laws, he had to temporarily leave the editorial staff, but the company continued to pay his salary, so he was able to remain in Debrecen and rejoin the workforce after liberation. In 1945, he moved to Budapest, took a position at the Trade Union Center, and then retired in the early 1950s. Andor Székely replaced Pálffy in the early days and held the position of assistant editor. His monthly salary during that period ranged from 240 to 320 pengő.²⁴

Zoltán Szathmáry

Among the staff of the newspaper, the tragically fated writer Zoltán Szathmáry held a prominent place. Zoltán Szathmáry was born in Debrecen in 1872;²⁵ the newspaper company hired him in 1925. A significant portion of his work consisted of writing theater reviews and reports. He earned particular acclaim for his series of articles titled *Régi debreceni alakok* [Old Figures

²⁰ The publisher did not pay separate honorary fees for the novels, but instead printed the books at a lower cost. The serialized novel installments published in the newspaper were set aside, “reformatted” into book form, and the book pages were printed that way. This made production significantly cheaper. In addition to novels, he occasionally published short stories, but otherwise his editorial duties kept him fully occupied. Pálffy Papers – The Editorial Staff. 4.

²¹ Pálffy Papers – The Editorial Staff. 5.

²² Gombó 124.

²³ He took shorthand notes for the city leadership on the entire proceedings of general assemblies, smaller meetings, and major committee sessions. Since the position of stenographer was not a regular one at the city, the leadership compensated Székely by providing him with a city apartment in one of the

villas in Nagyerdő at a lower rent and by having alterations and renovations carried out in the apartment at the city's expense. Of course, this did not exactly constitute “overpayment”, but this matter was nevertheless raised as irregular against the Mayor and Chief Clerk József Zöld. His wife, Anna Bészler Székely, distinguished herself in the field of fiction, having written several novels.

²⁴ Pálffy Papers – The Editorial Staff. 6.

²⁵ He completed his secondary education in Debrecen and showed an interest in literature even as a student. Influenced by Gyula Róvicsky, he wrote poems; his first published poem was written on the occasion of the poet's death and appeared in the daily newspaper *Debreczen* on July 24, 1889. Pálffy Papers – The Editorial Staff.

from Debrecen].²⁶ Due to his liberal views, he quickly became a target of the far-right press. He was repeatedly attacked in the newspaper *Hajdúföld* [Hajdú Land], especially when the theater revived Szathmáry's play *Enyingi Török Bálint* [Bálint Török from Enying], which was set in Debrecen. *Hajdúföld* unfairly lambasted the play, and during the ensuing controversy, a libel suit was even filed against him. The attacks against him took a heavy emotional toll on Szathmáry. According to the recollections of his contemporaries, his mental state gradually deteriorated, and he repeatedly voiced his fear that he would not be able to withstand the pressure weighing on him.

In mid-February 1927, the theater staged Zoltán Szathmáry's award-winning play, *Enyingi Török Bálint*, which had been a great success at the time not only in Debrecen but also elsewhere. Mihály Kolosváry Borcsa published a review of the performance in the pages of *Hajdúföld*, in which he criticized the play with unusual vehemence and, on several points, unfairly, while sparing no criticism of its author, Zoltán Szathmáry. The heated newspaper controversy ended up in court; Mihály Kolosváry Borcsa filed a libel suit against Szathmáry, who filed a counterclaim. The newspaper attacks and the difficulties associated with the libel suit took such a toll on Zoltán Szathmáry's nerves that on July 8, 1928, in a fit of nervousness, he drank denatured alcohol and died.²⁷

Sections and Section Editors

Newspapers also employed section editors, who were permanent staff members and professional journalists.²⁸ Together with their subordinates, they planned, wrote, and then pre-edited and co-edited the foreign affairs, domestic affairs, and economics sections – in short, all those columns that, in accordance with the newspaper's profile, had a fixed column space. They made suggestions to the editorial leaders regarding the content of the sections, then professionally and qualitatively evaluated, reviewed, and edited the materials belonging to the section. They strove to ensure that the individual materials of the section were handed over to the assistant editor in a form as ready for printing as possible, having been carefully selected.²⁹

At the *Debreczen* editorial office as well, the individual sections and their editors were clearly distinguished. Pál Benyovszky, for example, headed the legal, social, and literary sections; he also participated in editing the children's supplement and was a long-time contributor to the paper. He moved to Debrecen from Szatmár. He was born in Szatmárhegy in 1899; his father served as police captain in Szatmár. Following the political changes after the First World War, he was repatriated in 1919, after which he moved to Debrecen. He first joined *Tiszántúli Hírlap*, then became a member of the editorial staff of *Debreczen*. He headed the court, social, and literary sections. He was a well-known poet; he published two volumes of poetry and a short-lived literary journal titled *Alkotás* [Creation]. He was elected secretary of the Trans-Tisza Guild of Fine Craftsmen and edited the Guild's Almanac. At *Debreczen*, he was the editor of the children's supplement under the pseudonym "Uncle Pali."³⁰

Dr. József Pálffy, the son of the elder József Pálffy, joined the paper in 1940 as a trainee journalist. Initially, he worked on church and social news coverage; in addition, he wrote humorous sketches, and after liberation, he led the highly popular humor column titled *Debreceni Szabadszág* [The Outspoken Voice of Debrecen]. By this time, he was already performing more significant editorial duties. Following Andor Székely's departure, he took over the role of city hall and county reporter; in addition, news coverage related to the coalition parties was also among his responsibilities. In the summer of 1943, the National Press Chamber sent him to Berlin.³¹ He spent nearly six months in Germany; he witnessed the devastating air raids on Berlin, Hamburg, and other cities, about which he later wrote interesting and exciting reports.

During the German occupation, when *Debreczen* was banned, he worked for a time at the *Tiszántúli Déli Hírlap* [Trans-Tisza Midday Gazette] alongside Imre Sarkadi. After the paper ceased publication, he went with his father to the village of Tahi, but from there he was conscripted into the army. He returned home after a year in a prisoner-of-war camp, at which point he re-joined the editorial staff of *Debreczen*, where he remained a staff member and, in his final years, served as

²⁶ He had been passionate about acting his entire life; it bothered him that cinema had become a fierce competitor to the theater, and in the columns of *Debreczen* he suggested that the city should acquire the license and operating rights to one of Debrecen's movie theaters, using the theater's net profits to supplement the theater's revenue.

²⁷ The death of the highly popular Zoltán Szathmáry deeply shocked the majority of the Debrecen public. Tens of thousands attended his funeral, which amounted to a veritable demonstration; liberal and progressive circles turned out in huge numbers for the funeral. Szathmáry's body was laid in state in the theater lobby, a gesture signifying that the deceased had lived and died for the theater his entire life.

²⁸ The editor of the letters-to-the-editor section, for example, was not only responsible for compiling the section but also handled the letters received by the paper. Gombó 126.

²⁹ The staff members of each section were referred to as internal staff. Their main tasks were gathering information, reporting, and working as reporters and section editors. They dealt

exclusively with the topics relevant to them, maintained contact with the responsible persons in each section, and collected topic suggestions. Gombó 125.

³⁰ Pálffy Papers – The Editorial Staff. 7–8.

³¹ His father, József Pálffy Sr., later recounted the circumstances of his study trip to Germany. According to his recollection, the opportunity was originally reserved for a "favored" candidate supported by the Press Chamber. However, due to the increasingly intense Allied bombing of German cities, the person in question withdrew from the trip, so the Chamber ultimately nominated József Pálffy Jr. for the assignment. According to Pálffy, the assignment represented both a professional opportunity and a personal risk under wartime conditions. His father, József Pálffy Sr. – who was then working as a correspondent for *Magyar Nemzet* in Debrecen – sought the opinion of Endre Bajcsy-Zsilinszky on the matter. According to Pálffy's recollection, Bajcsy-Zsilinszky advised him to accept the assignment, saying, "You must accept the assignment; at least we will have an objective person out there." Pálffy Papers – The Editorial Staff. 7–8.

assistant editor. Eventually, he became the Paris correspondent for the Hungarian Telegraph Agency.

The paper also employed external contributors. This group included anyone who submitted material more or less regularly. These included, for example, contract staff who undertook and fulfilled certain regular obligations, staff from other newspapers, and so-called freelance journalists, who were not employed by the newspaper but generally submitted similar types of material to multiple newspapers. This group also included correspondents who provided regular reports on specific fields of expertise, regions of the country, or life in foreign countries. They were not all journalists: the paper also employed graphic designers, photographers, crossword puzzle creators, various specialists, cartoonists, and other external contributors.³²

Dr. István Szabó was a staff member of *Debreczen* from May 1924 to June 1925. He first worked at the City Archives, then joined the editorial staff from there. He stood out primarily for his valuable articles drawing on the city's past, and he also handled the city hall news column.³³ Imre Szalayosy Rácz was a staff member of *Debreczen* from 1928 to March 1944. He is considered the first village researcher; his reports from the Hajdúság region preceded those of the more famous folk writers. He also wrote interesting literary articles; he felt a deep affinity for the Ady family and published several valuable interviews with the poet's mother. He launched popular columns in the paper, such as *Jegyzőkönyv* [Minutes] and *Jegenyefák* [Poplar Trees], and also wrote many articles on social issues. His polemic with university professor Richárd Huss regarding the Volksbund is also noteworthy.³⁴

Richárd Römer was a staff member of the paper for five years, handling the police and sports columns; he was also an outstanding sports expert. He died tragically on December 20, 1933.³⁵ Mihály Bencze took over his position, with the exception of the sports section; however, he managed the *Tiszántúli Kisgazda* [Trans-Tisza Smallholder] page, which served as a supplement to the newspaper. Over time, he became a true agricultural expert and rendered significant services to the farming community. The supplement regularly published expert advice, as well as explanations and interpretations of regulations concerning agriculture.³⁶

László Tamássy was a staff member of the paper for 12 years, handling the legal and sports sections. In the latter, he launched several initiatives that generated significant interest. He remained on the staff until the paper ceased publication, after which he joined the postal service.³⁷

István Kiss was a staff member of the paper for 15 years. He initially wrote police news, but also produced reports in other areas, primarily in literature and the arts; in addition, he served as a theater critic for a time, with an exceptionally prolific output.³⁸ Dr. László Nyíri joined the editorial team in 1929.³⁹ He traveled abroad on several occasions, producing reports of outstanding quality, which he published in the newspaper.⁴⁰

The permanent workforce of the newspaper also included delivery workers and newspaper hawkers,⁴¹ whose numbers ranged on average between 80 and 120. They received a fixed salary, but also earned a 10% commission on the number of copies sold or delivered. Their earning potential was thus exceptionally favorable, and many of them were able to purchase their own family homes with their savings.⁴²

Reportage as a Journalistic Genre

"Without reporters, there is no newspaper."⁴³ The reporter, the most important figure in the modern press, emerged from the demand for immediacy and credibility. By the turn of the century, leaders of the Hungarian press had already realized that the press – especially the daily press, which had played an educational, instructive, and guiding role – was increasingly being pushed into the background. The focus shifted to conveying the bare facts as quickly and accurately as possible. They knew that a time would come when we would have to acknowledge that it was no longer publicists who were at the center, but reporters. Indeed, we can say outright that the function of entertainment has increasingly taken the place of information and opinion-forming. While these changes freed the press from the direct influence of political parties, the pursuit of business success soon began to raise concerns among those in the media.⁴⁴

Reportage can be described as factual or fact-based writing with a personal dimension, recounting

³² *Debreczen* had numerous freelance contributors and columnists; they did not receive honoraria, nor did they really ask for them. The exception was the music critic, who, in addition to free admission tickets, received a small monthly stipend – an average of 40 forints – to cover out-of-pocket expenses (clothing allowance, transportation costs).

³³ Pálffy Papers – The Editorial Staff. 8.

³⁴ Pálffy Papers – The Editorial Staff. 9.

³⁵ He was born on May 20, 1901, in Debrecen. His death was tragic: he collapsed and died at the Csokonai statue. Pálffy Papers – The Editorial Staff. 10.

³⁶ Born in Debrecen in 1902. Pálffy Papers – The Editorial Staff. 10.

³⁷ Born on July 18, 1901, in Debrecen. Pálffy Papers – The Editorial Staff. 10.

³⁸ He was the first person to fly over Debrecen in an airplane. Pálffy Papers – The Editorial Staff. 10.

³⁹ He worked at the newspaper until 1935, when he passed the bar exam and opened his own law firm.

⁴⁰ He was born on August 2, 1905, in Debrecen. Pálffy Papers – The Editorial Staff. 12.

⁴¹ According to the *Explanatory Dictionary of the Hungarian Language*, the term *rikkancs* refers to a mobile street newspaper vendor who loudly calls out the news or headlines. "There are all sorts of people who work as newspaper hawkers. It is not uncommon to find someone with a diploma, nor is it rare to find someone who once rode in a carriage and could call themselves the owner of a well-kept estate or a business with a substantial income. (...) There are also old, stooped grannies, young brides with small children, and cripples in wheelchairs, but the majority of newspaper hawkers were still agile children aged between ten and twelve. It was they who, with their incessant clamor, earned the name newspaper hawker." *Vasárnapi Ujság*, July 21, 1901.

⁴² Pálffy Papers – Wage Conditions. 3.

⁴³ Izidor Kálnoki: *School of Journalism*. 45.

⁴⁴ Géza Buzinkay: *History of Hungarian Newspapers, 1848–1918*. 100–101.

specific actions or events.⁴⁵ The reportage contains three important elements. First, it belongs to genres that convey or emphasize facts; fundamentally, it can therefore be considered news, which is why the journalist must gather material for the report with the same thoroughness. Second, the difference from news becomes apparent in the requirement for a personal experience. The journalist must immerse themselves in the story in order to convey it to the reader from a truly authentic perspective. Third, actions and events are the typical hallmarks of a feature story; thus, the journalists themselves become active participants in the story.⁴⁶ The reportage became an increasingly significant factor in the newspaper, and the reporter became an increasingly important figure in the newsroom. Soon, newspapers' editorial offices consisted of little else but reporters: police, economic, theater, court, stock market, and literary reporters.

Statistical data also confirm the growing importance of reporters. In 1890, a total of 454 newspaper reporters were registered in Hungary, which represented nearly a twofold increase compared to figures from a decade earlier. By 1900, their number had risen to 884, while in 1910, 1,201 newspaper reporters were registered.

The reportage evolved from the communication of information. Its purpose is to provide a realistic portrayal of an original event. It is a complex genre that utilizes elements from nearly all journalistic genres. Like the interview, it serves as a bridge between the reporting of facts and the expression of opinions. Even today, it remains one of the most prestigious journalistic genres. It contains numerous subjective elements, as the event reaches the reader through the reporter's mediation; moreover, the journalist is often a participant in or a shaper of the events themselves. It is one of the most unique journalistic genres, as the reporter must, to a certain extent, identify with the world they are writing about. Through their personal experiences, they recount the events and present the fates and experiences of the characters. The reporter can decide for themselves which aspects of the event to emphasize, which is why several types of reportage have emerged.

An event reportage is produced in connection with a significant event or at its location. A sociographic reportage presents the situation of a social group through specific human stories, or sheds light on a particular social problem or phenomenon. The travel reportage is an experiential, often cinematic account that captures the events and experiences of a journey. In the case of the investigative report, the journalist works to uncover a significant issue or problem, publishing their findings and research results in articles or series of articles.⁴⁷

Event Reportage

The event report is the type of report for which it is easiest to find examples. Essentially, it means that

whenever something happens anywhere in the world that is likely to be of great interest, the reporter covers it and presents it to readers. The event may be pre-planned, such as the Olympics, an election, or another major public event, but it may also be unexpected, such as a terrorist attack, a serious accident, a mining disaster, a train crash, or another extraordinary event. This category also includes movements of great social significance, such as demonstrations, riots, or wars.

Since these events are of particular public interest, the press typically covers them in numerous news stories and reports. These reports primarily convey the most important facts and figures, which reporters present based on their on-site experiences. At the same time, the reports mostly maintain the perspective of an outside observer.

However, simply presenting facts and figures is not enough to hold readers' attention. It is also necessary to place events within a broader context. For this very reason, event reporting does not merely present the event itself, but also explores its background, antecedents, and consequences. The reader is not only curious about what happened, but also about what lies behind the event, what processes led to it, and what its implications might be for the future.

A good example of this is the article titled *Eszméletlen leány a Petőfi-kertben* [Unconscious Girl in Petőfi Park], published in *Debreczen* under the subtitle *Titokzatos eset* [Mysterious Case], which reported on a young woman's sudden illness under mysterious circumstances. The article sought to maintain readers' interest by presenting details of the location, the circumstances of the event, and the police investigation. It clearly illustrates the fundamental characteristics of event reporting: the presentation of a fresh, unexpected event, the communication of on-site information, and the emphasis on the uncertainty and tension surrounding the story.⁴⁸ Another example is the article titled *Korányi Zoltán nyilatkozik a Debreczen-nek az ejtőernyős ugrásról* [Zoltán Korányi Speaks to Debreczen About the Parachute Jump], which reported on a parachute jump performed at the Debrecen airport. The article provided a detailed account of the circumstances of the event and the technical details of the jump, and also featured an interview with the protagonist. The piece effectively captures one of the key characteristics of event reporting: the focus on on-site experiences, personal impressions, and the spectacle, which allowed readers to feel as though they were part of the event themselves.⁴⁹ Reports on criminal incidents were also popular features of the paper. This is illustrated by the report titled *Verekedők véletlenül leütötték Kovács Aladár vendéglőst* [Fighters Accidentally Knocked Out Restaurant Owner Aladár Kovács], which covered a brawl that broke out among soldiers in a Debrecen restaurant. The article provided a detailed account of the

⁴⁵ The original meanings of the word *report* include: 1. to report, to give an account, to break the news; 2. a report, an account; 3. a gunshot. According to the *Explanatory Dictionary of the Hungarian Language*, a *riport* 'report' is "a newspaper, radio, or television report prepared on-site or based on on-site experience." Lajos Domokos: Press. The Theory and Practice of Print and Electronic Journalism. 28.

⁴⁶ Claudia Mast: The ABC of Journalism. 172.

⁴⁷ Tamás Harle: The Craft and Art of Journalism. 91–92.

⁴⁸ The framing of the "mysterious case" clearly served to heighten readers' curiosity, while the paper, in the absence of the results of the police investigation, suggested several possible explanations. *Debreczen*, May 28, 1924. 6.

⁴⁹ *Debreczen*. September 23, 1924. 3.

circumstances of the incident, the actions of those involved, and the police intervention. By building on unexpected twists and the dramatic elements of the conflict, the piece sought to capture readers' attention while presenting an ordinary local event in a news report format.⁵⁰

Travel Reportage

The travel report is a dynamic, exciting, entertaining, and plot-rich genre. It can be considered one of the oldest types of reporting in journalism, as even during the age of great geographical discoveries, detailed travelogues were written in which travelers shared their adventures and experiences with readers. Even accounts of the discovery of America, in many respects, can be considered precursors to the travel report. The purpose of the travel report is for the reporter to present distant regions, their culture, natural environment, and the daily lives of the people living there through their own experiences. The reader not only receives information about a given place but also gets to know the atmosphere, customs, and way of life of the region through the reporter's personal experiences. A distinctive feature of the genre is that, in addition to factual reporting, personal impressions and experiences play a significant role. The reporter recounts the things they saw, the people they met, and the events and experiences they encountered during their journey. Thus, the travel report serves simultaneously as a genre that informs and conveys experiences.

An example of travel reportage is the article titled *Egy magyar művész viszontagságos életútja Hajdúböszörményből Párisig* [The Eventful Life Journey of a Hungarian Artist from Hajdúböszörmény to Paris]. Through the life journey of painter Zsigmond Pál Nagy, the report presents the foreign locations and experiences that played a defining role in his career. By describing the stops along the journey and recounting the protagonist's experiences and trials, the author employs the characteristic tools of the travelogue genre.⁵¹

Sociographic Reportage

In many respects, the sociographic reportage can even be considered a literary work. It employs rich descriptions, detailed character portrayals, and powerful atmosphere-building, often making the stories presented an immersive experience for the reader as well.⁵²

However, a key difference from literary works is that every claim in a report must be based on real facts. The genre presents the everyday lives and fates of real people, depicting their stories in actual locations and under real-life circumstances. The reporter's task is not to create fiction, but to present social reality in an authentic and vivid manner, while drawing attention to broader social phenomena through human stories.⁵³

The article titled *Nagyarányú segélyakció a szegény gyermekeknek* [Large-Scale Relief Effort for Poor Children], though not considered a classic report, is nonetheless a good example of how social issues are

covered in the press. The report details the relief efforts of an association dedicated to child protection and draws readers' attention to the problem of poverty.⁵⁴

Investigative Reporting

A significant portion of investigative reporting actually differs from the classic reporting genre. While traditional reporting is primarily based on on-site experiences, personal impressions, and the direct presentation of events, investigative reporting focuses on uncovering a phenomenon, case, or problem. This type of reporting is based on extremely thorough data collection, document analysis, interviews, and extensive research. The journalist's goal is not merely to present events, but to uncover connections, identify underlying causes, and reveal information previously unknown to the public. As a result, investigative reporting often lies at the intersection of reporting and fact-finding journalism. One of the genre's most important characteristics is that it presents a thoroughly researched phenomenon or problem while striving for an authentic and verified presentation of the facts.⁵⁵

The report titled *Nyíregyházán merényletet akartak elkövetni Horthy kormányzó ellen* [An Assassination Attempt Was Planned in Nyíregyháza Against Governor Horthy] can be considered an early form of investigative or fact-finding reporting. The article not only reports on the alleged assassination attempt but also details the information uncovered during the investigation, the suspects' confessions, and the police measures taken. The purpose of the piece is not merely to record the event, but to uncover whether there was indeed a threat of an assassination, who might have been behind it, and what evidence supports the suspicion. In this way, the article already exhibits the characteristic features of an investigative report.⁵⁶

The article titled *Újabb terhelő vallomások a bombapörben* [Further Incriminating Testimonies in the Bombing Trial] can be classified as an investigative report on a criminal topic, as it provides a detailed account of the testimonies given during the trial, the defendants' contradictory statements, and the evidence uncovered during the investigation. The report's aim is not merely to document the event, but to present the background and context of the case, thus going beyond the scope of traditional court reporting.⁵⁷

The Technical Background of Debreczen's Production

The scope of operations of the Trans-Tisza Book and Newspaper Publishing Joint-Stock Company, the publisher of *Debreczen*, was quite diverse. Administration, the editorial office, the publishing office, the printing press, distribution, zincography, and bookbinding all constituted separate divisions within the joint-stock company.

At the height of its prosperity, the printing staff numbered as many as 32–34 members. The smallest

⁵⁰ *Debreczen*. August 5, 1924. 4.

⁵¹ *Debreczen*. November 24, 1924. 4.

⁵² Harle 97.

⁵³ Harle 100.

⁵⁴ The article's subject matter relates to the social issues examined in later sociographic reportages, but it lacks the on-

site experiences and depictions of personal fates characteristic of the reportage genre. *Debreczen*. September 12, 1924. 4.

⁵⁵ Harle 101.

⁵⁶ *Debreczen*. November 12, 1924. 2.

⁵⁷ *Debreczen*. November 22, 1924. 1.

workforce was during wartime, when only 12–16 people were employed. The *Debreczen*, which was published with a pictorial supplement on 16 pages on weekdays and 32 pages on Sundays, was typeset daily by five typesetters; during the period of reduced page count, three typesetters worked on its publication. Furthermore, the so-called “pre-typesetting” was also used for the Sunday edition. In addition to the typesetters, there was a page compositor who assembled the pages of the paper; moreover, advertisements were typeset separately by one or two hand compositors.⁵⁸ In the 1930s, typesetters’ wages were 65–70 pengő per week, and the page compositor’s were 90–100 pengő.⁵⁹

Debreczen was produced on a rotary press. The rotary press could print, fold, and count 12,000 copies per hour. The press operator in charge of the rotary press had the highest salary, which could reach 110–120 pengő per week. The production of the newspaper included a typesetting shop, which was managed by a typesetter and an assistant. Moulds were made from the composed pages, and stereotype plates were then cast for the rotary press.⁶⁰ The number of employees in the bookbinding department varied, as did that of the so-called commercial shop, which produced commercial forms to order.

Advertisements

Changes in the press’s genre and structure were accompanied by shifts in power.⁶¹ Business-oriented newspaper publishing went hand in hand with an increase in the number of advertisements.⁶² It was the Légrády brothers who introduced an important innovation through the *Pesti Hírlap* [Pest Gazette]; this is how classified ads emerged, which, instead of advertising products and companies, turned newspaper readers into advertisers, thereby fostering a closer connection with the paper.⁶³

⁵⁸ A collective agreement guaranteed the printers’ wages and working conditions. The collective agreement established the minimum work output, i.e., how many characters a typesetter was required to set. Generally, even the weakest typesetter met this requirement, which was checked only in the rarest of cases. There was no major friction between the company management and the printing staff; at most, there were occasional disputes regarding overtime.

⁵⁹ The workday was set at eight hours, but half an hour of that was for dinner.

⁶⁰ The stereotyper’s weekly wage was approximately 100 pengő.

⁶¹ Advertising and promotional revenue played a crucial role in the financing of media enterprises. In many cases, various advertisements and promotions provided not only the largest but also the most significant portion of the newspapers’ income. Claudia Mast: *The ABC of Journalism*. 31.

⁶² Even before the First World War, the term “business press” was not an accurate description. With a few exceptions, virtually the entire world press of the time fell into this category. Such exceptions included specialized scientific journals, periodicals dedicated to social progress in their own way, and socialist newspapers. In addition to subscriptions, advertising revenue was the most important source of income for the press. Géza Lengyel, *Hungarian Newspaper Magnates*. 5–6.

⁶³ Buzinkay 100–101.

⁶⁴ For example, in 1907, 65 of the 160 pages of *Az Újság* [The Newspaper] were filled with advertisements. Buzinkay 101.

⁶⁵ Buzinkay 100–101.

After the turn of the century, the number of advertisements began to grow rapidly, driven not only by economic factors but also by other reasons. Act X of 1900 abolished the special tax levied in the form of an advertising stamp, leading to rapid and dramatic changes in place of the often-repeated press advertisements that had previously occupied a maximum of one or two pages.⁶⁴

In the eyes of readers, the pages containing the advertising section were clearly distinct, but in reality, the truth was that the main editorial content of the daily newspapers was closely linked to the evolution of the papers’ spirit and content. By the early 20th century, economists and journalists had risen to become the most influential members of the editorial staff, many of whom went on to become prominent politicians and members of parliament.⁶⁵

The Thematic Structure and Economic Context of the Advertisements

To gain a comprehensive picture of how advertisements appeared in the pages of *Debreczen*, it is useful to examine one complete issue as a case study. Take, for example, the issue published on April 6, 1924, which clearly illustrates the newspaper’s early structure and content organization.⁶⁶

In this eight-page issue, editorial content and advertisements present a relatively balanced picture; however, it is clear that advertisements played a significant role even during the launch period. The first five pages were devoted almost entirely to public affairs, political, economic, and local news, while on the sixth page, advertisements appeared in a significant proportion alongside the economic and sports sections.⁶⁷ The sev-

⁶⁶ The classified ads section played a key role in the competition among Debrecen’s daily newspapers, serving as an important platform for information and networking for the readership of the era. In this regard, *Debreczen* was initially at a disadvantage compared to its main competitor, *Debreceni Újság*, which already had a significant advertising base. To break this monopoly, Gyula Szigethy, the director of *Debreczen*, employed an innovative solution: he entered into an agreement with the other papers under his management stipulating that any classified ad placed with any of them would be published in all four papers at the same price and in the same format. This strategic move significantly increased the reach and readership of the advertisements, as the combined audience of four papers provided a much wider reach than a single newspaper, no matter how popular. The initiative proved successful: advertisers gradually shifted their support to the press network centered around *Debreczen*, which ultimately gained dominance in the classified ads market. These developments proved so effective that, starting in late March, one full page of the eight-page paper was devoted exclusively to advertisements, while the remaining pages also featured them sporadically.

⁶⁷ Given the nature of the paper, public affairs, political and economic news dominated the content, together accounting for approximately 70% of the newspaper’s total volume. These two main categories can be further divided into three subcategories each, depending on whether the news was of local, national, or international relevance. Articles on political topics were placed on the first three pages of the newspaper, which clearly demonstrates their prominent role and central

enth and eighth pages served almost entirely as advertising space, so advertisements occupied approximately one-quarter to one-third of the issue's total volume.⁶⁸

The editorial practice of placing advertisements corresponded to the solutions generally applied in provincial daily newspapers of the era. Political and public affairs content was placed on the front pages, while advertisements were gradually pushed to the back of the paper. This editorial principle ensured both the primacy of news content and the availability of advertising space necessary for commercial revenue.⁶⁹

Advertisements can also be grouped by topic. The vast majority were linked to local businesses, but they also represented clothing and textile stores, haberdasheries, fur and fashion retailers, restaurants, pharmacies, advertisements for various tradespeople, as well as real estate and other classified ads. One example of a clothing and fashion advertisement is that of Hajdúság Men's Clothing, which offered a wide selection of spring clothing for men and children at 67 Piac Street. The hospitality industry was represented by Fest-Mos Coffeehouse on Csapó Street, while the Arany Angyal Pharmacy advertised pharmaceuticals and health products.

The Geographical Ties of the Advertisements

The geographical ties of the advertisements clearly linked the paper to Debrecen's economic life. Since the newspaper was published in Debrecen, the majority of advertisers were also drawn from the ranks of local merchants, entrepreneurs, and service providers. This is well illustrated by the fact that the advertisements almost without exception listed Debrecen addresses: the Hajdúság Men's Clothing Store on Piac Street, the Lipcsei Fur Shop on József királyi herceg Square, the Fest-Mos Coffeehouse on Csapó Street, while the Merino Cloth Trading Co. also operated on Piac Street. This also suggests that *Debreczen*, even in its early days, sought to establish close ties with the city's business community and involve them in the newspaper's operations.⁷⁰

Characteristics of the Advertising Language

The language of the advertisements fitted well with the characteristics of contemporary advertising communication. The ad copy was generally short, concise, and attention-grabbing, with the primary goal of capturing the interest of shoppers. Recurring phrases such as "attention", "cheap", "reasonable price", "latest", or "wide selection" were common, emphasizing the favorable qualities of the products or services in question. A good example of this is the advertisement for Hajdúság Men's Clothing, which highlighted its selection of "the latest spring fashions for men and children", as well as the advertisement for Merino Cloth Trading Co., which sought to pique shoppers' interest with the slogan "spring novelties have arrived."⁷¹

importance in the paper's editorial principles. Following the political content, though occasionally appearing on earlier pages as well, articles on economic topics appear.

⁶⁸ *Debreczen*, April 6, 1924. 1–8.

⁶⁹ *Debreczen*, April 6, 1924. 5–8.

⁷⁰ *Debreczen*, April 6, 1924. 5–8.

⁷¹ The language of the advertisements was direct and easy to understand, primarily aiming to highlight practical benefits.

The Target Audience and Social Background of the Advertisements

The advertisements – like the articles appearing in the paper – were tailored to the needs of the presumed readership. The clothing, haberdashery, pharmaceutical, and household goods advertisements appearing in the issues primarily reflected the needs of the urban bourgeoisie, the middle classes, and merchant and entrepreneurial groups.

At the same time, advertisements related to agricultural products, land, and farm equipment also appeared in the newspaper's columns. This suggests that *Debreczen* sought to reach not only the urban audience but also rural farmers and landowners among its readership. Notable examples include an advertisement for Pyramis Hungarian Landowners' and Tenant Farmers' Trading Joint-Stock Company, which dealt with grain, forest, and land transactions, as well as various classified ads for land sales and leases. In addition, some of the advertisements offering agricultural machinery and seeds were also aimed at the farming public.⁷²

Women's Roles and Ideals of Womanhood as Reflected in Advertisements

An interesting angle for examination is the analysis of what insights the advertisements provide into the ideals of womanhood and perceptions of women's roles during that era. In the early issues of *Debreczen*, female readers were often addressed directly, as indicated by advertising slogans such as "Attention, ladies!"

A significant number of the advertisements promoted fashion items, furs, hats, textiles, and household goods, specifically targeting women as consumers. These advertisements not only served commercial purposes but also indirectly conveyed the social expectations and images of women of the era. Good examples of this include the advertisement by the firm of Leopold Weisz and Entner, which promoted women's fashion items and fabrics; the advertisement for the Lipcsei Fur Shop; and the advertisement by Merino Cloth Trading Co. showcasing its spring novelties.⁷³

Seasonal and Holiday Advertisements in the Pages of Debreczen

Like the rest of the paper's content, advertisements were adapted to the seasons, holidays, and economic cycles. In the issue examined, for example, advertisements related to Easter fairs, Easter food, and spring merchandise had already appeared. This suggests that merchants deliberately tailored their advertisements to the consumption habits and needs of the given period. In the examined issue dated April 6, 1924, for example, advertisements related to the Easter holiday season had already appeared. A good example of this is the advertisement titled *Nagy húsvéti hírijság* [The Great Easter Newsletter], which promoted products related to the Easter shopping season, as well as

The advertisements were not intended to provide detailed information, but rather to attract attention and encourage the intent to purchase. Accordingly, the texts were based on short, assertive statements that conveyed the message to readers quickly and clearly. *Debreczen*, April 6, 1924. 5–8.

⁷² *Debreczen*, April 6, 1924. 5–8.

⁷³ *Debreczen*, April 6, 1924. 5–8.

the advertisement with the headline *Húsvétra!* [For Easter!] which recommended festive foods and various consumer goods to readers. In addition, several retailers based their advertisements on the start of the spring season, such as Merino Cloth Trading Co., which advertised its new inventory with the slogan *Tavaszi újdonságok érkeztek* [Spring novelties have arrived].

An analysis of seasonal advertisements offers an opportunity to explore which holidays, events, and periods played a decisive role in consumer culture. Furthermore, it is possible to examine which products individual merchants associated with specific holidays, seasons, or times of year, as well as how the composition of advertisements evolved over the years.⁷⁴

Advertisements as Sources of Urban Modernization

Finally, it is important to note that advertisements also provide an excellent source of material for studying the city's modernization processes between the two world wars. The advertisements featured new products, services, business models, and consumption patterns that clearly reflected the evolution and development of urban lifestyles. The emergence of modern commercial methods, specialized stores, contemporary fashion items, technological innovations, and evolving services can all be interpreted as signs of urbanization and the rise of the middle class. Thus, advertisements not only stimulated consumption but also reflected social and economic changes.

The advertisement for the Lipcsei Fur Shop can be interpreted as a sign of the emerging urban lifestyle, as it appeared in the newspaper's columns as a specialized store. The installment payment options featured in the advertisements, the emphasis on a wide selection, and the increasingly specialized commercial offerings also point to the spread of modern commercial methods. The presence of the developing service sector is also evident in the advertisements for pharmacies, the hospitality industry, and various service businesses. Advertisements for the Arany Angyal Pharmacy or the Fest-Mos Coffeehouse indicate that specialized services and businesses built on consumer needs played an increasingly significant role in the daily lives of the urban population.

The study of these advertisements is therefore significant not only from the perspective of press history, but also from the perspectives of urban and social history. With their help, it is possible to reconstruct how Debrecen's consumer culture, economic structure, and daily life evolved during the period under examination.

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⁷⁴ An analysis of advertisements from this perspective not only provides insight into changes in commercial practices,

but can also offer important data on the consumer habits, lifestyles, and social values of the era. *Debreczen*, April 6, 1924. 5–8.

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MEDICAL SCIENCES

INFLUENCE OF GENITAL INFECTIONS ON LEUCOCYTE DNA METHYLATION IN EARLY PREGNANCY MISCARRIAGE

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Abstract

This study examined the impact of genital infections on leukocyte DNA methylation in women with early miscarriage. It was concluded that in women with full-term pregnancies and full-term deliveries who had genital infections before pregnancy, a balanced ratio of proinflammatory (TNF- α , IL-1 β) and anti-inflammatory (IL-10) cytokines, as well as balanced MMP/IMMP levels and moderate epigenetic changes, contribute to effective immune regulation, which facilitates a favorable pregnancy even in the presence of infection. In women who had miscarriages at 12 weeks of gestation and also had genital infections before pregnancy, a pronounced cytokine imbalance (high TNF- α , IL-1 β ; low IL-10) indicates excessive inflammation and the risk of complications associated with miscarriages. Significant increases in MMP and decreases in IMMP can disrupt tissue integrity, worsening conditions for pregnancy. Increased DNA methylation (elevated DNMT1 and 5-methyl-2'-deoxycytidine) indicates epigenetic abnormalities that potentially impact immune adaptation and reproductive function.

Keywords: interleukins, proteases, protease inhibitors, DNA methyltransferase 1, early pregnancy, genital infections.

Introduction

Bacteria induce changes in DNA and histone methylation patterns in the host by secreting bacterial effector proteins or hijacking host methyltransferases via bacterial structures and molecular stimuli [5]. These methylation changes affect signaling pathways, transcription factors, chromatin structure, host receptors, and microRNAs. This leads to altered expression of genes involved in the immune response, allowing immune evasion, bacterial survival, and replication within the host cell. Ultimately, these epigenetic changes facilitate effective infection [2]. Research on compounds targeting methyltransferases shows clinical relevance in the treatment of diseases in which epigenetic patterns are disrupted. Research into epigenetics and methyltransferase inhibitors in infection may help better understand the molecular mechanisms of infection. Specific chemical inhibitors may help answer these questions [7]. This may facilitate the identification of new treatment strategies that will ultimately reduce antibiotic use and help combat growing antimicrobial resistance. This area remains understudied, and further research is needed to examine the potential and actual impact of epipreparations on infection [1].

Pregnancy provides an exceptional platform for studying stress and stress responses under normal conditions and during pathogenic infection, where epigenetic regulation plays a key role in determining gestational development. A better understanding of certain epigenetic mechanisms, such as DNA methylation,

post-transcriptional modification of histones, and regulatory non-coding RNAs, may help us identify biomarkers for pregnancy-related risk factors or disease risk [8]. Epigenetic alteration can also trigger inflammatory responses, such as autoimmune diseases or allergic reactions in healthy individuals. Prenatal exposure to immune factors can often be a significant factor, causing epigenetic modification and leading to the development of brain disorders in newborns [4]. Pathogenic infections (bacterial, viral, and fungal) can have a significant impact on the overall well-being of the mother and fetus. Significant changes in the cytokine profile (INF- γ , TNF- α , TGF- β , and interleukins) and epigenetic regulation during infection during pregnancy have been shown to cause adverse pregnancy outcomes [3]. Much more in-depth knowledge is required to understand the factors causing changes in epigenetic regulatory mechanisms during pregnancy under infectious and normal conditions. This may be useful for determining the phenotypes of offspring and preventing or reducing the risk of health hazards to future offspring. Detailed information in this regard may be crucial for understanding pregnancy, the immune paradigm, and other emerging complications and will be useful for taking certain basic measures to minimize the impact of infection and any other factors during pregnancy [6].

Study Objective

To study the impact of genital infections on changes in leukocyte DNA methylation in women with early pregnancy loss.

Materials and Methods

Seventy-four women were examined, divided into three groups. Group 1 included 29 women who had had a full-term pregnancy and full-term birth, and who had no history of genital infections before pregnancy. Group 2 included 25 women who had had a full-term pregnancy and full-term birth but had genital infections before pregnancy. Group 3 included 22 women who had miscarriages at 12 weeks of pregnancy and also had genital infections before pregnancy.

Blood samples from women were analyzed using ELISA before, 6, and 12 weeks of pregnancy for proinflammatory markers (interleukin-1 β (IL-1) and tumor necrosis factor- α (TNF- α)), and anti-inflammatory markers (interleukin-10). Matrix metalloproteinases (MMP-9) and protease inhibitors (matrix metalloproteinase inhibitor-1).

Methylation occurs at the C5 position of the 2'-deoxycytidine molecule, forming the methylated base 5-methyl-2'-deoxycytidine. Therefore, changes in DNA methylation levels can be quantified by measuring the concentration of 5-methyl-2'-deoxycytidine. Therefore, changes in DNA methylation levels in the supernatant of washed hemolyzed leukocytes isolated in fecol-verografin were determined based on the concentration of 5-methyl-2'-deoxycytidine using an ELISA method. DNA methyltransferase 1 activity was also determined in the supernatant of washed hemolyzed lymphocytes isolated in fecol-verografin using an ELISA kit.

Statistical analysis was performed using the analysis of variation statistics, calculating mean values and their standard errors, and determining the Student-Fisher difference reliability coefficient (t). Differences were considered statistically significant at $p < 0,05$.

Results and Discussion

The studies revealed that women in the second group had significantly higher TNF- α blood levels before pregnancy than women in the first group, by 1,8 times. At 6 weeks of pregnancy, this level in women in

the second group was 1,4 times higher than before pregnancy and significantly higher than similar results in the first group. At 12 weeks of pregnancy, TNF- α levels in group 2 did not change significantly compared to week 6, but were 1,9 times higher than before pregnancy levels and 1,8 times higher than those in group 1. In women in the third group, TNF- α levels before pregnancy were significantly higher than those in the first group (4,0 times) and the second group (2,2 times). At 6 weeks of pregnancy, this level in women in the third group was 2,1 times higher than before pregnancy levels, 5,5 times higher than those in the first group, and 3,3 times higher than those in the second group. At 12 weeks of pregnancy, significant changes were also observed in the third group, with TNF- α levels 3,0 times higher than pre-pregnancy levels, 6,7 times higher than in the first group, and 3,7 times higher than in the second group.

The IL-1 β study revealed changes similar to those found for TNF- α . Women in the second group demonstrated significantly higher and significantly different results both before pregnancy and at 6 and 12 weeks of pregnancy, compared to women in the first group. Furthermore, these values were also significantly and significantly higher compared to pre-pregnancy levels in the same group. The third group also recorded higher levels of this parameter before pregnancy, as well as at 6 and 12 weeks of pregnancy, confirming the significant differences in the results of the third group compared to the first and second groups. Also, as a result of the studies, it was established that the level of interleukin-10 (IL-10) in the blood of women in the second group pregnancy was 1,2 times higher than in women of the first group, but the difference did not reach statistical significance. At 6 weeks of pregnancy, the level of IL-10 in the blood of women of the second group decreased, reaching 1,3 times lower than the values before pregnancy, while it was slightly higher than in group 1. At 12 weeks of pregnancy, the level of IL-10 was 1,3 times lower

Table

Changes in TNF- α , IL-1 β , IL-10, MMP-9, and IMMP-1 levels in the blood of women, as well as DNA methyltransferase 1 and 5-methyl-2'-deoxycytidine levels in leukocytes in the groups examined

Parameters studied	Group	Pre-pregnancy	6 weeks pregnant	12 weeks pregnant
IL-TNF pg/ml	1	7,1 $\pm$ 0,9	10,8 $\pm$ 1,3*	12,9 $\pm$ 1,4 *
	2	12,7 $\pm$ 1,3 ^o	17,9 $\pm$ 1,8* ^o	23,7 $\pm$ 2,5* ^o
	3	28,3 $\pm$ 2,9 ^{o+}	59,2 $\pm$ 6,1* ^{o+}	84,9 $\pm$ 8,6* ^{o+}
IL-1 β pg/ml	1	4,2 $\pm$ 0,5	8,3 $\pm$ 0,9*	10,1 $\pm$ 1,2*
	2	8,9 $\pm$ 0,9 ^o	14,8 $\pm$ 1,5* ^o	19,7 $\pm$ 2,1* ^o
	3	22,4 $\pm$ 2,3 ^{o+}	43,7 $\pm$ 4,4* ^{o+}	62,8 $\pm$ 6,4* ^{o+}
IL-10 pg/ml	1	9,3 $\pm$ 1,2	7,4 $\pm$ 0,8	5,9 $\pm$ 0,7*
	2	11,2 $\pm$ 1,3	8,5 $\pm$ 0,7	6,4 $\pm$ 0,5*
	3	3,7 $\pm$ 0,4 ^o	2,1 $\pm$ 0,24* ^o	1,4 $\pm$ 0,17* ^o
MMP ng/ml	1	0,7 $\pm$ 0,04	0,9 $\pm$ 0,07*	1,2 $\pm$ 0,11*
	2	1,1 $\pm$ 0,09 ^o	1,5 $\pm$ 0,13* ^o	1,8 $\pm$ 0,16* ^o
	3	1,7 $\pm$ 0,15 ^{o+}	3,1 $\pm$ 0,28* ^{o+}	4,3 $\pm$ 0,39* ^{o+}
IMMP ng/ml	1	1,1 $\pm$ 0,07	0,8 $\pm$ 0,06*	0,6 $\pm$ 0,05*
	2	1,3 $\pm$ 0,10	1,1 $\pm$ 0,09 ^o	0,8 $\pm$ 0,07* ^o
	3	0,9 $\pm$ 0,08	0,6 $\pm$ 0,04* ^{o+}	0,3 $\pm$ 0,01* ^{o+}
DNA methyltransferase 1 nM/m	1	38,6 $\pm$ 3,5	27,1 $\pm$ 2,4*	21,3 $\pm$ 1,9*
	2	46,8 $\pm$ 4,3	34,2 $\pm$ 3,2*	28,4 $\pm$ 2,5*
	3	61,2 $\pm$ 5,8 ^o	74,6 $\pm$ 7,1 ^{o+}	83,5 $\pm$ 7,9* ^{o+}
5-methyl-2'-deoxycytidine ng/ml	1	81 $\pm$ 7,7	59 $\pm$ 5,4*	48 $\pm$ 4,5*
	2	96 $\pm$ 9,2	72 $\pm$ 6,8	61 $\pm$ 5,7*
	3	133 $\pm$ 11,7 ^{o+}	148 $\pm$ 13,5 ^{o+}	162 $\pm$ 14,9 ^{o+}

Note: 1 - women with a full-term pregnancy and no urogenital infections; 1 - women with a full-term pregnancy and urogenital infections; 2 - women with miscarriages and urogenital infections.

* - significantly different values from pre-pregnancy values.

^o - significantly different values from Group 1 values.

⁺ - significantly different values from Group 2 values.

than at 6 weeks, but at the same time it was 1,8 times higher than the values before pregnancy, remaining at a level close to the values of women from the first group (the difference was also not statistically significant). In the third group, the level of IL-10 before pregnancy was significantly lower than in the first and second groups. Specifically, it was 2,5 times lower compared to the values of the first group and 3,0 times lower compared to the results of the second group. At 6 weeks of pregnancy, IL-10 levels in the third group were 1,8 times lower than before pregnancy and significantly lower than those in the first and second groups (3,5 and 4,0 times, respectively). At 12 weeks of pregnancy, IL-10 levels in the third group remained lower, with a 2.6-fold difference compared to pre-pregnancy levels, a 4,2-fold difference compared to the first group, and 4,6 times lower than those in the second group.

The studies showed that in the second group, MMP blood levels before pregnancy were significantly higher (1,6 times) than in the first group. At 6 weeks of pregnancy, this indicator in this group increased by 1,4 times compared to pre-pregnancy values and was 1,7 times higher than in the first group. At 12 weeks of pregnancy, the MMP level in Group 2 was slightly lower than at 6 weeks (by 1,2 times), but was significantly higher than before pregnancy (by 1,6 times) and 1,5 times higher than in Group 1. In Group 3, the MMP level before pregnancy was significantly higher than in Group 1 (by 2,4 times) and 1,6 times higher than in Group 2. At 6 weeks of pregnancy, this indicator in Group 3 increased by 1,8 times compared to baseline data and was also 3,4 times higher than in Group 1 and

2,1 times higher than in Group 2. At 12 weeks of pregnancy, the MMP level in Group 3 was significantly 2,5 times higher than pre-pregnancy values, 3,6 times higher than in Group 1, and 2,4 times higher than in Group 2.

Analysis of MMP data in Group 2 before pregnancy revealed a slight (non-significant) increase of 1,2 times compared to Group 1. At 6 weeks of pregnancy, the same women's MMP levels were statistically significantly higher than Group 1 values by 1.4 times, but showed a non-significant decrease of 1,2 times compared to their pre-pregnancy data. By the 12th week of pregnancy, a reliable decrease in the indicator was noted in group 2 by 1,6 times lower than the initial level (before pregnancy), 1,4 times lower than the values of the 6th week and 1,3 times higher than in group 1. In women in group 3, the level of IMMP before pregnancy was insignificantly lower by 1,2 times compared to group 1 and 1,4 times lower relative to group 2. At the 6th week of pregnancy, a statistically significant decrease in the indicator was recorded in this group by 1,5 times lower than the initial values, 1,3 times lower than group 1 and 1,8 times lower than group 2. By the 12th week of pregnancy, in group 3 the level of IMMP reached minimum values, demonstrating a reliable decrease of 3,0 times relative to pre-pregnancy data, 2,0 times lower than the indicators of group 1 and 2,7 times lower than group 2.

The study results revealed significant differences in DNA methyltransferase 1 (DNMT1) activity between the groups before pregnancy and at different gestational periods. In Group 2, DNMT1 activity was

slightly 1,2 times higher before pregnancy than in Group 1. At 6 weeks of pregnancy, a significant decrease in the indicator relative to the pre-pregnancy result by 1,4 times was noted, while the values remained 1,3 times higher than in Group 1. By 12 weeks of pregnancy, DNMT1 activity decreased by 1,2 times compared to week 6, demonstrating a significant difference from the pre-pregnancy level of 1,7 times and an excess of Group 1 values by 1,3 times. In Group 3, DNMT1 activity before pregnancy was significantly higher than in Group 1 by 1,6 times and Group 2 by 1.3 times. At 6 weeks of pregnancy, a slight increase in activity relative to pre-pregnancy levels was noted (1,2 times), with values significantly exceeding those in Group 1 (2,8 times) and Group 2 (2,2 times). By 12 weeks of pregnancy, DNMT1 activity was 1.4 times higher than pre-pregnancy levels, reaching maximum differences of 3,9 times in Group 1 and 2,9 times in Group 2.

The results of the studies showed that the level of 5-methyl-2'-deoxycytidine in the blood of women in the second group before pregnancy was only slightly higher than in women in the first group, by 1,2 times. At the 6th week of pregnancy, this indicator in women in the second group was slightly lower, amounting to insignificantly 1,3 times less than before pregnancy, but at the same time remained insignificantly 1,2 times higher than in women in the first group. At the 12th week of pregnancy, the level of 5-methyl-2'-deoxycytidine in group 2 was slightly lower compared to the 6th week by 1,2 times, but remained 1,6 times higher than before pregnancy, and 1,3 times higher than the indicators of the first group. In women in the third group, the level of 5-methyl-2'-deoxycytidine before pregnancy was significantly higher than in women in the first group (by 1,6 times) and the second group (by 1,4 times). At 6 weeks of pregnancy, this indicator was slightly higher than baseline values, 1,1 times higher, 2,5 times higher than in women in Group 1, and significantly higher than in Group 2, 2,1 times higher. At 12 weeks of pregnancy, 5-methyl-2'-deoxycytidine levels in Group 3 showed minor changes, remaining 1,2 times higher than pre-pregnancy levels, significantly higher than Group 1, 3,4 times higher, and 2,7 times higher than Group 2.

The study results revealed significant differences in the women's immune-inflammatory and epigenetic profiles in early pregnancy, which is important for assessing the risk of complications. In Group 2, levels of proinflammatory interleukins (TNF- α , IL-1 β) were higher before pregnancy compared to Group 1 and continued to increase until 12 weeks of pregnancy. At the same time, IL-10 levels in this group were slightly higher than in the first group, and by the 12th week of pregnancy, they had stabilized or slightly decreased compared to pre-pregnancy levels. These changes, judging by the dynamics of the ratio of pro-inflammatory and anti-inflammatory interleukins, are within the normal regulatory range, indicating a balanced immune response and the absence of a tendency toward increased pro-inflammatory processes. Thus, the body effectively copes with infectious agents, creating optimal conditions for maintaining pregnancy.

Regarding matrix metalloproteinases (MMPs), women in the second group had higher levels, which

continued to increase until the 12th week of pregnancy. At the same time, tissue inhibitor of matrix metalloproteinases (TIMPs) levels in the second group were higher before pregnancy than in the first group, and although they decreased at weeks 6 and 12, they remained higher than those in the first group. Increased MMP levels and decreased IMMP levels may contribute to increased proinflammatory responses, and an imbalance in the MMP/IMMP ratio during severe infections may lead to uncontrolled proteolytic activity and increased inflammation. The data obtained confirm that changes in both MMP and IMMP levels within normal limits indicate a balanced ratio of these parameters, which, in turn, contributes to a favorable pregnancy course, despite the presence of infection.

A study of DNA methyltransferase 1 activity in leukocytes in the second group revealed a slight decrease in its activity compared to pre-pregnancy levels. However, this indicator remained slightly higher than in the first group. Similar changes were also recorded for 5-methyl-2'-deoxycytidine levels, which decreased compared to pre-pregnancy levels but remained slightly higher than in the first group. These results also confirm the insignificant impact of existing infections on DNA methyltransferase 1 activity and changes in DNA methylation in leukocytes, which contributes to the maintenance of stable epigenetic processes in the body and a favorable pregnancy course. The results of the third group significantly exceeded those of the second and first groups. For example, the level of TNF- α in this group was significantly higher than in the first and second groups both before pregnancy and at 6 and 12 weeks. This may indicate increased inflammatory activity in women in this group, which is important for further clinical observations, as high levels of TNF- α are associated with the risk of inflammation and complications during pregnancy. Similar changes were observed for IL-1 β , which was also significantly elevated in the third group compared to the first. IL-1 β plays an important role in inflammatory processes and may be a marker of impaired immune regulation, which may subsequently be associated with an increased risk of miscarriage or other complications. Levels of IL-10, an anti-inflammatory cytokine, also showed significant differences. In Group 3, IL-10 levels were significantly lower, which may indicate a disrupted immune response, a reduced ability to suppress inflammation, and possibly an increased risk of inflammatory diseases.

Significantly elevated MMP levels in Group 3 indicate possible degradation of tissue matrix components, which may be associated with disruptions in normal uterine function, for example, during embryo implantation or the inflammatory response. Changes in TIMP levels indicate that women in Group 3, despite initially lower levels, ultimately experience more pronounced changes toward a decrease in levels, which may indicate compensatory mechanisms aimed at regulating MMPs.

Changes in DNMT1 activity in leukocytes showed that in Group 3, its activity was significantly higher than in Groups 1 and 2, which may indicate increased activity of DNA methylation processes involved in the control of gene expression, which in turn may influence

the body's adaptation to pregnancy. Changes in 5-methyl-2'-deoxycytidine levels, a DNA methylation marker, also support the hypothesis that group 3 had more pronounced epigenetic changes, possibly related to immune and reproductive function. These results suggest that an imbalance between proinflammatory and anti-inflammatory cytokines, dysregulation of MMP/IMMP, and epigenetic changes associated with DNA methylation may play an important role in the pathogenesis of pregnancy complications, especially in group 3.

Conclusions: In women with a full-term pregnancy and full-term delivery who had genital infections before pregnancy, a balanced ratio of proinflammatory (TNF- α , IL-1 β) and anti-inflammatory (IL-10) cytokines, as well as balanced MMP/IMMP levels and moderate epigenetic changes, contribute to effective immune regulation, which contributes to a favorable pregnancy even in the presence of infection.

In women who had miscarriages at 12 weeks of gestation and also had genital infections before pregnancy, a significant cytokine imbalance (high TNF- α , IL-1 β ; low IL-10) indicates excessive inflammation and the risk of complications associated with miscarriages. A significant increase in MMPs and a decrease in TIMPs can disrupt tissue integrity, worsening conditions for pregnancy. Increased DNA methylation (elevated DNMT1 and 5-methyl-2'-deoxycytidine) indicates epigenetic abnormalities that potentially impact immune adaptation and reproductive function.

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METABOLIC SYNDROME: SECRETS AND CURRENT MANAGEMENT APPROACHES**Symak Z.**

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<https://doi.org/10.5281/zenodo.21411825>**Abstract**

Metabolic syndrome (MS) remains one of the key global public health challenges due to its increasing prevalence and close association with obesity, insulin resistance, type 2 diabetes, and cardiovascular diseases. The aim of this review is to systematize current approaches to managing MS—including lifestyle modifications, pharmacological strategies, nutraceuticals, and innovative methods of personalized therapy.

An analysis of current evidence regarding the effectiveness of dietary models, physical activity, medications (in particular, GLP-1 agonists and SGLT2 inhibitors), and dietary supplements has been prepared.

Main conclusion: Comprehensive approaches that combine lifestyle changes with individualized therapy focused on component-specific correction remain the most effective. Further research should focus on integrating biomarkers, the microbiome, and digital technologies to personalize treatment.

Keywords: metabolic syndrome, insulin resistance, obesity, dietary therapy, physical activity, nutraceuticals, personalized therapy.

INTRODUCTION

Metabolic syndrome (MS) is defined as a cluster of interrelated metabolic disorders: central (visceral) obesity, hypertension, dyslipidemia (elevated triglycerides, low HDL cholesterol), impaired glucose tolerance, or insulin resistance [1].

According to recent studies, the prevalence of MS among adults is approximately 12.5–31.4%, depending on the diagnostic criteria. It correlates with an increased risk of cardiovascular disease, diabetes, cancer, and all-cause mortality in a dose-dependent manner [2].

The pathogenesis involves insulin resistance, excessive visceral adipose tissue, chronic systemic inflammation, oxidative stress, and endothelial dysfunction [3].

Due to the significant risk of developing cardiovascular disease (CVD), nonalcoholic fatty liver disease (NAFLD), type 2 diabetes (T2D), and overall mortality, managing metabolic syndrome is a priority in preventive cardiology and endocrinology [4].

Today, medicine is moving away from simply treating symptoms toward deeper levels of intervention. Modern approaches to managing metabolic syndrome (MS) are based on the concept of “4P medicine”: personalization, prediction, prevention, and patient participation.

A detailed description of the key strategies that define the current standard of care for MS is provided in Table 1.

Table 1

Modern Directions of Pathogenetic Correction of Metabolic Syndrome

Approach	Components / What it includes
Lifestyle Modification	Dietary modification (LCHF, intermittent fasting), personalized exercise programs.
Pharmacotherapy	Use of GLP-1 receptor agonists, SGLT2 inhibitors, and insulin sensitizers.
Microbiome	Targeting the gut microbiota to regulate glucose metabolism.
Psychosomatics	Stress management and correction of circadian rhythms (sleep).

This review aims to summarize modern approaches to the prevention and treatment of MS, assess the evidence for the effectiveness of different strategies, and define avenues for further research.

RESULTS AND DISCUSSION

The main trend in recent years has been the shift from treating isolated symptoms (such as blood pressure or blood glucose) to targeting the fundamental mechanisms of obesity and insulin resistance.

Etiology and Pathogenesis of Metabolic Syndrome

MS is a multifactorial condition. Genetic and epigenetic factors play a significant role: studies demonstrate that (epi)genetic modifications, particularly those affecting the functional parameters of the hypothalamus and neuropeptides (such as BDNF), can be pivotal in the development of MS [5].

Adipose tissue localization plays a crucial role: visceral obesity stimulates the release of free fatty acids and pro-inflammatory cytokines (TNF- α , IL-6), along with a reduction in adiponectin levels, which drives the development of insulin resistance [1].

Dyslipidemia, hypertension, insulin resistance, and endothelial dysfunction form a detrimental metabolic profile that leads to atherosclerosis and T2D [6].

Modern research emphasizes that MS should be viewed not merely as a cluster of risk factors, but as a complex systemic disease that affects the liver, kidneys, heart, blood vessels, and nervous system [6].

Nutritional Therapy in the Management of Metabolic Syndrome

Dietary modification is a fundamental component of MS treatment. Caloric restriction and subsequent weight loss (a reduction of $\geq 5\%$ is recommended) are associated with improvements in insulin resistance and lipid profiles [4].

The Mediterranean diet has accumulated the strongest body of evidence. Characterized by a high intake of vegetables, fruits, whole grains, olive oil, and fish, alongside moderate consumption of red meat, it is associated with a reduced risk of developing MS and improved metabolic parameters.

Furthermore, low-glycemic index (Low-GI) diets, carbohydrate restriction, low-carbohydrate (Low-Carb) diets, and intermittent fasting demonstrate significant potential for MS management [7]. The role of micronutrients and antioxidants is also notable: magnesium, chromium, polyphenols, and omega-3 PUFAs are currently being investigated as adjunct options to improve the metabolic profile [8].

According to recent meta-analyses and randomized controlled trials (RCTs), a Mediterranean dietary pattern significantly reduces triglyceride levels and insulin resistance indices (HOMA-IR) within 6–12 months of intervention in patients with metabolic syndrome and NAFLD [9].

A systematic review and meta-analysis titled "*The impact of the Mediterranean diet on cardiovascular risk factors in patients with non-alcoholic fatty liver disease*" demonstrated that, compared to control groups, the Mediterranean diet:

- significantly lowers triglycerides;
- reduces HOMA-IR (insulin resistance) [10].

Physical Activity

Physical activity plays a pivotal role in the management of MS: aerobic training (e.g., 150 minutes/week of moderate intensity) and resistance exercises contribute to enhanced insulin sensitivity, reduction of visceral adipose tissue, and improvement of both lipid profiles and blood pressure [2].

Consistency, moderate-to-high intensity, long-term adherence, and tracking are all factors that influence the outcome. The authors emphasize that rather than a one-time intervention, the sustainability of lifestyle changes is what remains paramount [2].

Pharmacological Therapy

Although data directly addressing the treatment of metabolic syndrome as a single, unified diagnosis remain limited, the targeted therapy of its individual components demonstrates substantial efficacy.

• **Insulin Resistance and Metabolic Control:** Metformin and thiazolidinediones are widely utilized to address insulin resistance.

• **Cardiovascular and Lipids Management:** Statins, omega-3 fatty acids, and antihypertensive

agents are employed to correct dyslipidemia and blood pressure [2].

• **Next-Generation Agents:** GLP-1 receptor agonists (such as semaglutide and tirzepatide) and SGLT2 inhibitors demonstrate profound outcomes. Beyond lowering blood glucose, they induce radical weight reduction and mitigate cardiovascular risk [2]. Specifically, SGLT2 inhibitors provide potent cardioprotection and nephroprotection by promoting osmotic diuresis and excreting excess glucose via urine.

• **Combination Therapy:** Modern protocols increasingly advocate for the early combination of these two drug classes to achieve a synergistic therapeutic effect.

It is crucial to emphasize that pharmacotherapy must always be accompanied by lifestyle modifications. According to a recent review, while treating individual components of MS successfully reduces cardiovascular disease (CVD) risk, there is still insufficient evidence that directly treating MS as a holistic syndrome lowers hard adverse clinical outcomes [2].

The Role of Nutraceuticals and Dietary Supplements

Adjunct therapies are gaining popularity in the management of MS. For instance, a systematic analysis of 37 studies on the effects of resveratrol demonstrated that this supplement can lower systolic and diastolic blood pressure, as well as blood glucose levels [8]. Other supplements—including magnesium, chromium, polyphenols, and probiotics—are currently being investigated as potential agents to improve the metabolic profile.

Certain essential trace elements, particularly iron (Fe), copper (Cu), and manganese (Mn), play vital roles in biochemical and physiological functions at low concentrations but can exert toxic effects on the gut microbiota at higher levels. Some potentially essential trace elements, such as chromium (Cr), silicon (Si), and nickel (Ni), which are considered intermediate in terms of essentiality and toxicity, have shown varied effects on the gut microbiota and its metabolites. Furthermore, bidirectional relationships have been identified between heavy metals and the gut microbiota [12].

At the same time, it is crucial to emphasize that current data remain insufficient to support broad clinical application, and such interventions must be accompanied by proper monitoring and medical supervision.

Innovative and Personalized Approaches

• **Gut Microbiome-Targeted Therapy:** Substantial evidence underscores the profound impact of the gut microbiota on the development of obesity and insulin resistance.

• **Genetic and Epigenetic Testing:** This includes assessing the role of BDNF and other neurotrophic factors in the pathogenesis of MS, as well as identifying genetic predispositions to specific lipid or carbohydrate metabolic pathways [5].

• **Digital Technologies:** Mobile applications and wearable devices that track physical activity, sleep, and nutrition enable the creation of highly personalized intervention programs. This includes the use of continuous sensors even in non-diabetic individuals to identify which specific foods trigger sharp insulin spikes.

- **Digital Twins and Metabolic Modeling:** Simulating a patient's metabolic processes within software programs to predict treatment outcomes.
- **Chrononutrition and Circadian Rhythms:** Aligning dietary intake and exercise schedules with circadian biology is rapidly gaining popularity as a component of future therapeutic strategies.
- **Chronic Stress Management:** Utilizing psychometabolic correction techniques and cognitive behavioral therapy (CBT) to combat emotional eating and elevated cortisol levels.

- **Social Support Systems:** Shifting toward multidisciplinary teams (consisting of a physician, nutritionist, health coach, and psychologist) rather than relying on a single general practitioner.

While these approaches open new horizons in metabolic health, they require further robust clinical research [11]. The key trends of modern approaches compared to traditional ones are summarized in Table 2.

Table 2

Comparative Analysis of Traditional and Modern Approaches to Metabolic Health Correction

Parameter	Traditional Approach (2010s)	Modern Approach (2025–2026)
Primary Goal	Weight loss and glucose reduction	Metabolic health and quality of life
Methods	"Eat less, move more"	Hormonal regulation and biohacking
Nutrition	Standardized diets (e.g., Diet No. 9, Diet No. 10)	Personalized nutrition driven by GLP-1 therapy
Monitoring / Control	Periodic blood tests	Continuous monitoring (wearables + CGM)
Medications	Metformin, statins	GLP-1/GIP receptor agonists, SGLT2 inhibitors

Analyzing the data in Table 2, a clear conclusion can be drawn regarding a fundamental paradigm shift in metabolic health management over the past 15 years. Medicine and the wellness industry have transitioned from the standardized, often grueling restrictions of the 'previous generation' toward high-tech, personalized biohacking, where hormonal correction, digital technologies, and intelligent management of the body's biological processes have become the primary tools.

CONCLUSION

Metabolic syndrome is a multifactorial pathology that requires comprehensive management. The most effective strategies are those that combine lifestyle modifications (diet and physical activity) with individualized therapy targeting the specific components of the syndrome. Pharmacological and nutraceutical interventions can serve as powerful adjuncts but do not replace the foundation, which is lifestyle change. Promising avenues include the integration of genetics, microbiota, and digital solutions to personalize the approach. Further research should focus on the efficacy rates of full metabolic syndrome correction as a unified diagnosis, rather than just treating its individual components.

Perspectives for Further Research

There is a need to conduct randomized controlled trials aimed specifically at reducing risk through the management of metabolic syndrome as a holistic condition. This includes investigating the impact of nutraceuticals in large cohorts, as well as developing algorithms for personalized nutritional therapy that account for genetic, microbiome, and behavioral characteristics. Additionally, the implementation of digital technologies and mobile solutions is crucial for the long-term support of patients with metabolic syndrome.

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PEDAGOGICAL SCIENCES

TRANSFORMATION OF EDUCATIONAL ACTIVITIES OF EDUCATORS AND LEARNERS IN THE PROCESS OF IMPLEMENTING "EDUCATION 4.0"

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Abstract

The article focuses on the continuous and gradual development of the civilization process in accordance with the calls of the industrial revolutions, the formation of adequate bases and superstructures, and provides a concise scientific commentary on the main features of the "Techno-democratic-information society" that exists in the modern era and currently makes people stronger, the education system that is formed adequately to these features, the concepts that reveal its nature, among which the concept of "teaching activity" is one of the most important elements of the process of implementing education, which is understood as a system, and this element has an important "enabling function" in the efficiency of the system in question.

It is emphasized that in the process of implementing education, the management vector is determined by "interest → action → a new qualitative state of the desired development, education and upbringing of the party involved in the process (the student)". In the research work, educational activity is perceived as a type of personality activity, a specific form of social activity, and the essence and functions of the components (teaching situation, teaching operations, control, evaluation) included in its structure are clarified; the interpretation of the transformation of the aforementioned components into the parties (dialectics) of the unit in the organization and management of the joint educational activity of the student and the educator as components of the educational implementation process, and their enabling functions are given.

Keywords: Base and superstructure; education; teaching activity; teaching situation; task; opportunity; action; cognitive operations; measurement and evaluation.

Relevance of the research topic:

It is known that educational activity includes creative acts that exist between the educator and the learners in the process of implementing education, this type of activity has a complex structure, and the effectiveness (quality level) of the implementation of the educational process is determined by the transformation of the educational activities of the learner and the educator into parts of a unit. The regulation (facilitation) of the emphasized state in the process of implementing education directly depends on the understanding of the essence of the concept of educational activity. Therefore, we claim the relevance of conducting research on the topic "Transformation of educational activities of the educator and learners in the process of implementing Education 4.0".

Methodological basis of the research:

In the process of conducting the research, L. Bertalanfi's "Idea of System Analysis" [7; 104-108] was used (the idea, which is interpreted as an attempt to study the properties of an object based on the properties of its parts - italics are ours - F.I., SI) The "System-structural approach", which has been formed as an important branch of dialectics and has risen to the level of its alternative, empirical, empirical-theoretical and theoretical methods of scientific cognition, the internal relationships of the forms of scientific cognition, and various pedagogical and psychological

research generalizations were used as a methodological basis.

Interpretation of research generalizations:

As is known, the process of civilization has been continuously formed in response to the calls of the "Industrial Revolutions", systems of socio-economic relations have been established on the basis of dialectical conditioning of one another (logical expectation), and superstructures based on the aforementioned bases have been formed. Currently, there is such a system-basis as the "Techno-democratic-information society", which makes a person stronger, the implementation of information services at a sufficiently high level is a specific feature of the society in question. The information society, unlike the industrial society, is a more intellectual society and creates conditions for the highly educated, skilled, determined, and comprehensive development of people. According to our subjective understanding, members of the "Techno-democratic-information society" are characterized by information culture (this is the knowledge, intellectual skills and habits necessary for a person to adapt to the information society) and technological literacy (this is the ability of people to use various digital technologies, analyze information and operate safely in a digital environment. The development of digital skills is essential to ensure their safe and effective interaction with digital technologies in the future [9; 78-94].

A comprehensive and integrated approach of education systems is necessary to support the development of the skills of all learners to be active and ethical users of digital technologies [12; 57-79]. Digital education allows people to participate independently in social life. In addition, the reality of digital education and the digital revolution requires fundamental changes in the forms and methods of moral education, leading to the transformation of digital skills into the most important skills [11; 58-64]. There is no doubt that the development of digital skills of learners will lead to their more active participation in society as digital citizens in the future [10], [12; 57-79]. This skill is not limited to using a computer and the Internet, but also:

- 1) Observing digital safety and cybersecurity rules;
- 2) Working with artificial intelligence and automation;
- 3) Digital analytics and data processing skills;
- 4) Using cloud technologies;
- 5) Includes rapid adaptation to new technologies), otherwise they will not be able to assert themselves as active and creative members of the society in question.

Due to the rapid development of technology, the knowledge and skills that students acquire during their education become obsolete by the time they graduate. In order to help develop and shape the use of today's fastest-growing technologies in scientific and technical education, it is necessary to train students and prepare them for the digital environment. Adapting to a rapidly changing environment will make it necessary for students to stay in touch with educational institutions even after graduation, providing both workers with updated skills and young students (and faculty) with a new direction related to the rapidly changing realities of the industrial and corporate sectors [13; 25-30], [14; 579-592].

Education, which is a process of sharing human experience, has been formed on a basis that includes the characteristics of industrial revolutions in stages as a product of social practice. According to our subjective understanding, it is appropriate to formulate the aforementioned sharing process as "the process of mastering systematized knowledge, skills and habits in accordance with the nature of the state, society and individual and its result" [5; 260]. "General education", which is an important stage of the education system, has taken its place on the superstructure of the basis formed on the basis of the calls of the IV industrial revolution and has become a "system formulated as a student-centered "S-S" in general education schools".

It is worth emphasizing that this system is open to the application of the theories of "Multiple Intelligences" (Howard Gardner), "Stages of Intellectual Development" (Jean Piaget), "Social Development" (Lev Vygotsky), "Thinking Styles" (Carol Dweck), "Spiritual Development" (Lawrence Kohlberg), "Conditions of Learning" (Robert Gagne), and "Emotional Intelligence" (Daniel Goleman).

The establishment of a new pedagogical mindset and the successes achieved in the field of the concept of activity have led to the emergence of many concepts related to education, which can be interpreted with the concepts of "value", "process", "result", "system", and a change in views on it. Among the aforementioned

concepts, the concept of "teaching activity" has also taken its place.

Teaching activity is one of the most important elements of the process of implementing education, understood as a system; this element has an important "enabling function" in the effectiveness of the system in question.

By the way, let's clarify the concept of "enabling function." In doing so, we argue that the concept of "teaching activity" includes the creative activity that exists between the educator and the learners in the process of implementing education.

It is known that something cannot come from nothing, and the new can only arise from certain preconditions, the essence of which is laid in the bosom of the old. The potential existence of the new is precisely the possibility. The possibility arises in the existing reality and is realized, embodied in the new reality. Being hidden tendencies expressing various directions in the development of an object, possibilities characterize reality in terms of its future. Dialectics assumes that development does not consist in expanding the set of ready possibilities, but in the process of the constant emergence of possibilities within the framework of reality and their transformation into a new reality. The process of realization of possibilities, their transformation into reality is possible thanks to activity and communication. Possibility does not mean action in itself. It is absurd to talk about a new quality if there is no idea that causes action. By "idea" we understand an idea that has risen to a high degree of objectivity, completeness and concreteness and is at the same time directed towards practical implementation [6; 16-17]. As a variation of one of the interesting ideas of ancient Greek philosophers, we should say that the teacher affirms himself when he has the opportunity for action that conditions his creative pursuits. From his mixed and vague ideas, clear pedagogical thinking emerges. Here it is appropriate to say that the idea that causes action is a vital being that creates a new model of development.

It is worth drawing attention to the very relevant analysis of Professor R.F. Mustafayev on the internal unity of possibility, action and personality. He rightly emphasizes that the concept of "possibility" plays a special role in our thinking and is in a certain sense equivalent to our existence, our everyday life. Being acquires essence when it has the possibility of action. The latter is impossible without deep creative searches. Where there is possibility, this means action. In turn, this creates a dialectical unity between particles and the whole. The idea that creates action is a vital being that forms a new model of development [4; 88].

It is undeniable that interest is always an opportunity. It is interest that drives opportunity. Interest can be transformed by the inner world of the personality and acquire value in its actions. Personality is always an opportunity. In our opinion, in the process of implementing education, the management vector "interest → action → a new qualitative state of the party involved in the process to the desired level of development, education and upbringing" determines the "interest → action → the rise of the desired level of

development, education and upbringing” of the party involved in the process. In this process, the “choice” factor is of particular importance. At least the algorithmic and heuristic activity ratios are related to choice. In the process of implementing education, “opportunities”, not “probabilities”, correspond to the function of belonging.

In our opinion, we can talk about the “specificity function” by referring to Lutfizadeh’s idea, which allows modeling human thoughts, finding methods in various options, and implementing accepted decisions. Determining what is most consistent with the specificity functions in the process of implementing education actually means revealing the essence of this process.

Let us emphasize that “teaching activity” is multifaceted. Although training is an important characteristic of teaching activity, it does not cover all its aspects. Training, in the broad sense of the word, involves the acquisition of new knowledge, skills and habits. However, acquisition and teaching activity are essentially different phenomena. Acquisition is not only the learning process, but also an integral part of every field of activity, for example, play or work. Teaching activity is a type of activity, a specific form of social activity of the individual[2;150].

The concept of educational activity (D.Velkonin, V.V.Davydov, etc.) distinguishes the following components in the structure of educational activity: 1) educational situation; 2) educational operations; 3) control; 4) assessment (evaluation). Educational activity is a type of activity, a specific form of social activity of the individual [15].

Educational activity is a type of activity of both the teacher and the student in the “S-S” (“subject” “subject”) system, which is absurd to imagine these types of activity without assessment. The joint activity of the educator and the students in the pedagogical process begins to be realized with the transformation of the goal set by the educator into the goal of the student [7; 130-134]. In other words, when the part of human experience, adequate to the purpose of its presentation by the educator, which should become the subject of education, developed on scientific-pedagogical grounds and systematized, becomes the object of satisfaction of its cognitive needs, the event of the implementation of education in one form or another - the joint creative activity of the student and the educator begins, the students are ready to accept the educational task of the educator [8; 289-290].

Educational activity begins with the solution of educational tasks. The question is: “What do they mean when they say educational tasks?” Although its essence is reflected in the meaning of the task, its character is connected with the meaning of “educational”. Educational tasks are distinguished from any scientific, military, sports, etc. tasks by one important feature. Educational tasks involve the discovery and mastering of educational-general solution methods (principles, regularities) by students (students).

By presenting teaching tasks, the teacher places students in a unique teaching situation: in this situation, they become familiar with the content of general methods for solving teaching tasks, taking into account

all specific and concrete options, and acquire the appropriate knowledge, skills, and habits.

By the way, let us note that the meaning of knowledge (information) includes the following: certain facts, terminology; methods of selecting facts; conceptual symbols; development trends; classification; criteria for verification and evaluation; research methods applied in a relevant field or problem; general concepts, structures and theories; principles and regularities necessary to explain and interpret phenomena and foresee their future development; knowledge of theories and structures[4;152].

Educational tasks have many unique characteristics, but one thing is clear: to solve them, students must master the necessary educational operations.

Teaching operations are diverse. Many of them are of a general nature and are used almost equally in the mastering of various teaching materials. Some teaching operations are more specific for the mastering of certain teaching materials (mathematical, linguistic, etc.). They also distinguish teaching operations applied in special cases. Intellectual processes - analysis, composition, comparison, generalization, etc. are always carried out by applying them to the content of a certain subject (mathematics, grammar, etc.) and therefore appear in the form of various subject operations (for example, mathematical). From this point of view, the formation of teaching operations is directly related to the acquisition of mental activity by students.

As a side note, J. Guilford distinguished 120 intellectual abilities in the structure of intelligence (“SOI”). Analyzing experimental materials, he came to the conclusion that intellectual abilities differ from each other according to three parameters: 1) the nature of intellectual operations; 2) the content of intellectual processes and 3) the products of intellectual activity. J. Guilford distinguished 5 operations, 4 types of content and 6 types of products of intellectual activity and considered them separately as factors. Thus, in J. Guilford’s model, 120 intellectual abilities are characterized by 15 (5+4+6) factors. Of the three parameters distinguished in the “SOI” model, the first (the nature of intellectual operations) is of greater importance. The second and third parameters can be explained precisely on its basis. J. Guilford distinguished the following according to the nature of mental operations: cognition, memory, divergent productive thinking, convergent productive thinking, and evaluation (evaluative thinking) [2;43-44].

The structural analysis of the intellect has shown that its core is thought. This provision had a special scientific and methodological significance for the concept of developmental education. In order to develop students intellectually, it is necessary, first of all, to develop thinking in them. In this process, it was necessary to take into account the genetic and functional interaction of thinking with emotions and perception, on the one hand, and with memory, and finally, with imagination, on the other. In the structural model of J. Guilford, thinking was systematically considered, its genetic and functional connections with various cognitive processes were explained.

By the way, let us also emphasize that the formation of learning operations in learners is a major requirement of modern times. The successful implementation of the principles of developmental learning depends, first of all, on the solution of this issue (for more information, see: [1]).

Control also plays a significant role in the formation of educational activity. The effectiveness of the activity is directly related to the level of control, as well as to the educational operations. From this point of view, it seems that two aspects should be noted separately: 1) The student compares the educational operations he performs and their results with the purpose of his activity, identifies and eliminates his own mistakes. It is necessary to always draw the attention of students to this aspect - the results of educational operations, teach them to mentally plan educational operations, primarily to carry them out internally and analyze their results. When analyzing metacognitive functions, Flavell distinguished two aspects in terms of control: in the first case, the student controls himself by organizing his attention, and in the second case, he controls the problem-solving process (problems are solved through cognitive issues). Both functions are of particular importance in educational activity. 2) When control is effective, the student's educational activity is carried out as a manifestation of his will: he makes efforts to overcome the difficulties encountered, shows special activity for the implementation of the goal, and the direction of his activity is already conditioned by mediated interest. In this situation, control gradually turns into self-control, begins to develop effectively on the basis of reflection. Control is directly related to assessment, which is of great importance as a unique component of educational activity. The question may be asked: "What is the difference between assessment and control?" When examining educational activity from this point of view, it is necessary to distinguish its two sides - the final result and the methods of achieving the result.

In the control process, more attention is paid to the extent to which these methods are effective and adequate. In other words, in the control process, the results of individual teaching operations are examined, not the final result of teaching activities. However, in the assessment process, the final result of teaching activities is analyzed, and its compliance with the purpose of teaching activities is determined. The assessment situation is characterized by psychologically complex features. In this situation, more than the assessment itself, perhaps the aspects that emphasize the teacher's attitude to the student with emotional shades play a special role. When assessment is psychologically effective, it gradually turns into self-assessment, playing an important role in the formation of the student's self-awareness. It creates radical changes in the dynamics of the student's level of assertion in the field of assessment. It creates qualitatively new features in his learning motivation. Psychologically favorable conditions are created for the actualization of cognitive interests in teaching activities.

During the monitoring and evaluation of pedagogical processes and events, the activities of

learners and educators, one often encounters the problem of measuring one or another quality indicator. Therefore, the question "Is it possible to measure the quality indicators of processes in numbers?" worries many specialists. In this regard, the American scientist J. Morrissey showed that the most difficult problem is to overcome the emotional opinions of people working in the field of management about the quantitative assessment of quality, such as "there are no accurate and reliable methods for quantitative assessment of creative work", and to monitor the solution of this problem and develop new approaches to their solution [3;38].

To solve these and similar problems, first of all, it is necessary to get acquainted in some detail with the concepts of "measurement", "measurement scale". Measurement is the implementation of appropriate algorithmic operations to express the observed states of an object (process, event) with appropriate signs (unit, number or symbol). As a result of measurement, information about the studied object is obtained, in other words, the state of the studied object is assessed. Depending on the purpose of measurement (evaluation), such rules for measurement are selected and determined that allow assessing the main properties of the object. Each such rule requires determining its own "measurement scale". Currently, the following measurement scales and their modifications accepted by specialists are used: named (nominal) scale; ranked (degree) scale; interval scale; ratio scale; absolute scale[3;39].

Scientific novelty and practical significance of the research:

1. A specific (laconic) scientific explanation of the main features of the "Techno-democratic-information society" that makes a person stronger at the current stage of civilization development is given to the education system, to the concepts that reveal its nature, among which the concept of "educational activity";
2. The attention of educational theorists and practitioners has been drawn to the fact that educational activity includes creative acts existing between the educator and the students in the process of implementing education, and that the efficiency (quality level) of the implementation of the educational process is determined by the transformation of the educational activities of the student and the educator into the parties of the unit; The direct dependence of the correct regulation of the emphasized state in the process of implementing education on the understanding of the essence of the concept of educational activity has been emphasized;
3. The interpretation of the educational activities of the student and the educator as parties of the unit will greatly facilitate the work of the educator in terms of the systematic selection of creative acts existing between them in the real pedagogical process (in the process of implementing education).

Conclusion:

1. Educational activity is one of the most important elements of the process of implementing education, understood as a system (as well as a process, result, value), this element has an important "enabling function" in the effectiveness of the system in question;
2. In the process of implementing education, "interest

→ action → a new qualitative state of the desired level of development, education and upbringing of the party involved in the process” determines the management “vector”, which plays the main role in the organization and management of the joint activity of the educational activity (its components - educational situation; educational operations; control; assessment (value)) as a component of the educational implementation process, transforming the unit into parties (dialectics), and directing the enabling functions.

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THE BASIS OF A STUDENT'S CREATIVE THINKING AND THE MEANING, ESSENCE OF ITS FORMATION, IMPROVEMENT**Murzaev N.**

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ОКУУЧУНУН ЧЫГАРМАЧЫЛЫК МЕНЕН ОЙЛОНУУСУНУН НЕГИЗИ ЖАНА АНЫ КАЛЫПТАНДЫРУУНУН, ӨРКҮНДӨТҮҮНУН МААНИ, МАҢЫЗЫ**Мурзаев Н.Т.**

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Abstract

The nature of creativity is complex and strange, mysterious. It is studied by philosophers, psychologists, historians, physiologists, and educators, each in accordance with the specifics of their own science. Psychologists are interested in studying the ways of formation and improvement of a creative personality with a transitional state of the creative process. The problem of creativity is of more interest to modern researchers not as a separate phenomenon, but as issues related to the majority of people with universal patterns in it. There are many definitions of the word "creativity", but it all boils down to the fact that creativity is a form of human activity that generates a qualitatively new value, a thing, a new idea, a solution to a new one by improving a particular task. Since creativity is inherent in a person from a young age, teachers write about its formation and development firsthand, but directly from the school desk. In fact, this is a very serious problem. This requires extensive scientific research.

Since creativity is inherent in a person from a young age, teachers write about its formation and development firsthand, but directly from the school desk. In fact, this is a question that has attracted very deep attention even before. This requires extensive scientific research. The article will focus on how to awaken a child's creative abilities early, and give him good attention from adults: parents, teachers. It is necessary to take responsibility for the creative consciousness of the child. This is because creative activity accompanies a person throughout his life. Therefore, it is of great benefit to both the child and society if the child begins in a period of enthusiasm, purity of thoughts and feelings. The creative thinking of the greatest geniuses of mankind began at a very young age.

Аннотация

Чыгармачылыктын табияты татаал жана кызык, табышмактуу. Аны философтор, психологдор, тарыхчылар, физиологдор, педагогдор ар бири өздөрүнүн илимдеринин өзгөчөлүгүнө ылайык изилдешет. Психологдорду чыгармачылык процесстин өтүү абалы менен чыгармачыл инсандын калыптандыруу, өркүндөтүү жолдорун изилдөө кызыктырат. Чыгармачылык маселеси азыркы изилдөөчүлөрдү өзгөчө көрүнүш катары эмес, андагы жалпы адамзаттык мыйзам ченемдер менен адамдардын негизги массасына тиешелүү маселелери көбүрөөк ынтызар кылат. “Чыгармачылык” дегендин көп эле аныктамасы бар, бирок анын баары келип эле, чыгармачылык бул – адамдын ишмердүүлүгүнүн формасы, ал сапаттык жаңы баалуулукту, нерсени, жаңы идеяны жаратуучу, жаңыны тигил же бул маселени өркүндөтүү менен чечүү болуп эсептелет.

Чыгармачылык адам баласына жаш кезде эле мүнөздүү болгондуктан, аны мектеп партасынан эле калыптандыруу, өнүктүрүү жөнүндө педагогдор учкай айтып жазып келе жатышат. Чындыгында, андан мурда да өтө терең көңүл буруучу маселе. Ал илимий негизде кенен изилдөөнү талап кылат. Макалада баланын чыгармачылыгын эрте ойготуу керектиги, ага чоң адамдар: ата-энеси, мугалимдер жакшы көңүл буруусу жөнүндө сөз болот. Баланын чыгармачыл аң сезимине жоопкерчилик менен мамиле жасоо зарыл. Себеби, чыгармачылык ишмердүүлүк адамды өмүр бою коштоп жүрөт. Андыктан бала дилгир, таза мезгилинде, ою, сезими да таза мезгилде башталса балага да, коомго да чоң пайда берет. Адамзаттын эң улуу генийлеринин чыгармачылык менен ой жоруусу жаш мезгилинде башталган.

Keywords: creativity, student, teacher, activity, speech, observation, thinking, analysis, work, skills, something new

Ачкыч сөздөр: чыгармачылык, окуучу, мугалим, ишмердүүлүк, сүйлөө, байкоо, ойлоо, талдоо, эмгек, шык, жаңы нерсе.

Чыгармачылык ишмердүүлүксүз болбойт. "Чыгармачылык-сапаттуу жаңы материалдык жана Ишмердүүлүк гана чыгармачылыкты жаратат. руханий баалуулуктарды жаратуучу адамдын

ишмердүүлүк процесси. Чыгармачылык-бул адамдын эмгекте пайда болгон, чыныгы жеткирилген материалдан (объективдүү дүйнөнүн мыйзам ченемдүүлүктөрүн таанып билүүнүн негизинде) көп түрдүү коомдук керектөөлөрдү канааттандырган жаңы чындыкты жаратуу жөндөмдүүлүгү" [7, 474 б.].

Жөн гана керектөөчү мүнөздөгү жана продуктивдүү мүнөздөгү ишмердүүлүк бар. Адамдын ишмердүүлүгү продуктивдүү мүнөздө болгондо, аны чыгармачылык ишмердүүлүк деп эсептейбиз. Муну окуучуга жөнөкөй гана мынтип түшүндүрүүгө болот: жаңы бир нерсени жасоо чыгармачылык, ошондой эле ал (мурда болгон) нерсеге жаңыча өзгөрүү киргизүү да чыгармачылык болуп эсептелет. Мисалы, бет аарчы кыргыз элинде илгертеден эле колдонулуп келген буюм. Мурунку муундарда кыз-келиндер тарабынан жигиттерге белек берилген, айрыкча аны көңүлгө жаккан жигиттерге берүү адат сыяктуу болгон. Ч.Айтматовдун “Эрте келген турналар” повестиндеги Мырзагүлдүн Султанмуратка берген бетаарчысына “С +М” деп жазып бериши – чыгармачылык десе болот ж.б.

Чыгармачылык аң сезим – фактылуу кубулуш жана татаал түзүлүшкө ээ болгондуктан, аны түшүндүрүүнү татаалдандырат. Чыгармачылык ойлоонун маңызын түшүндүрүү үчүн анын психологиянын предмети экенин, анын факторлорунун, принциптеринин, механизмдеринин, критерийлеринин жана формаларынын, түзүлүштөрүнүн бөлүнүштөрүн аныктоо менен ойлоонун башка түрлөрү жана формалары менен мамилесин аныктоону талап кылат.

Ойлоо ишмердүүлүктүн өзгөчө түрү, ал түз же кыйыр түрдө инсандын материалдык-предметтик ишмердүүлүгүнө байланышта болот. Эгер ойлоо материалдык-предметтик ишмердүүлүк менен шартталган болсо, анда ой жүгүртүү бул иш-аракет баш ийген фактылардан чыгууга тийиш. Себеби, ишмердүүлүк курчап турган дүйнөнү таанып-билүүгө, үйрөнүүгө жана чыгармачылык менен өзгөртүүгө жумшалган адамдын жигердүү аракетинин түрү десек болот. Ишмердүүлүк учурунда адам материалдык жана рухий маданияттын предметтерин жаратат. Ошонун аркасында өзүнүн шык-жөндөмүн өнүктүрөт, өзгөртөт, табиятты сактайт, өстүрөт, коомду курат. Табиятта анын активдүүлүгүсүз болбогон нерселерди, предметтерди жаратат. Буга адамдын ишмердүүлүгү себеп болот. Адамдын чыгармачылык ишмердүүлүгүнүн аркасында адам коому, шаарлар, машиналар, жүрүүчү, учуучу техникалар курулду. Аларды куруу үчүн да эмгек куралдарынын түрлөрү, түрдүү буюмдар пайда болду. Ушулардын баары продуктивдүү ишмердүүлүк үчүн окуучуга кенен түшүндүрүүгө керектүү мисалдар боло алат.

Окуучуга чыгармачылык ишмердүүлүктү түшүндүрдө жалаң гана чоң продуктаны мисал кылып көрсөтүү туура эмес. Окуучулардын ой жүгүртүүсү эмпирикалык жалпылоо жана формалдуу -логикалык чыгаруу мыйзамдарынын

негизинде пайда болушу мүмкүн, же ал диалектикалык логиканын мыйзамдарынын негизинде түзүлөт. Эгерде ой жүгүртүү диалектиканын мыйзамдарын четке какса, анда ал чектелген мүмкүнчүлүккө ээ жана чындыктын диалектикалык байланыштарын камтый албайт.

Чыгармачылык ой жүгүртүү диалектикалык болушу керек, себеби ага предметти терең байланышында бүтүн таануу мүнөздүү. Азыркы мезгилде коомдук өсүштүн, практиканын денгээли окутуунун диалектикалык ыкмасын колдонуу менен чыгармачылык ойлоону таануусу илимий прогресстин тарыхый маанидеги керектөөсү болуп калды. Себеби ушул мезгилдеги жасалма интелект сыяктуу адамзаттын атаандашы турганда, адамзаттын өзүнө чыгармачылыкта кандай мүмкүнчүлүк бар деген да суроо туулат. Адамдын мүмкүнчүлүгү чексиз, ага жасалма интелект эч тоскоол болбойт.

Чыгармачыл ойлоону психологиянын үйрөнүү объектиси болуп келген жана болуп кала берет. Ал үйрөнүлгөн предметтин байланыштарын ойлонулган ыктыярда түздөн түз чагылдырат, анын натыйжасында материалдык продукция, субъективдүү жаңы билим же идеалдуу образ пайда болот. Окуучунун чыгармачыл ойлоонуусу чыгармачыл инсанды калыптандырууга багытталуусу зарыл. Мында окуучунун чыгармачылык этабында, башталгыч класстан тартып, жогорку мектепке чейин мүмкүн деп пикирлер бар. А чынында адам баласынын чыгармачылыгын изилдөө жаш өзгөчөлүктүн андан эрте экенин көрсөттү. Мисалы, чыгармачылыктын эрте башталганын япон окумуштуусу Масару Ибука өз китебинде жазып чыкты. Ал китебинде: “Баланын өнүгүшүндө билим менен чөйрө тукум куучулукка караганда алда канча маанилүү роль ойнойт”,- деп жазган [4,56]. Бул пикири чыгармачылыкка да тиешелүү.

Бирок окуучунун чыгармачылыгында чоң ачылыштын болбой калышы маанилүү эмес, жок дегенде өзү үчүн бир ачылуу же жаңылык болушу керек. Окуучулардын чыгармачылыгында коомдук жаңылыктын болбой калышы алар аткарган чыгармачылыктын түзүлүшүн маанилүү өзгөртүүгө учуратпайт. Чыгармачылык процесстин этаптары өзүнө тиешелүү мыйзамченемдүүлүктө окумуштуунун да, өспүрүмдүн да ишмердүүлүгүндө бирдей эле өлчөмдө көрүнөт. Чыгармачылык менен ойлоону жөндөмүнө ээ болуш үчүн 1-класстан 12-классты бүтүп кеткенге чейин окуу мезгилинде да окуудан сыртта да алардын табигый шык-жөндөмүн ачуучу жана өнүктүрүүчү чыгармачылык ситуацияны дайым түзүү керек.

Чыгармачыл ойлоонун биринчи фактору катары муну айтууга болот:

Чыгармачылык – мээнин табигый функциясы деп изилдөөчүлөр тарабынан негиздүү далилденген, ошондуктан ар бир балага чыгармачылык мүмкүнчүлүктөр бала кезде эле берилет жана ал максатка багытталган тарбиялоо процессинде гана өнүгүшү мүмкүн. Чыгармачылык ойлоону жөнүндө биз ишмердүүлүктүн түрү

жөнүндө айтпастан адамдын коомдук практикасынын бардык жагдайында керек болгон адамдын иш-аракетинин стили жөнүндө айтабыз.

Экинчиси, окуучулардын чыгармачылык инсандыгын өнүктүрүү алардын окуу жана окуудан тышкары ишмердүүлүгүн туура уюштурууда ишке ашат: окуучу практикалык маселелердин жүрүшүндө гана чыгармачыл ой жүгүртүү стилине үйрөнө алат, ал үчүн окуу иш-аракеттерин уюштуруунун өзгөчө формасы талап кылынат, анда окуу кичине изилдөөчүлүк иш-аракетке айланышы керек

Окуучулардын чыгармачылыгы дегенде шарт эле чоң бир ачылышты ача салуу же бир жаңы нерсени жарата коюу дегенди түшүнбөстөн, баланын кандай нерсеге болбосун өтө кызыгуу менен киришип, өздөштүрүп, жаңы бир нерсе киргизүүгө жасаган аракетин түшүнүүбүз керек. Куду ушул майда нерсе кийин чоң ачылыштардын башаты болот деп эч ким так айта албагандай, башаты болбойт деп да кесе айтууга болбойт, кеп аны өрчүтө билүүдө туарына көптөгөн улуу адамдар маани беришкен. Баланын шыгын, кызыгуусун өстүрүү баланын гана эмес, чоңдордун да милдети, болгондо да, аларга көбүрөөк жоопкерчиликтүү жагы туура келет.

Чыгармачылык процессинде бала интеллектуалдык жана эмоциялык жактан өсөт, айлана – чөйрөдө, коомдо өз ордун аныктайт, адамдар менен алака кылуу тажрыйбасына, ар түрдүү эмгек куралдары жана материалдар менен иштөө көндүмдөрүнө ээ болот, өз денесин, үнүн, сүйлөө кебин башкарууга үйрөнөт. Чоңдордун чыгармачылыгы сыяктуу эле балдардын чыгармачылыгы да көп түрдүү. Техникалык, сүрөтчүлүк, музыкалык, аткаруучулук, кол өнөрчүлүк ж.б. Бала өз турмушунда көп нерсеге кызыгат, чыгармачылыктын ар кайсы түрүнө жолугат, аны улап кетүү, өнүктүрүп кетүү шартка, тарбияга туш келеби, бул башка маселе. Бирок кандай чыгармачылыкка кызыкса да, чыгармачылык бала үчүн жашоого кызыгуунун ички механизми ойготору бышык. Чыгармачылык бала үчүн чоң таасир берүүчү дүйнө экени анын өзүнө билинбеген табышмак. “Чыгармачылык менен иштөө адамды өмүр бою жандап жүрөт. Анын башаты бала кезде жатары, ошого жараша өзгөрөрүнө чоң маани берүү керек. Бала кезде чыгармачылыкты калыптандыруу – ийгиликке эрте жол ачуу. Ошонун ичинде да калем менен ойлоону эң кыйыныраагы десек туура болот” [6, 49].

Балдардын көркөм чыгармачылыгы жөнүндө сөз болгондо ал жалпы тарбиянын эстетикалык жана көркөм табитти өстүрүүчү бөлүгү экенин дайым эске тутуубуз керек. Балдардын чыгармачылыгы өз алдынча же чоңдордун жетекчилиги, үйрөтүүсү астында болуусу мүмкүн. Аларга сүрөт, музыка, ылайдан, пластилинден чаптап жасоо, театралдык сахналаштыруу, бий, оозеки жана жазуу түрүндөгү көркөм чыгармачылык кирет. Көркөм чыгармачылыкка хорлор, жыгачтан оюулар, куурчак театры, оюн түрүндөгү фильмдерди да кошушат. Аткаруучулук жөндөмүн арттыруучу “Манас” айтуу, музыкалык

аспаптарда ойноо, көркөм окуу, элдик чыгармачылыктын салттуу түрлөрүн аткаруу (табышмак, жаңылмач, жомок, акыйнек) айтуунун чоң таасирлери тиет. Массалык көркөм чыгармачылыкка тартылган балдардын таланты барбы, жокпу анысына каралбайт. Көркөм тарбия берүүдө кадимки баланы таланттуу балдарга салыштырууга болбосун Л.С. Выготский да айткан.

Көркөм чыгармачылык менен алектенүү баланын инсандыгын ойготот, ачат, айлана-чөйрөгө, улуу-кичүүгө жашына жана кыз, бала экенине ылайык, сезим, акыл-эс, эрк, дене түзүлүшүнө жараша мамиле жасоого үйрөтөт. Балдардын көркөм чыгармачылыгы баланын өсүү жолундагы маанилүү, ишенимдүү жол. Канчалаган балдар ал жолдо тарбияланды. Бул практика далилдеген, педагогикалык, психологиялык жактан баланын өсүшүнө документтер, изилдөөлөр дапсилдеп көрсөткөн чоң баалуулук жана акыйкат чындык. Көркөм чыгармачылыкты педагогикалык жактан туура түшүнүүчү жагдай бар. Мисалы, педагог түзгөн өбөлгө, жагдай менен бала өзүнүн дүйнө, өзү, жашоодогу орду, тууралуу жана өз айлана-чөрөсүндөгү, жашоосундагы социалдык чындыкты чагылдырууга аракет кылат.

Маани-маңызы, каражаты боюнча балдардын көркөм чыгармачылыгы да кесипкөй сүрөтчүнүн, музыканттын чыгармачылыгына кыйыр окшош. Көркөм чыгармачылыктын башаты 2 жаштан баштап байкала баштайт. Чоңдор менен биргеликте ишке ашырыла турган көркөм чыгармачылыктын алгачкы “интерпсихикалык” фазасы (А.Валлон, Л.С.Выготский) 1,5-3 жашта болуп, чоңдор менен мамиледе болуу, алардын тажрыйбасын кабыл алуу көркөм чыгармачылыкта чечүүчү шарт болуу менен анын өнүгүшүнө чоң таасир берет. Ушул фазанын маанисине көптөгөн ата – энелер маани бербейт.

Кийинки фаза 4-5 жашта болот. Бул мезгилде бала өз алдынча аракеттенүү менен даяр үлгүлөр боюнча алдына колдон келүүчү, күчү жете турган милдеттерди коюп, искусствонун түрүнө жараша колдонулуучу, өзү колдоно турган каражаттар, ошого ылайык кыймыл аракеттерди жасап чечүүгө далалат кылат. Эң алгач көркөм чыгармачылык импровизация түрүндө болот. Сүрөт, музыка, бий боюнча импровизация үчүн балдар оюнду тууроо гана эмес, чыныгы турмуштагы нерселер, шамал үнү, айбанаттардын менен чымчыктардын үндөрү, дабыштар, тамганын, сааттын чыкылдаганы, угулган обондуу ырлар, күүлөр, буюмдардын түсү, формалары, айбанаттардын кызык жүрүм-турумдары материал болушу мүмкүн. Кийинчерээк курал колдонуп аткарылуучу көркөм чыгармачылыктын түрлөрү жолугат. Мисалы, боек менен сүрөт тартуу, кураштыруу. Булар боек кагаз менен иштөөнүн көндүмдөрүн талап кылат. Көркөм чыгармачылык татаал, ал гана баланын инсандык туюмдарын ойготот, жетилтет. Көркөм чыгармачылык баланын инсандыгынын жалпы өсүшү менен байланыштуу. Бирок, анын башаты боюнча түрдүү пикирлер бар. С.Л. Выготский көркөм чыгармачылык оюндан башталат, алгач синкреттүү (башкалардан бөлүнбөгөн, жалпы)

түрдө болот деп эсептесе, анын оюндан чыгарына кээ бирөөлөр каршы болушса (Е.И.Игнатъев, Г.В. Лабунская), үчүнчү бирөөлөр көркөм чыгармачылык жана оюндар бар нерсе, бирок алар өзгөчө мыйзамдар менен өнүгөт дешет. С.Л. Выготский балдардын көркөм чыгармачылыктын тигил же бул түрлөрү менен алектенүүсүндө аларга кызыгуусу улам алмашылып турарын белгилеген. Мектепке чейинки балдардын музыкалык-драмалык, сөз менен импровизациялоо, айрыкча коллективдүү бий түрүндөгү кыймылдар тартканы менен мектепке чейинки курактын аягында сүрөттөөчү көркөм чыгармачылыкка кызыкчылыктары оогону байкалат. Кийинки заманбап маалыматтарга таянсак балдардын сүрөттөөчү чыгармачылыкка (изобразительный) чыгармачылыкка массалык кызыгуусу 10-12 жашка чейин окуучулардын 60-70 пайызында сакталат. 10-14 жаштан адабий чыгармачылыкка кызыгып, ыр жазууга аракет жасаганы көрүнөт, үн жаздырууга, массалык бийлерге, кооздоочу оймо – чиймелерге аралаша баштайт. Балалык кездин аягында, жогорку мектеп жашында театралдык ишмердүүлүккө, хорлорго, көркөм окууга, роль аткарууга көп кызыгышат. Жогорку мектеп жашында көркөм чыгармачылыкта угуучу, көрүүчү, окурман катары автор менен биргелешет, авторлошот, олуттуу адабият, музыка менен алектенүүгө өтөт. Окуучунун дил баяны бир жагынан илимий, бир жагынан көркөм чыгармачылыктын таасирин көрсөтөт. Андыктан “дил баян жазууда төмөнкүдөй процессти окуучу баштан өткөрөт: көңүл буруу, кызыгуу, кабыл алуу жана түшүнүү, ойлоо, элестетүү, жеке пикир, корутундулоо, туура түшүнүктү ырааттуу жазуу” [5, 199]

Бала кандай чыгармачылыкка көңүл бөлсө, аны өстүрүү жолун чоңдор ойлонуп маани берүүсү керек. Бул тууралуу С.Л. Выготский мындай жазат: “Ребенок пишет стихи или рисует вовсе не потому, что в нем прорывается будущий творец, не потому что сейчас нужно для ребенка и еще потому что, это известные творческие возможности заложены в каждом из нас. Процессы отбора гениальности и таланта еще настолько смутны, не изучены какие именно меры содействует сохранений и воспитанию будущих гениев” [2, 290-стр.] Бул улуу психологдун айтканы. Ар бир балада талант болорун улуу жазуучу М. Горький да айткан. Философ Н. Бердяев мындай дейт: “Творчество неотъемлемо присуще человеческой природе, уже ребенок обладает огромными творческими задатками – памятью, воображением непосредственной яркостью впечатлений. Потом все это уходит, человек “темнеет”, если ему не удастся сохранить в себе это “детское” начало превращается в обычную заурядную личность” [1, 81].

Чыгармачылык жөндөмдү, талантты сактоо да, өстүрүү да оңой эмес. Ал үчүн көп иштөө, көп көнүгүүлөр сарпталат. “Упряжият внимания-значить вызывает его всякий раз посредством такой внутренней реакции. Самособой разумеется, что чем чаще мы это делаем, чем больше вызываем

таких случаев, тем сильнее закрепляем связь между внутренним раздражителем и реакциями внимания”, -дейт Л.С. Выготский [2, 307].

Чыгармачылыктын мааниси, пайдасы ушунда аны менен алектенген адам өзүн, коомду тез тааныйт, коомдогу өз ордун аныктайт. Бул, айрыкча, көркөм адабият жана коомдук илимдерге тиешелүү. Адамды чыгармачылык жаман жолдон сактайт. Бул тууралуу кыргызда акын, жомокчулардын көп эле айткандары бар. Чыгармачылык тазалыкты, чынчылдыкты, калыстыкты талап кылат. “Подлинное творчество не может быть демоническим, оно всегда есть выход из тьмы. Демонические зло человеческой природы сгорает в творческом экстазе, притворяется в иное бытие”, - дейт орус философу Н. Бердяев [1, 115].

Балдардын көркөм адабият боюнча чыгармачылыгы оозеки жана жазуу кеби калыптанганда, дүйнөгө өз үнүн кошууга дилгир болгон чакта башталат. Бул 10-14 жаштан башталарын айттык. Мектепте адабий чыгармачылыкка кызыктырууда адабият кружокторунун орду чоң. Чыгармачылыкка үйрөтүүдө дил баян жаздыруунун орду чоң, албетте, муну менен дил баян жаздыруу жалаң акын- жазуучуну даярдоо үчүн керек дегенди айтуудан алыспыз, анткени менен чыгармачылыктын даамын татып калуусуна, түшүгүн түшүнүүгө керек. Дил баянды тез-тез жаздырып туруунун ой жүгүртүү процессинин жакшыруусуна алып келет. Ал үчүн окуучу да, мугалим да дил баяндын үстүндө иштей алуусу керек. Мугалим да сабакка кирип эле: “Дил баян жазабыз”, -дегени туура эмес. Бала да даярданышы керек. Даярдыгы мыкты болмоюнча, эч качан мыкты дил баян жазылбайт. Ал турсун оозеки түрдө айтып даярдануунун чоң пайдасы бар. Мектеп окуучуларынын чыгармачылыгынын туу чокусу эле дил баян жазуу. “Из всех трудовых процессов человека самый трудный – творческий. Прежде чем что-то создать, сочинить, человек должен вдуматься, вжиться в тему, дать мозгу время поработать подступно, вызвать из памяти аналогичные ощущения и переживания – тогда сочинение выльется из души” [3, 28]. “Дил баян аркылуу адам өзүн өзү чагылтат, б.а ишмердүүлүктүн бул формасы - адамдын өзүн-өзү көрүп туруучу күзгүсү” [5, 526-бет]. Бардык чыгармачылык деп эсептелген иштерде автордун “мени” кайсыл бир деңгээлде кошулса, окуучунун дил баянында ал эң көп кошулат, ошондо ал чыгармачылык менен жазылган болот. Жөн эле көчүргөн материал дил баян боло бербейт. Чыгармачылык менен иштөө адамды өмүр бою жандап жүрөт. Анын башатын бала кезде жатары, ошого жараша өнүгөрүнө чоң маани берүү керек. Бала кезде чыгармачылыкты калыптандыруу - ийгиликке эрте жол ачуу. Ошонун ичинде да калем менен ойлонуу эң кыйыныраагы десек туура болот.

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PHILOLOGICAL SCIENCES

MORPHEME MEANING AS THE BASIS OF WORD FORMATION AND SEMANTIC INTERPRETATION

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Abstract

The study of word meaning and meaning in morphemes is a fundamental aspect of modern linguistics, focusing on how the smallest meaningful units of language contribute to the formation and interpretation of words. A morpheme is recognized as the smallest two-facet linguistic unit possessing both form and meaning. While extensive research has been devoted to the phonological and morphological structure of language, the semantic properties of morphemes have received comparatively less attention. This paper examines the various types of meanings associated with morphemes, including lexical, grammatical, denotational, connotational, stylistic, functional, and differential meanings. Root morphemes primarily carry lexical meaning, forming the semantic core of words, whereas affixal morphemes often express generalized concepts, grammatical functions, or changes in word class. The analysis also highlights the role of derivational affixes in conveying emotional and stylistic nuances, as well as their contribution to the creation of new lexical items. Special attention is given to differential meaning, which distinguishes words sharing common morphemes, even in cases where a morpheme lacks an independent denotational meaning, such as in *cranberry*. Furthermore, the paper explores the relationship between morpheme meaning and overall word meaning, demonstrating how individual morphemes interact to produce complex semantic structures. By examining both theoretical perspectives and illustrative examples, this study emphasizes the importance of morpheme semantics in understanding word formation, vocabulary expansion, and language organization. The findings contribute to a deeper understanding of morphological analysis and semantic interpretation, highlighting the essential role of morphemes in linguistic theory and practical language learning.

Keywords: morpheme, lexical meaning, word formation, morphological analysis, semantics.

Introduction - In modern linguistics, the morpheme is recognized as the smallest meaningful unit of language. Unlike a phoneme, which only distinguishes sounds, a morpheme possesses both form (sound or written shape) and meaning. Words are often made up of one or more morphemes, each contributing to the overall meaning or grammatical function of the word. The study of morphemes is essential because it helps explain how words are formed, how meanings are created, and how language develops. Although the phonological and morphological structures of language have been thoroughly investigated, the semantic aspects of morphemes their meanings and functions have received comparatively less attention. Understanding the different types of meanings associated with morphemes is therefore an important area of linguistic study.

A morpheme is the smallest linguistic unit that carries meaning or performs a grammatical function. Morphemes cannot usually be divided into smaller meaningful parts.

Examples: **boy** = one root morpheme, boyish = boy + -ish, boyhood = boy + -hood, unhappiness = un- + happy + -ness

Each morpheme contributes something to the meaning or grammatical role of the entire word. Morphemes are generally divided into:

Root morphemes – carry the main lexical meaning.

Affixal morphemes – prefixes and suffixes that modify meaning or grammatical category.

The most important semantic feature of many morphemes is their lexical meaning. Lexical meaning refers to the actual concept or idea represented by a morpheme. For example: boy means "a male child."

In boyhood, boyish, and schoolboy, the root morpheme boy retains essentially the same lexical meaning. Similarly: teach → teacher, friend → friendship, child → childhood. The root morpheme carries the central meaning throughout all these words. Unlike root morphemes, affixes usually express more general meanings. Examples: **-er** = one who performs an action – teacher, writer, singer; **-less** = without, homeless, careless, hopeless

These suffixes do not identify a specific object but express general concepts applicable to many words.

One important difference between words and morphemes concerns grammatical meaning. Words often possess grammatical categories such as: number, case, tense, person. For example: man, man's, men. These different forms express grammatical meanings. However, the root morpheme **man-** in: manly, manhood, manful does not show grammatical categories such as singular, plural, or case. Therefore, root morphemes are generally considered to lack independent grammatical meaning. Instead, grammatical meanings belong mainly to complete word forms rather than isolated morphemes.

Lexical meaning can be divided into two components. The first is denotational meaning. Denotational meaning refers to the direct, dictionary meaning of a morpheme or word. Examples: dog → a domesticated

animal, tree → a large plant, house → a building for living.

The same principle applies to root morphemes. For example: The root *book* always denotes the concept of a book whether it appears in: *bookshelf*, *notebook*, *bookstore*, *textbook*. The denotational meaning remains stable across different word formations. Besides denotation, morphemes may also express connotational meaning. Connotation includes: emotional coloring, evaluation, stylistic effect, personal attitude. Many suffixes carry strong emotional meanings. Examples include: **-ette** – *kitchenette*, *cigarette*. Originally meaning "small," it often suggests something smaller or less important. **-ie / -y** - Examples: *dearie*, *doggie*, *girlie*. These suffixes express affection, intimacy, or childishness. **-ling** Examples: *duckling*, *gosling*.

The suffix often conveys small size together with tenderness. Thus, affixes can contribute emotional meaning in addition to lexical meaning.

Affixes usually have generalized lexical meanings. Examples include:

Suffix	General Meaning	Example
-er	person performing an action	teacher
-less	without	hopeless
-ful	full of	beautiful
-hood	state or condition	childhood
-ship	status or relationship	friendship

Unlike root morphemes, these meanings are abstract and applicable across many words. Another important function of morphemes is expressing part-of-speech meaning. Root morphemes themselves usually do not indicate whether they are nouns, verbs, or adjectives. Consider: *man*, *manly*, *manliness*, *to man*. The same root appears in different grammatical categories. However, derivational affixes often determine the part of speech. Examples: *happy* → *happiness*, *kind* → *kindness*, *teach* → *teacher*, *care* → *careful*, *beauty* → *beautiful*. The suffix determines whether the new word functions as: noun, adjective, verb. In many derivational morphemes, lexical and grammatical meanings are closely connected.

Some morphemes possess little lexical meaning but perform an important grammatical function. This is called functional meaning. For example: *just* → *justice*, the suffix **-ice** contributes very little lexical content. Its primary function is to change: adjective → noun Similarly:

different → difference
important → importance

The suffixes mainly alter grammatical category rather than introducing substantial new meaning. Morphemes may also possess differential meaning, a semantic component unique to morphological analysis [Cruse, D. A. 2011]. Differential meaning enables one word to be distinguished from another containing the same root. Examples: *bookshelf*, *bookcase*, *bookstore*, *bookshop*. The morphemes: *shelf*, *case*, *store*, *shop* distinguish these words from each other. Likewise: *notebook*, *copybook*, *exercise-book*, *address-book*. Here: *note-* *copy-* *exercise-* *address-* provide the differential meanings. Thus, differential meaning identifies one member of a word family from another.

Sometimes different affixes share nearly identical denotational meanings but differ greatly in connotation. Consider the following adjectives: *womanly*, *womanlike*, *womanish*. All indicate similarity to a woman. However: **-ly** - positive, admirable, graceful. Example: *womanly behavior*

-like – neutral, descriptive. Example: *womanlike appearance* **-ish** - often negative, slightly derogatory. Example: *womanish habits*. Thus, while their denotational meanings are similar, their connotations differ significantly.

Certain morphemes also possess stylistic meaning. Some suffixes are associated with scientific, technical, or formal language. Examples: *chlorine*, *rhomboid*, *effervescence*. Suffixes such as: *-ine*, *-oid*, *-escence* immediately suggest scientific or academic vocabulary. Their stylistic value helps identify the register of the language.

Some morphemes possess almost no independent denotational meaning but still serve a differential function. A famous example is: *cranberry* - The element **cran-** has no independent meaning in Modern English. Yet it distinguishes: *cranberry*, *blackberry*, *gooseberry*, *blueberry*.

Therefore, even without denotational meaning, **cran-** contributes differential meaning.

Such morphemes are often called unique morphemes or *cranberry morphemes*. Some linguists have discussed words such as: *receive*, *deceive*, *perceive*, *conceive*. If these words are analyzed into morphemes: *re-* + *ceive*, *de-* + *ceive*, *per-* + *ceive*, *con-* + *ceive* the prefixes no longer possess clear lexical meanings in present-day English.

Instead, they merely distinguish one word from another. Synchronically that is, from the perspective of present-day English their meanings are almost entirely differential.

The meaning of a word is usually the combined result of the meanings of its constituent morphemes. For example: *unhappiness* contains: *un-* = not, *happy* = feeling pleasure, *-ness* = state or condition. Together they produce the meaning: "the state of not being happy." Similarly: *carelessness* contains: *care* -less -ness meaning: "the condition of being without care."

Thus, word meaning often results from the interaction of lexical, grammatical, functional, and differential meanings contributed by individual morphemes.

The study of morpheme meaning is important because it: explains how words are formed, reveals relationships among words, improves vocabulary learning, assists in language teaching, supports lexicography, contributes to translation studies, helps understand semantic change, advances morphological and linguistic research. Knowledge of morphemes allows speakers

and learners to interpret unfamiliar words by analyzing their components.

This study is scientifically important because it provides a comprehensive analysis of the meanings expressed by morphemes, the smallest meaningful units of language, and their contribution to the semantic structure of words. By examining lexical, grammatical, denotational, connotational, stylistic, functional, and differential meanings, the research enhances the understanding of how word meanings are formed and interpreted in modern linguistics. The study contributes to the fields of morphology, semantics, and lexicology by clarifying the relationship between individual morphemes and the overall meaning of words. It also demonstrates how derivational processes enrich vocabulary and influence grammatical categories, making it valuable for linguistic theory, language teaching, translation studies, lexicography, and natural language processing. Furthermore, the analysis of differential meaning and unique morphemes offers insights into complex patterns of word formation in English, supporting further research in morphological analysis and semantic interpretation. Overall, the study advances scientific knowledge of language structure and provides a theoretical foundation for future investigations into word formation and meaning.

Conclusion - The study of word meaning and meaning in morphemes demonstrates that morphemes are the fundamental building blocks of language, serving as the smallest meaningful units that contribute to the formation, interpretation, and development of words. Although morphemes are smaller than words, they play a crucial role in expressing lexical, grammatical, functional, stylistic, connotational, denotational, and differential meanings [Bauer, L. 2003]. The interaction of these meanings determines not only the semantic content of individual words but also the organization of the vocabulary as a whole. This study has shown that root morphemes primarily carry lexical meaning, representing the core semantic content shared by related words, while affixal morphemes perform a wide range of functions. Derivational affixes contribute to the creation of new words, modify lexical meaning, indicate grammatical categories, and often convey stylistic or emotional nuances. In many cases, the meanings expressed by affixes are more generalized than those of root morphemes, yet they remain essential for understanding how vocabulary expands and evolves. Furthermore, some affixes primarily perform functional or grammatical roles by changing the part of speech of a word rather than introducing substantial lexical content.

Particular attention has also been given to differential meaning, which distinguishes one word from another within the same morphological family. This aspect of morpheme semantics illustrates that not all meaningful elements possess an obvious denotational meaning. Certain morphemes, such as those found in *cranberry* or in verbs like *receive* and *deceive*, retain significance because they differentiate words from one another, even when their independent lexical meanings

are no longer recognizable in contemporary English [Plag, I. 2018]. Such examples demonstrate the complexity of morphological structure and highlight the importance of considering both synchronic and diachronic perspectives in linguistic analysis.

The relationship between morpheme meaning and word meaning is dynamic rather than mechanical. The overall meaning of a word emerges from the interaction of its constituent morphemes, whose semantic contributions may reinforce, modify, or extend one another. Consequently, understanding morpheme semantics enables linguists to explain patterns of word formation, semantic change, lexical productivity, and vocabulary development more accurately. It also provides valuable insights into how speakers interpret unfamiliar words by analyzing their morphological structure.

From a broader scientific perspective, the study contributes to several branches of linguistics, including morphology, semantics, lexicology, cognitive linguistics, and applied linguistics. It also has practical applications in language teaching, translation studies, lexicography, corpus linguistics, computational linguistics, and natural language processing, where accurate morphological analysis is essential for effective language description and processing. Knowledge of morpheme meaning supports vocabulary acquisition, improves reading comprehension, and enhances learners' ability to infer the meanings of new lexical items through morphological analysis.

In conclusion, the semantic study of morphemes provides a deeper understanding of the structure and functioning of language. Morphemes are not merely formal components of words but meaningful linguistic units that shape lexical interpretation and grammatical organization. Their multiple semantic functions reveal the complexity and flexibility of the English language and demonstrate the close relationship between morphology and semantics. Continued research into morpheme meaning will further enrich linguistic theory, improve practical approaches to language education, and contribute to advances in interdisciplinary fields that rely on the analysis and processing of human language.

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PHYSICAL SCIENCES

STUDY ON COSMOLOGY AND MYSTERIES QUESTION OF THE UNIVERSE

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Abstract

The universe is filled with profound mysteries that continue to challenge our understanding of physics and reality. From the invisible forces driving cosmic expansion to the ultimate fate of information inside a black hole, scientists are actively working to decode the deepest secrets of the cosmos. The steady-state universe is an eternal cosmos in which the universe is constantly expanding at a constant rate. New matter is created at the same rate to maintain the density. Despite the discovery of the cosmic microwave background, various existing concerns ultimately undermined the steady-state theory. Astrophysicists are trying to solve the most common problems in the early universe. Dark matter is an invisible substance that acts like a cosmic scaffolding. Without its gravitational pull, galaxies would fly apart, yet it does not emit or absorb light. The character of dark matter is at present beyond our comprehension. Dark energy is an enigmatic force causing the expansion of the universe to accelerate. Its exact origin and composition remain one of modern science's greatest puzzles. The leading candidates claim it is some sort of collision-less cold or slow fluid. But when we run simulations and compare with observations, we observe that there are many fewer satellite galaxies around large galaxies. However, despite decades of space exploration and the discovery of thousands of exoplanets, there is currently no definitive evidence of life beyond Earth. In this qualitative analytical article, effort will be taken to discuss and analyses of the most mysterious question in modern astronomy.

Keywords. Dark matter, dark energy, JWST, CDM, GZK, Λ CDM

Introduction

Modern physics grapples with profound mysteries in the Universe, including the nature of dark matter and dark energy, the origins of the Big Bang, and the potential for life beyond Earth. Stars and planets consist of ordinary matter, which only accounts for roughly 5% of the entire universe. The other 95% are comprised of the mysterious dark matter and dark energy, creating many riddles yet to be solved. While dark matter is an unseen entity making up for 27% of the entire universe, dark energy accounts for 68% and accelerates the expansion of the Universe. Yet the exact ingredients of the former, as well as the latter, are not yet known. Additionally, the cause for the Big Bang and what the future of our universe might be are yet undetermined – whether it will keep on expanding forever, or undergo another "Big Crunch." Matter dominates the cosmos, yet the Big Bang should have created equal amounts of matter and antimatter, which would have destroyed each other. We don't know what's actually at the center of a black hole—the singularity—or how supermassive black holes grew so large so fast. Scientists are looking for evidence of life beyond Earth and for a theorized ninth planet, or Planet X, in our solar system. Outside the 46 billion light-year visible horizon, the rest of the universe could be endless with many additional galaxies. The universe is full of secrets, from the backyard of our own solar system to the furthest borders of the cosmic ocean. It's always been this way. Ancient astronomers puzzled about the nature of comets and speculated about the chemical makeup of stars centuries ago. Now these ancient riddles have been solved, but as bigger telescopes and more sensitive sensors look further into space, they have been replaced by new conundrums. We observe a considerably diminished density in the

centers of galaxies compared to the expectations of Λ -CDM, or "dark energy and cold dark matter" hypotheses. These phenomena are the so-called missing satellites problem and core-cusp problem, respectively. Some ideas depend on dark matter having some self-interaction. In addition, we do not understand the formation of structures in the early universe. Thus, our knowledge of the early Universe is limited, save for the cosmic microwave background (CMB), which provides evidence for some degree of early structure formation.

The Cosmic Dark Ages is a special period that few people are aware of. It covers the time from the release of the Cosmic Microwave Background (CMB) until the formation of the first stars, called Population III stars. One way we can probe this period is by looking at the radio emissions of neutral hydrogen gas. Neutral hydrogen emits light at a certain wavelength, known as the 21-cm transition. But the universe's expansion redshifts this light to wavelengths we can't see: 1) It is reflected by the ionosphere back into space, and 2) it is redshifted into the frequencies used for telecommunications, causing interference with man-made noise. Radio astronomy on the far side of the Moon is expected to thrive in the future. The LuSEE-Night telescope is set to land on the Moon in 2026. Thousands of kilometers of rock will shield it from the din of our civilization. Currently, we do not understand the role of metallicity in galaxy evolution and its impact on the features of stars, planets, and structure. It is well-known that metallicity is a characteristic of a material, which is the ratio of metals (elements heavier than helium) to hydrogen and helium. For example, the Sun's metallicity is 1.2%, implying that 98.8% of the Sun's atoms are hydrogen and helium. Mysteriously, this percentage is actually a high metal-

licity for a star. Metals are highly crucial to cosmic development since 1) they assist gas to cool and condense to form new stars and planets and 2) metallicity may play a large role in the formation of planetary systems, which influences the ability of life to form. Metals are created inside dying stars, which are compelled to fuse larger and heavier nuclei together once they have run out of hydrogen to fuse into helium. One day, low-mass fading red giants like our Sun will spread low-mass metals such as carbon, nitrogen, oxygen, silicon, et al. in the gas in galaxies. These stars become exceedingly puffy, lose their material readily, and make planetary nebulae. These planetary nebulae then go on to generate the next generation of stars when the gas cools.⁷⁵ Type Ia supernovae and neutron star mergers produce high-mass metals that are essential to electronics and developing civilizations. Iron, gold, neodymium, platinum, lead, uranium, etc. While we understand that metals are highly vital to cosmic evolution, one aspect of metallicity that remains unclear is the role of the circum-galactic medium (CGM). "Circum" means around, "Galactic" is about a galaxy, and "Medium" means material. So CGM is stuff that surrounds galaxies. It's hot, poofy gas, a million degrees Celsius, and it's around large galaxies like the Milky Way.

Now the question is how metal-rich is this gas, and how does that interplay with galactic evolution? "We're trying to determine the metallicity of this gas now by looking at a tremendously bright flashlight behind it, looking for missing ultraviolet light with the Hubble Space Telescope, and identifying metals that way. And that was compared to the missed light because of neutral hydrogen. But this is a significant problem. We need both neutral and ionized hydrogen to comprehend the metallicity of the CGM. But we can only see neutral hydrogen directly. We can detect ionized hydrogen with recombination lines, but we still have the problem that we cannot effectively investigate highly ionized gas because Hubble, although a fantastic telescope, doesn't have the colors to see much of this incredibly hot ionized gas. So, we need a telescope in the soft X-rays. That's where the Line Emission Mapper (LEM) comes in. The LEM can significantly enhance our understanding of galaxy evolution compared to our current knowledge.⁷⁶ The LEM is a proposed soft X-ray telescope that will be able to explore this super-hot ionized plasma and subsequently answer these questions. There are numerous ideas, such as a failed supernova and then collapse to a neutron star or black hole or a tidal disruption event around an intermediate-mass black hole that tears apart a passing star and accretes it. What's certain is that they need to be propelled by a compact "central engine" because they all seem to dis-

play intense X-ray and radio emission typical of accretion. One was also just caught shining in optical flares at minute scales as brilliantly as a supernova at its peak before fading as rapidly as it appeared. Definitely an intriguing riddle to solve as these things and their behavior were a surprise discovery. In fact, astrophysics contains a relatively high number of unresolved mysteries, which may be legitimately interpreted as proof that the prevailing theory is insufficient. The present anomalies and the abundance of astronomical data suggest that we can empirically base this theorizing on further tests. We are in a very intriguing situation where different theories can explain some phenomena but not all, indicating the need for new physics; however, it is crucial to note that JWST observed cold Y-dwarfs, which did not contain phosphine in their atmosphere. One fascinating observation is that Jupiter, unlike Y-dwarfs, does show phosphine in its atmosphere.⁷⁷ There is still no solid reason for this. On the other hand, stars, brown dwarfs, and planetary mass objects can form on their own, although some research implies that star formation abruptly ends below some mass (5-10 Jupiter masses).

A recent result by Pearson & McCaughrean did not detect a cutoff in the Orion Nebula. Could this observed cutoff be only an instrument limit of the astronomers? Modern cosmology and the latest physics have answered many questions about the cosmos. But there is still a lot about the universe we don't know. By 2026, the limits of our understanding will be defined by the numerous unresolved questions that scientists are currently investigating. We know that something binds galaxies together, but dark matter does not absorb, reflect, or emit light. It makes up around 27% of the cosmos, but what its particle makeup is unknown. Again, dark energy makes up about 70% of the universe. This unexplained force is driving the accelerated expansion of the cosmos. Its nature is still one of the greatest mysteries in science. The Big Bang theory explains the evolution of the cosmos but not the genesis of the original singularity or what (if anything) existed before it. Again, scientists are still attempting to find out what will be the final fate of the cosmos—whether it will be expansion forever or the Big Freeze, collapse or the Big Crunch, or rip apart or the Big Rip. According to current scientific understanding, the Big Bang should have produced equal amounts of matter and antimatter. According to current scientific understanding, the Big Bang should have produced equal amounts of matter and antimatter.⁷⁸ The identical amounts of matter and antimatter would have destroyed each other, leaving behind an empty universe without any light or stars. Besides, while black holes may be theorized upon, there is much we do not know about the physical laws that

⁷⁵ Gott III, J. Richard; Mario Jurić; David Schlegel; Fiona Hoyle; et al. (2005). "A Map of the Universe" (PDF). *The Astrophysical Journal*. 624 (2): 463–484, doi:10.1086/428890, accessed on 13 Jun 2026

⁷⁶ Lineweaver, Charles; Davis, Tamara M. (2005). "Misconceptions about the Big Bang". *Scientific American*. 292 (3): 36–45, doi:10.1038/scientificamerican0305-36, accessed on 13 Jun 2026

⁷⁷ Overbye, Dennis (2018). "All the Light There Is to See? 4×10^{84} Photons". *The New York Times*, 3 December 2018, available at:

<https://www.nytimes.com/2018/12/03/science/space-stars-photons-light.html>, accessed on 13 Jun 2026

⁷⁸ Abdollahi, S.; Ackermann, M.; Ajello, M.; et al. (30 November 2018). "A gamma-ray determination of the Universe's star formation history", *Science*, 362 (6418): 1031–1034, doi:10.1126/science.aat8123, accessed on 13 Jun 2026

control black holes, especially in their singularity. This ignorance leaves room for contradictions between the laws of quantum physics and general relativity.⁷⁹ Moreover, Fast Radio Bursts, which are short but strong radio waves lasting milliseconds and coming from far away galaxies, are another mystery. No one knows what causes FRBs, and people argue on whether they come from magnetars or black holes or other objects in space. Most recently, scientists discovered something new called Jupiter-Mass Binary Objects, consisting of pairs of free-floating rogue planets in space.

However, the puzzle still needs to be answered is the 'Hubble Tension'—a big mismatch in measurements of how fast the universe is expanding. That suggests either bad observations or missing physics. Again, the corona of the Sun is hundreds of times hotter than its surface, which is contrary to accepted thermodynamic models. You can calculate gravity. What is missing is a complete theory of quantum gravity, that is, a theory that connects gravity with the other fundamental forces. If there existed a region of space made up of antimatter, then we'd notice this "border" with the part of space made up of matter from the gamma rays. Because space isn't really empty. There's hydrogen and helium and interstellar dust (or anti-hydrogen, anti-helium, and anti-dust). From a Newtonian perspective, we don't fundamentally comprehend gravity, and we may wonder if it could be a massless graviton particle. But in an Einsteinian picture, gravity is not a thing. Instead, what we call gravity is really the bending of spacetime. That's at least of a large size, but quantum gravity is something else entirely. But can we figure out where all those missing socks are going and determine the expansion rate of the cosmos as well as dark energy?⁸⁰ Actually, it is intriguing how our little star system sits in a little bubble of exceptionally empty space, off a minor arm filament, in a small galaxy cluster, part of a tiny supercluster, in the heart of a vast vacuum bubble! Again, two words have dominated space in 2021: and those are perseverance and ingenuity. The Martian robots top the list of cosmic wonders as we approach the halfway point, delivering stunning views of the Martian surface. On the other hand, in Ingenuity's case, achieving the first powered flight on another planet.^{81,82} The basic unanswered question is whether there exists intelligent life somewhere else in the universe. There have been efforts made to find out, such as the detection of biosignature in exoplanets via the James Webb Space Telescope (JWST).

To explore the frontiers of science and discover how researchers are hunting for answers to these vast questions. For instance, in 2020, astronomers in the UK observed the presence of the chemical phosphine in the

thick clouds of Venus, indicating possible life; nevertheless, more observations are required. On the other hand, one interesting phenomenon is the signal received in 1977 called the "Wow!" Signal. As of early 2026, the 1977 "Wow! Signal" remains one of the most tantalizing, unrepeated, and unexplained radio anomalies in astronomy. Modern study has yielded exciting new natural ideas, but 'Signal' remains one of the most tantalizing, unrepeated, unexplained radio anomalies in astronomy.⁸³ The 1977 data have been thoroughly studied, although the signal has never been detected again after its 72-second appearance. Today, with no repeat signal to analyze, it remains an enduring enigma and, for many, the best 'whisper from the stars' ever recorded. But astronomy is the scientific study of celestial bodies and the universe as a whole. Astronomy has achieved remarkable accomplishments over the years. There is much more that we now know about the universe than what was known to the early astronomers when they gazed into the heavens because of the developments in space telescopes and the missions to deep space.⁸⁴ However, there are several basic problems that still need answers. The presence of such mystery indicates the boundaries of our current knowledge and the enormous amount of knowledge yet to be discovered. This is an analytical article, where author has intended to explore few mysterious questions of astronomy along with wisdom of Holy Books.

Unsolved Questions about Cosmos and Mysteries of Universe

One of the biggest problems for astronomers today would be figuring out what dark matter is. Dark matter can easily be inferred from its name; this means that it neither emits nor absorbs light, making it imperceptible by astronomy apparatus. However, despite the fact that it cannot be observed, dark matter accounts for 27 percent of all matter-energy in the universe. The existence of dark matter can only be detected by the gravity exerted on other observable materials, like planets or galaxy clusters. It has never been found out what dark matter comprises. Some theories include WIMPs, axions, and sterile neutrinos, but after many years of extensive research, no one has ever managed to detect dark matter. Experiments involving the discovery of dark matter's properties have also proved futile, as they were conducted both above and below ground and even using astronomical observations. Making the quest even more challenging is another problem known as dark energy. The 2011 Nobel Prize in Physics was awarded for the finding that the universe is expanding at an accelerated rate. This is believed to be due to dark energy. Dark energy is believed to constitute roughly 68 percent of the universe's energy density. But what it is one

⁷⁹ Loeb, Abraham (2002). "Long-term future of extragalactic astronomy". *Physical Review D*. 65 (4) 047301, doi:10.1103/PhysRevD.65.047301, accessed on 19 Jun 2026

⁸⁰ Liddle, Andrew (2015). *An Introduction to Modern Cosmology*. John Wiley. ISBN 978-1-118-50214-3, accessed on 19 Jun 2026

⁸¹ <https://www.cnet.com/science/hubble-spots-lopsided-fried-egg-galaxy-caught-in-a-tug-of-war/>, accessed on 22 Jun 2026

⁸² <https://www.cnet.com/science/features/2021-space-calendar-chinas-mars-landing-spacex-starship-nasa-launches-and-more/>, accessed on 22 Jun 2026

⁸³ <https://earthsky.org/space/the-wow-signal-seti-hydrogen-line-maser/>, accessed on 17 Jun 2026

⁸⁴ <https://www.facebook.com/secretsofuniverse/posts/it-all-began-in-1923-for-centuries-earths-atmosphere-has-posed-significant-chall/1233771401729792/>, accessed on 17 Jun 2026

of the deepest riddles in cosmology. A number of hypotheses exist that seek to explain dark energy. The theory of the cosmological constant was first introduced by Albert Einstein. There are other theories that include the dynamic fields theory. Yet, despite numerous observations made on supernovae and cosmic microwave backgrounds, the exact nature of the dark energy remains elusive to science.

Many questions remain to date unanswered regarding the evolution and formation of galaxies. While simulations and observation provide a lot of information on how galaxies evolve and form, there is much left to learn about the process. The main issues concern the formation of the first galaxies, the part played by supermassive black holes, and galaxy merging. Watching galaxies far away from the Earth gives us information about the universe's early stages, but modeling such observations is very complicated because many different things should be considered. With improved resolution due to new space telescopes, such as JWST, we hope to obtain answers about some of these issues. Magnetic fields exist in the cosmos; they affect charged particles and influence interstellar and intergalactic matter. Nevertheless, we still do not know why they are present. There are several hypotheses concerning the origin of these magnetic fields; they suggest that magnetic fields might be produced by the dynamo effect in the first stars and galaxies or primordial magnetism of the Big Bang era. Still, the exact process of the formation of these enormous magnetic fields requires further investigation.⁸⁵

Fast Radio Bursts (FRBs) are strong, millisecond-long flashes of radio waves, originating from faraway galaxies. These mysterious signals were first detected in 2007 and last only a few milliseconds, but they emit as much energy as the sun does in a few days. We don't know where FRBs come from. Other theories suggest that neutron stars, black holes, or even stranger ideas such as extraterrestrial technologies cause these bursts. There have been numerous discoveries and follow-up studies regarding them, but still, the processes underlying the FRB phenomena are poorly understood. Learning about FRBs will provide us with additional knowledge about the environment in distant galaxies

and the processes associated with high-energy astrophysical phenomena. One of the most interesting and promising fields in astronomy is searching for extraterrestrial life. There were many exoplanets found which orbit in the habitable zones of their suns, however, there is still no proof that extraterrestrial life exists. Some special projects such as SETI look for signs of an intelligent life form out there. Still, up until now there is no proof of any extraterrestrial life found. Even finding microorganisms on another planet would be a great discovery for further research regarding life forms around the universe. Nevertheless, there is still a long way to go and much to discover in our universe.

Beyond Neptune, there are thousands of icy bodies called Trans-Neptunian Objects (TNOs), including recognized dwarf planets like Pluto, Eris, Haumea, and Makemake. Extreme TNOs (ETNOs) like Sedna have highly elongated orbits due to gravitational perturbations from external forces.^{86,87} Astronomers generally attribute these strange, stretched trajectories. Are there any non-dwarf planets outside of Neptune in the solar system? And why are orbits of extreme trans-Neptunian objects elongated?^{88,89} Again, Saturn's moon Iapetus is one of the stranger objects in our Solar System. Unlike other objects its size, Iapetus is walnut-shaped, with a clearly defined chain of mountains along its equator. Now the question is, how could it have formed billions of years ago with the rest of the Solar System, and yet still have its unique shape?⁹⁰ More questions are the mountains the relic of a young, hot, rapidly spinning Iapetus? The mountains consist of material that has gathered on the surface over time, originating from the rings of Saturn?^{91,92} As we know that, Saturn's magnetosphere rotates at a pace similar to its clouds as the planet's magnetic field is anchored to its deep, spinning interior. Current observations reveal the two are dynamically coupled: upper atmospheric winds driven by planetary auroras interact with the magnetosphere, aligning the magnetosphere's rotation with atmospheric movements.⁹³ Now the question is why does Saturn's magnetosphere rotate at about the same pace as the planet's clouds? And, where does the line of high mountains that runs close around the equator of Saturn's moon Iapetus come from?

⁸⁵ Vourlidas, A.; Patsourakos, S.; Savani, N.P. (2019). "Predicting the geoeffective properties of coronal mass ejections: current status, open issues and path forward". *Philosophical Transactions A*. **377** (2148), doi:10.1098/rsta.2018.0096, accessed on 27 Jun 2026

⁸⁶ https://ssd.jpl.nasa.gov/tools/sbdb_query.html, accessed on 27 Jun 2026

⁸⁷ Holler, Bryan J.; Benecchi, Susan D.; Brunetto, Rosario; Cartwright, Richard; Cook, Jason C.; Emery, Joshua P.; Ieva, Simone; Pinilla-Alonso, Noemí; Protopapa, Silvia; Stansberry, John A.; Wong, Ian; Young, Leslie A.; de Souza Feliciano, Ana C. (2024), "Constraining the origin and dynamical evolution of extreme trans-Neptunian objects through NIR spectroscopy". JWST Proposal GO3: 4665. Bibcode:2024jwst.prop.4665H, accessed on 27 Jun 2026

⁸⁸ Bower, Ernest Clare (1931). "On the orbit and mass of Pluto with an ephemeris for 1931-1932". *Lick Observatory Bulletins*. **15** (437): 171–178. Bibcode:1931LicOB.

15..171B. doi:10.5479/ADS/bib/1931LicOB.15.171B. ISSN 0075-9317, accessed on 13 Jun 2026

⁸⁹ Standage, Tom (2000). *The Neptune file: a story of astronomical rivalry and the pioneers of planet hunting*. New York: Walker. p. 188. ISBN 978-0-8027-1363-6, accessed on 24 Apr 2026

⁹⁰ <https://www.universetoday.com/articles/saturns-moon-iapetus-enjoys-eternal-youth>, accessed on 24 Apr 2026

⁹¹ <https://science.nasa.gov/saturn/moons/iapetus/>, accessed on 13 Apr 2026

⁹² Sucerquia, Mario; Alvarado-Montes, Jaime A.; Zuluaga, Jorge I.; Cuello, Nicolás; Cuadra, Jorge; Montesinos, Matías (August 2024). "The missing rings around Solar System moons". *Astronomy & Astrophysics*. **691**: A74, doi:10.1051/0004-6361/202449453, accessed on 13 Apr 2026

⁹³ <https://newsroom.northumbria.ac.uk/pressreleases/scientists-solve-decades-long-mystery-about-why-saturn-appears-to-change-its-spin-3440586>, accessed on 24 Apr 2026

Now, referred to as JuMBOs (Jupiter Mass Binary Objects), these unexpected pairs of free-floating planets have been observed by the JWST in star-forming regions like the Orion Nebula. There are two main formation theories: Micro-star formation and Ejection mechanisms.⁹⁴ Now the questions are, how prevalent are planetary systems similar to the solar system? Some of the planetary systems we have seen have super-Earths and hot Jupiter's quite close in to their sun. Jupiter-like planets in Jupiter-like orbits appear to be rare. There are several reasons why Jupiter-like orbits might be rare, including lack of data or the great tack hypothesis. How do binaries with a Jupiter mass form?⁹⁵ As we know that, the Sun produces its reversing magnetic field through the solar dynamo process, and driven by the internal movement of electrically charged plasma. Differential rotation and convective currents stretch, twist, and amplify the magnetic field lines over the 11-year solar cycle. As the magnetic field tangles, it becomes buoyant and rises to the visible surface and the eruptions form sunspots, which appear in pairs with opposite magnetic polarities.⁹⁶ Moreover, near the peak of the solar cycle (solar max), the sunspots decay, and their remaining magnetic flux is carried by convective flows to the polar regions. It deposited flux cancels out the existing poles and rebuilds them with the opposite polarity, completing the 11-year flip. As the newly established poles are reversed, the entire process takes 22 years to return to the exact initial state.⁹⁷ Simple question is that, how does the Sun produce its regularly reversing large-scale magnetic field?

The solar cycle rebounds when depleted polar magnetic flux slowly accumulates until it reaches a critical threshold, triggering a polarity reversal and restarting regular cyclic activity. Even during a quiescent grand minimum, the Sun's dynamo keeps operating near a minimum threshold, continuing to deposit small amounts of magnetic flux toward the poles.⁹⁸ Now, once this critical mass of polar magnetic flux is reached, the Sun's magnetic poles successfully reverse polarity. This kick-starts the dynamo, allowing it to re-establish the standard, 11-year Solar Cycle.⁹⁹ What is the mechanism that created the Maunder Minimum and

other grand minima, and how does the solar cycle rebound from a minimum state?¹⁰⁰ Magnetic reconnection is a physical process occurring in electrically conducting plasmas, in which the magnetic topology is rearranged and magnetic energy is converted to kinetic energy, thermal energy, and particle acceleration.¹⁰¹ The surface of the Sun is roughly 5,500°C, and the corona reaches up to 3 million degrees Celsius. This baffling phenomenon, known as the coronal heating problem, is powered by two main magnetic mechanisms. The constant churning of the Sun twists its magnetic field lines. When these lines cross and snap, they release millions of tiny, localized explosions called nanoflares, which superheat the surrounding plasma. Data from NASA's Parker Solar Probe also suggests a helicity barrier traps turbulent energy in the atmosphere and channels it directly into heating the plasma.¹⁰² Few questions arise as why is the corona of the Sun so much hotter than the surface of the Sun? What makes the magnetic reconnection effect many orders of magnitude faster than what the mainstream models predict?¹⁰³

Stars comprise most of the baryonic and luminous mass of galaxies; synthesize heavy elements; and inject mass, momentum, and energy into the interstellar medium. Stars are also home to the planets. As stellar properties are primarily decided by their mass, the so-called stellar initial mass function (IMF) is critical to the structuring of our Universe.¹⁰⁴ Questions are, there does the stellar mass spectrum arise? That is, why do astronomers find the same distribution of stellar masses, the beginning mass function, presumably independent of initial conditions?¹⁰⁵ Coronal mass ejections (CMEs) eject twisted magnetic structures as flux ropes from the Sun. And the CMEs rotate during their journey, and their internal magnetic fields can orient southward. This sustained southward field interacts with Earth's northward magnetosphere via magnetic reconnection, and transferring massive energy and driving intense geomagnetic storms.¹⁰⁶ Question are, how does the Sun produce powerful southward-directed magnetic fields in solar coronal mass ejections that lead to geo-

⁹⁴ <https://www.jodcast.net/archive/202412/>, accessed on 13 Apr 2026

⁹⁵ <https://www.bbcearth.com/>, accessed on 13 Apr 2026

⁹⁶ David H. Hathaway, "The Solar Cycle", Living Reviews in Solar Physics, March 2010, Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany. ISSN 1614-4961, accessed on 23 Jul 2026

⁹⁷ Houghton, J.T.; Ding, Y.; Griggs, D.J.; Noguera, M., eds. (2001), 6.11 Total Solar Irradiance—Figure 6.6: Global, annual mean radiative forcings (1750 to present), Climate Change 2001: Working Group I: The Scientific Basis. Intergovernmental Panel on Climate Change, accessed on 23 Jul 2026

⁹⁸ https://cc.oulu.fi/~usoskin/personal/Miyahara_AG06.pdf, accessed on 23 Jul 2026

⁹⁹ <https://greenly.earth/en-gb/blog/ecology-news/what-is-the-maunder-minimum>, accessed on 23 Jul 2026

¹⁰⁰ Casagrande, L.; Schönrich, R.; Asplund, M.; Cassisi, S.; Ramírez, I.; Meléndez, J.; Bensby, T.; Feltzing, S. (2011). "New constraints on the chemical evolution of the solar neighbourhood and Galactic disc(s)". *Astronomy &*

Astrophysics. 530:

A138. arXiv:1103.4651. Bibcode:2011A&A...530A.138C. doi:10.1051/0004-6361/20101627, accessed on 17 May 2026

¹⁰¹ Mozer, Forrest S.; Pritchett, Philip L. (2010), "Magnetic field reconnection: A first-principles perspective", *Physics Today*. 63 (6): 34–39, doi:10.1063/1.3455250. ISSN 0031-9228, accessed on 23 Jul 2026

¹⁰² <https://www.quora.com/Why-is-the-corona-of-the-Sun-much-hotter-than-the-surface>, accessed on 23 Jul 2026

¹⁰³ Michael J. Thompson (2014). "Grand Challenges in the Physics of the Sun and Sun-like Stars". *Frontiers in Astronomy and Space Sciences*. 1: 1, doi:10.3389/fspas.2014.00001, accessed on 17 May 2026

¹⁰⁴ <https://www.annualreviews.org/content/journals/10.1146/annurev-astro-052622-031748>, accessed on 17 May 2026

¹⁰⁵ Kroupa, Pavel (2002). "The Initial Mass Function of Stars: Evidence for Uniformity in Variable Systems". *Science*. 295 (5552): 82–

91, doi:10.1126/science.1067524, accessed on 17 May 2026

¹⁰⁶ <https://superdarn.ca/tutorials-12>, accessed on 23 Jul 2026

magnetic storms? How to forecast geomagnetic and solar superstorms?¹⁰⁷ Supernova is a powerful and luminous explosion of a star. A supernova occurs during the last evolutionary stages of a massive star, or when a white dwarf is triggered into runaway nuclear fusion. However, it is expected that supernovae in our galaxy occur on average once every 61 years, although the last to be observed was Kepler's Supernova in 1604.¹⁰⁸ As a fading star explodes in a supernova because the sudden collapse of its core creates an incredibly dense, rigid neutron core, causing the infalling outer layers of the star to violently bounce backward and blow apart in a massive shockwave.¹⁰⁹ Why does a fading star explode as it collapses?

Our observable universe is composed almost entirely of matter, a profound mystery in physics known as the baryon asymmetry problem. While theoretical models suggest the Big Bang should have produced equal amounts of matter and antimatter, leading to mutual annihilation, a tiny imbalance—roughly one extra matter particle for every billion antimatter particles—allowed normal matter to survive and form the cosmos. In physical cosmology, the baryon asymmetry problem, also known as the matter asymmetry problem or the matter–antimatter asymmetry problem.¹¹⁰ Why is there far more matter than anti-matter in the observable universe?¹¹¹ The cosmological constant or called Einstein's cosmological constant, is a coefficient that Albert Einstein initially added to his field equations of general relativity.¹¹² The cosmological constant Λ is the simplest possible explanation for dark energy and is used in the standard model of cosmology known as the Λ CDM model.¹¹³ The zero-point energy of the vacuum must produce a big cosmological con-

stant. Why doesn't it?¹¹⁴ The true size of the entire universe is unknown and currently impossible to measure.¹¹⁵ Current measurements from instruments like the Planck satellite indicate the universe is geometrically flat, meaning current cosmological models favor the theory that it is likely infinite. However, because we can only see a limited bubble of space, the exact nature of the whole cosmos remains one of the great mysteries in astrophysics.¹¹⁶ The size of the entire cosmos is unknown, but the observable universe is about 93 billion light-years across. Is it infinite?

Astronomer Edwin Hubble is that great human for whom the Hubble Space Telescope is named. He has discovered cosmic expansion in 1929, observing that the farther away a galaxy is from Earth, the faster it appears to be receding from us. The Hubble Tension is the most debated discrepancy in modern astrophysics, which refers to the fact that measuring the expansion rate of the universe (or Hubble Constant, H_0) yields two significantly different, highly precise values depending on the method used.¹¹⁷ The disagreement has become so severe that many physicists now refer to it as a crisis rather than a tension.¹¹⁸ Astrophysicists have written over a thousand research papers attempting to solve the mystery. The leading theories to explain the many discrepancies.¹¹⁹ The Hubble tension is a hint of the breakdown of the cosmic principle?¹²⁰ As we know that FLRW is a metric that describes a homogeneous, isotropic, expanding universe that is path-connected, but not necessarily simply connected.¹²¹ Again, when combined with Einstein's field equations, the metric gives the Friedmann equations, which have been developed into the *Standard Model* of modern cosmology and further developed into the Lambda-CDM model.¹²² Now the question, is the FLRW metric the true metric

¹⁰⁷ Vourlidis, A.; Patsourakos, S.; Savani, N.P. (2019). "Predicting the geoeffective properties of coronal mass ejections: current status, open issues and path forward". *Philosophical Transactions A*. 377 (2148), doi:10.1098/rsta.2018.0096, accessed on 17 May 2026

¹⁰⁸ Rozwadowska, Karolina; Vissani, Francesco; Cappellaro, Enrico (2021), On the rate of core collapse supernovae in the milky way, *New Astronomy*. 83 101498, doi:10.1016/j.newast.2020.101498, accessed on 17 May 2026

¹⁰⁹

https://www.reddit.com/r/space/comments/lisohfh/supernov_as_what_is_actually_happening_during_the/,

¹¹⁰ <https://home.cern/topics/antimatter/matter-antimatter-asymmetry-problem>, accessed on 26 Jun 2026

¹¹¹ Steinhardt, P. & Turok, N. (2006). "Why the Cosmological constant is so small and positive". *Science*. 312 (5777): 1180–1183, doi:10.1126/science.1126231, accessed on 07 Jun 2026

¹¹² Peebles, P. J. E.; Ratra, B., (2003), "The Cosmological Constant and Dark Energy". *Reviews of Modern Physics*. 75 (2): 559–606, doi:10.1103/RevModPhys.75.559, accessed on 07 Jun 2026

¹¹³ Colin, Jacques; Mohayaee, Roya; Rameez, Mohamed; Sarkar, Subir (2019), "Evidence for anisotropy of cosmic acceleration". *Astronomy and Astrophysics*. 631: L13, doi:10.1051/0004-6361/201936373, accessed on 27 Jun 2026

¹¹⁴ Wang, Qingdi; Zhu, Zhen; Unruh, William G. (2017-05-11). "How the huge energy of quantum vacuum gravitates to

drive the slow accelerating expansion of the Universe". *Physical Review D*. 95 (10), accessed on 07 Jun 2026 103504, doi:10.1103/PhysRevD.95.103504, accessed on 07 Jun 2026

¹¹⁵

<https://www.facebook.com/groups/jameswebbtelescopecosmicexplorations/posts/763256696765737/>, accessed on 11 Jun 2026

¹¹⁶ <https://www.instagram.com/reel/DUk34Thkm3Q/?hl=en>, accessed on 01 Jul 2026

¹¹⁷ <https://phys.org/news/2026-02-hubble-tension-magnetic-fields-universe.html>, accessed on 21 Jul 2026

¹¹⁸ <https://theconversation.com/the-hubble-tension-how-magnetic-fields-could-help-solve-one-of-the-universes-biggest-mysteries-274003>, accessed on 21 Jul 2026

¹¹⁹ <https://www.universetoday.com/articles/is-the-hubble-tension-starting-to-go-away>, accessed on 21 Jul 2026

¹²⁰ Abdalla, Elcio; Abellán, Guillermo Franco; Aboubrahim, Armin (11 Mar 2022), "Cosmology Intertwined: A Review of the Particle Physics, Astrophysics, and Cosmology Associated with the Cosmological Tensions and Anomalies", *Journal of High Energy Astrophysics*, 34: 49, doi:10.1016/j.jheap.2022.04.002, accessed on 29 May 2026

¹²¹ Ellis, G. F. R.; van Elst, H., (1999), *Cosmological models* (Cargèse lectures 1998), In Marc Lachièze-Rey (ed.), *Theoretical and Observational Cosmology*. NATO Science Series C. Vol. 541. pp. 1–116, ISBN 978-0-7923-5946-3, accessed on 29 May 2026

¹²² Bergström, Lars; Goobar, Ariel (2008), *Cosmology and particle astrophysics*. Springer Praxis books in astronomy and planetary science (2. ed., reprinted ed.). Chichester, UK:

of the cosmos if the cosmological principle is correct?¹²³ According to the Copernican principle, human beings do not occupy a privileged or central position in the universe, meaning our observations from Earth are representative of those that could be made from any average location. In astronomy, the phrase refers to the transition from geocentrism to heliocentrism.¹²⁴ Simple question is, do the cosmological observations from the Earth represent the observations from the other positions in the universe according to the Copernican principle?¹²⁵

Dark matter is some kind of substance that has gravity and that holds galaxies together. It's true that, yet cannot be directly seen with any instrument yet created.¹²⁶ Scientists are still actively investigating exactly what dark matter is, but it is almost certainly not made of the atoms and particles that make up ordinary matter. Simple question is, how scientists use the bending of light and galaxy rotation speeds to map out dark matter's gravitational effects across the universe?¹²⁷ What is the identity of dark matter, and what is it made of? Is dark matter made of particles? If so, is it a WIMP, an axion, a lightest superpartner (LSP), or something else? Or is it some other form of matter, not an extension of gravity, that is causing the phenomena attributed to dark matter?¹²⁸ The accelerated expansion of the cosmos is the observed phenomenon. In the universe is expanding at an increasingly faster rate, driven by a mysterious force known as dark energy. Discovered in 1998 through distant Type Ia supernova observations, this realization fundamentally changed modern cosmology and received the 2011 Nobel Prize in Physics.¹²⁹ What drives the observed accelerated expansion of the cosmos (the de Sitter phase)? Are the measurements of the

accelerated expansion of the universe correctly interpreted, or do they indicate that the cosmological principle is false?¹³⁰ Why is it that the energy density of the dark energy component is of the same order as the density of matter today, although the two change somewhat differently with time? Could this observation be an accident of timing? Is dark energy a pure cosmic constant, or do concepts of quintessence, such as phantom energy, apply? Can early dark energy theories solve the Hubble tension?¹³¹

The great works of Burbidge, Burbidge, Fowler and Hoyle and separately A. G. W. Cameron in 1957 showed how the majority of naturally occurring nuclides beyond the element iron can be made in two kinds of neutron capture processes, the s- and the r-process.^{132,133} And some neutron-deficient nuclides found in nature are not reached in these processes and therefore at least one additional process is required to synthesize them and those are known as p-nuclei. Question is what is the astrophysical process responsible for the nucleogenesis of these rare isotopes?¹³⁴ Fast Radio Bursts (FRBs) are millisecond-long, hyper-energetic radio pulses originating from distant galaxies. The leading theory attributes them to magnetars. As FRB signals travel billions of light-years, passing through dense intergalactic plasma, scientists can use their fleeting dispersion and Faraday rotation to map invisible cosmic matter.^{135,136} Now questions arises as what creates these short-lived radio pulses from faraway galaxies that endure only a few milliseconds? Why do some FRBs reoccur on unpredictable timescales, yet so many others do not? A number of models have been suggested, but no one idea has gained universal acceptance.¹³⁷ Again, the Ultra-high-energy cosmic rays

Praxis Publ. p. 61, ISBN 978-3-540-32924-4, accessed on 29 May 2026

¹²³ Krishnan, Chethan; Mohayaee, Roya; Colgáin, Eoin Ó; Sheikh-Jabbari, M. M.; Yin, Lu (16 September 2021). "Does Hubble Tension Signal a Breakdown in FLRW Cosmology?". *Classical and Quantum Gravity*. 38 (18): 184001, doi:10.1088/1361-6382/ac1a81, accessed on 29 May 2026

¹²⁴ Saliba, George (December 1979). "The First Non-Ptolemaic Astronomy at the Maragha School". *Isis*. 70 (4): 571–576. doi:10.1086/352341, accessed on 29 May 2026

¹²⁵ Colin, Jacques; Mohayaee, Roya; Rameez, Mohamed; Sarkar, Subir (20 November 2019). "Evidence for anisotropy of cosmic acceleration". *Astronomy and Astrophysics*. 631: L13, doi:10.1051/0004-6361/201936373, accessed on 29 May 2026

¹²⁶ <https://news.uchicago.edu/explainer/dark-matter-explained>, accessed on 29 May 2026

¹²⁷ https://www.reddit.com/r/cosmology/comments/1c2mmlp/what_exactly_is_dark_energy_and_dark_matter/, accessed on 29 May 2026

¹²⁸ Brooks, Michael (March 19, 2005). "13 Things That Do Not Make Sense". *New Scientist*. Issue 2491, accessed on 29 May 2026

¹²⁹ <https://science.nasa.gov/dark-energy/>, accessed on 17 Jun 2026

¹³⁰ Ellis, G. F. R. (2009). "Dark energy and inhomogeneity". *Journal of Physics: Conference Series*. 189 (1)

012011. Bibcode:2009JPhCS.189a2011E. doi:10.1088/1742-6596/189/1/012011, accessed on 07 Jun 2026

¹³¹ Poulin, Vivian; Smith, Tristan L.; Karwal, Tanvi; Kamionkowski, Marc (2019-06-04). "Early Dark Energy can Resolve the Hubble Tension". *Physical Review Letters*. 122 (22), accessed on 07 Jun 2026 221301, doi:10.1103/PhysRevLett.122.221301, accessed on 26 Jun 2026

¹³² E. M. Burbidge; G. R. Burbidge; W. A. Fowler; Fred Hoyle, (1957), "Synthesis of the Elements in Stars". *Reviews of Modern Physics*. 29 (4): 547–650. Bibcode:1957RvMP...29..547B. doi:10.1103/RevModPhys.29.547,

¹³³ Cameron, A. G. W., (1957), "Nuclear Reactions in Stars and Nucleogenesis". *Publications of the Astronomical Society of the Pacific*. 69 (408). IOP Publishing: 201–222. Bibcode:1957PASP...69..201C. doi:10.1086/127051,

¹³⁴ Protheroe, R.J.; Meyer, H. (2000). "An infrared background-TeV gamma-ray crisis?". *Physics Letters B*. 493 (1–2): 1–6, doi:10.1016/S0370-2693(00)01113-8, accessed on 17 May 2026

¹³⁵ <https://www.nature.com/articles/s41467-022-31923-y>, accessed on 17 May 2026

¹³⁶ https://ind.iitb.ac.in/new_theoretical%20_model_throws_light_on_mysterious_fast_radio_bursts, accessed on 17 May 2026

¹³⁷ Platts, E.; Weltman, A.; Walters, A.; Tendulkar, S.P.; Gordin, J.E.B.; Kandhai, S. (2019). "A living theory catalogue for fast radio bursts". *Physics Reports*. 821: 1–27. arXiv:1810.05836. Bibcode:2019PhR...821....1P. doi:10.1016/j.physrep.2019.06.003, accessed on 17 May 2026

(UHECRs), like the 1991 "Oh-My-God" particle and the 2023 "Amaterasu" particle and those exceed the "Greisen–Zatsepin–Kuzmin cutoff" (GZK) limit.¹³⁸ They are likely accelerated through massive cosmic shock waves (Fermi acceleration) in extreme environments like Active Galactic Nuclei (AGN), Gamma-Ray Bursts (GRBs), or potentially via exotic. Again, the GZK limit states that cosmic ray protons traveling over intergalactic distances will interact with the Cosmic Microwave Background (CMB) radiation.^{139, 140} The question related to oh-my-God particle and other ultra-high-energy cosmic rays is what scientific processes can accelerate cosmic rays to energies above the GZK limit?¹⁴¹

According to Newtonian physics, stars in the outer edges of galaxies should rotate much slower than those in the dense center. But, Vera Rubin in the 1970s has shown that rotational speeds remain constant or flat regardless of distance from the center. So, the galaxy rotation problem is a major discrepancy between the predicted and observed orbital velocities of stars and gas in spiral galaxies.¹⁴² The rotation curve of a disc galaxy is a plot of the orbital speeds of visible stars or gas in that galaxy versus their radial distance from that galaxy's centre.¹⁴³ Now the question is, does dark matter (alone) explain the disparity between the expected and observed speed of stars around the center of galaxies? Age–metallicity relation in the Galactic disk Is there a universal age–metallicity relation (AMR) in the Galactic disk (both the "thin" and "thick" regions of the disk)? There is no sign of a strong AMR in the local (rather narrow) disk of the Milky Way. We have investigated the possible existence of an age-metallicity connection in the galactic thick disk using a sample of 229 nearby "thick" disk stars and found evidence for the presence of an age-metallicity relation in the thick

disk.^{144, 145} Ages of stars derived from asteroseismology do not show a robust age–metallicity link in the galactic disk.¹⁴⁶ Spacetime torsion is a geometric twisting; are the fundamental particles with intrinsic spin act as sources of torsional distortion. Extended theories of gravity, like Gauge Theory Gravity and Einstein-Cartan theory, link this quantum spin to macroscopic or quantum fluctuations, generating phenomena in advanced physics.¹⁴⁷ Question is, in Quantum effects, torsion, or other phenomena; do they make general relativity break down in the interior of a black hole? What is inside a black hole? Do black holes have a structure? If so, how can one investigate the internal structure?

Ultra luminous X-ray Sources (ULXs) are cosmic objects that emit immense amounts of X-rays (up to 10 million times more energy than the Sun). They shine so brightly that they regularly exceed the Eddington limit, a physical threshold for stellar mass, implying they are powered by extreme, super-critical accretion onto neutron stars or black holes.¹⁴⁸ Questions are, what powers X-ray sources that are not related to active galactic nuclei but are more luminous than the Eddington limit of a neutron star or stellar black hole? Are they driven by intermediate-mass black holes? Some ULXs show periodicity, indicating non-isotropic emission of a neutron star. Is this true for all ULXs? How may such a system be formed and stable?¹⁴⁹ Again, the infrared/TeV crisis: No attenuation of very high-energy gamma radiation from extragalactic sources.¹⁵⁰ It refers to an astronomical puzzle where very high-energy gamma rays from distant extragalactic sources were observed to arrive with less attenuation than predicted. Astronomers and astrophysicists have largely resolved the crisis through a combination of refined observations and

¹³⁸ Cho, Adrian (2014). "Physicists spot potential source of 'Oh-My-God' particles". *Science*, 8 July 2014, doi:10.1126/article.22871 (inactive 12 July 2025). eISSN 1095-9203. ISSN 0036-8075, accessed on 17 May 2026

¹³⁹ Sokolsky, (2010). "Final Results from the High-Resolution Fly's Eye (HiRes) Experiment". *Nuclear Physics B: Proceedings Supplements*, 212–213: 74–78, doi: 10.1016/j.nuclphysbps.2011.03.010, accessed on 17 May 2026

¹⁴⁰ <https://www.quantamagazine.org/the-particle-that-broke-a-cosmic-speed-limit-20150514/>, accessed on 17 May 2026

¹⁴¹ Wolchover, Natalie (2015-05-14). "The Particle That Broke a Cosmic Speed Limit". *Quanta Magazine*, accessed on 17 May 2026

¹⁴² Hammond, Richard (May 1, 2008). *The Unknown Universe: The Origin of the Universe, Quantum Gravity, Wormholes, and Other Things Science Still Can't Explain*. Franklin Lakes, NJ: Career Press, accessed on 17 May 2026

¹⁴³ Wechsler, Risa H.; Tinker, Jeremy L., (2018), *The Connection Between Galaxies and Their Dark Matter Halos*, *Annual Review of Astronomy and Astrophysics*. 56 (1): 435–487, doi:10.1146/annurev-astro-081817-051756. ISSN 0066-4146, 2018-09-14, accessed on 17 May 2026

¹⁴⁴ Casagrande, L.; Schönrich, R.; Asplund, M.; Cassisi, S.; Ramírez, I.; Meléndez, J.; Bensby, T.; Feltzing, S. (2011). "New constraints on the chemical evolution of the solar neighbourhood and Galactic disc(s)". *Astronomy & Astrophysics*. 530:

A138. arXiv:1103.4651. Bibcode:2011A&A...530A.138C. doi:10.1051/0004-6361/201016276, accessed on 17 May 2026

¹⁴⁵ Bensby, T.; Feltzing, S.; Lundström, I. (July 2004). "A possible age-metallicity relation in the Galactic thick disk?". *Astronomy and Astrophysics*. 421 (3): 969–976. arXiv:astro-ph/0403591. Bibcode:2004A&A...421..969B. doi:10.1051/0004-6361:20035957, accessed on 22 May 2026

¹⁴⁶ Casagrande, L.; Silva Aguirre, V.; Schlesinger, K. J.; Stello, D.; Huber, D.; Serenelli, A. M.; Scho Nrich, R.; Cassisi, S.; Pietrinferni, A.; Hodgkin, S.; Milone, A. P.; Feltzing, S.; Asplund, M. (2015). "Measuring the vertical age structure of the Galactic disc using asteroseismology and SAGA". *Monthly Notices of the Royal Astronomical Society*. 455 (1): 987–1007. arXiv:1510.01376, doi:10.1093/mnras/stv2320, accessed on 22 May 2026

¹⁴⁷ <https://www.mdpi.com/2073-8994/18/3/525>, <https://www.mdpi.com/2073-8994/18/3/525>, accessed on 22 May 2026

¹⁴⁸ <https://www.jpl.nasa.gov/news/nasa-study-helps-explain-limit-breaking-ultra-luminous-x-ray-sources/>,

¹⁴⁹ Aharonian, Felix A (2004). *Very High Energy Cosmic Gamma Radiation: A Crucial Window On The Extreme Universe*. World Scientific Publishing Co. p. 432. ISBN 981-02-4573-4, accessed on 22 May 2026

¹⁵⁰ <https://www.sciencedirect.com/science/article/abs/pii/S0370269300011138>, accessed on 22 May 2026

revised theoretical modeling.¹⁵¹ The universe appeared unexpectedly transparent to these energetic photons, challenging standard models of the Extragalactic Background Light (EBL). What are small red spots?¹⁵²

Quasars are the intensely bright, active cores of distant galaxies, powered by supermassive black holes growing at extraordinary rates. These black holes grow by devouring colossal amounts of surrounding gas, dust, and stars, which swirl into a massive, superheated accretion disk before falling into the black hole.¹⁵³ Most distant quasars (at redshifts >6 to 7), seen within 700 million to 1 billion years of the Big Bang) grow their supermassive black holes through super-Eddington accretion and the rapid accretion of cold, dense primordial gas streams.¹⁵⁴ How do the most distant quasars grow their supermassive black holes? or early in the history of the universe? black holes emit a faint thermal radiation and which known as Hawking radiation. Theoretical physicist Stephen Hawking in 1974 has proposed this phenomenon and that has a direct consequence of the intersection between quantum mechanics and general relativity.¹⁵⁵ Now the question is, do black holes radiate thermal radiation as theory predicts? If black holes can melt away, what happens to the information they contain? This seems to be a problem because annihilation of information is forbidden by the unitarity of quantum mechanics. Does the radiation eventually cease for black hole remnants?¹⁵⁶ The M–sigma relation is an empirical correlation between supermassive black hole mass (M) and stellar velocity dispersion sigma in galactic bulges. It was discovered independently by two research teams in the year 2000 by Ferrarese and Merritt and Gebhardt.¹⁵⁷ What is the genesis of the M–

sigma link between supermassive black hole mass and galaxy velocity dispersion?¹⁵⁸

Supermassive black holes seem to have coalesced, and one pair of these intermediate masses has been seen at PKS 1302–102.¹⁵⁹ But theory predicts that supermassive black holes separated by around a parsec can take billions of years to get near enough to combine—longer than the lifetime of the universe.¹⁶⁰ Now, many mysterious questions have arisen. Is the cosmic censorship hypothesis true? Is naked singularity possible?¹⁶¹ Is the universe homogeneous and isotropic at sufficiently large scales as claimed by the cosmological principle and assumed by all the models using the Friedmann–Lemaître–Robertson–Walker (FLRW) metric, including the current version of the Lambda cold dark matter (Λ CDM) model, or inhomogeneous or anisotropic?^{162,163} Is the CMB dipole purely kinematic, or does it indicate anisotropy of the universe resulting in the breakdown of the FLRW metric and the cosmological principle? The accelerating expansion of the universe is an observationally confirmed phenomenon, but its underlying cause or dark energy is one of the biggest mysteries in physics. It does not directly prove the cosmological principle false, but it has prompted researchers to rigorously test and occasionally challenge it.¹⁶⁴ Now the question is, are the observations seen as the speeding expansion of the universe accurately understood, or are they rather proof that the cosmological principle is false?¹⁶⁵

We know that, Jean-Pierre Luminet's 2003 model of the Poincaré dodecahedral space (PDS) explain a finite, positively curved, and "wrap-around" 3-manifold—beautifully explained early cosmic microwave

¹⁵¹ <https://arxiv.org/abs/astro-ph/0406565>, accessed on 22 May 2026

¹⁵² Troitsky, Sergey (2021). "The local-filament pattern in the anomalous transparency of the Universe for energetic gamma rays". *The European Physical Journal C*. 81 (3), accessed on 22 May 2026
264. arXiv:2004.08321. Bibcode:2021EPJC...81.264T. doi:10.1140/epjc/s10052-021-09051-6, accessed on 22 May 2026

¹⁵³ <https://news.arizona.edu/news/cosmic-predators-how-supermassive-black-holes-slow-star-growth-nearby-galaxies>, accessed on 22 May 2026

¹⁵⁴ <https://www.space.com/astronomy/black-holes/could-the-secret-to-black-hole-formation-be-locked-away-in-this-record-breaking-ancient-quasar?> accessed on 22 May 2026

¹⁵⁵ https://www.researchgate.net/post/Hawking_Radiation_Chemistry2, accessed on 22 May 2026

¹⁵⁶ Ouellette, Jennifer (21 December 2012). "Black Hole Firewalls Confound Theoretical Physicists". *Scientific American*. Archived from the original on 9 November 2013. Retrieved 29 October 2013. Originally published Archived 3 June 2014, accessed on 22 May 2026

¹⁵⁷ Savorgnan, Giulia A. D.; Graham, Alistair W. (2015), Overmassive black holes in the MBH– σ diagram do not belong to over (dry) merged galaxies, accessed on 22 May 2026

¹⁵⁸ Ferrarese, Laura; Merritt, David (2000). "A Fundamental Relation between Supermassive Black Holes and their Host Galaxies". *The Astrophysical Journal*. 539 (1): L9–L12, doi:10.1086/312838, accessed on 22 May 2026

¹⁵⁹ D'Orazio, Daniel J.; Haiman, Zoltán; Schiminovich, David (17 September 2015). "Relativistic boost as the cause of periodicity in a massive black-hole binary

candidate". *Nature*. 525 (7569): 351–

353, doi:10.1038/nature15262, accessed on 22 May 2026

¹⁶⁰ Milosavljević, Miloš; Merritt, David (October 2003). "The Final Parsec Problem" (PDF). *AIP Conference Proceedings*. 686 (1). American Institute of Physics: 201–210, doi:10.1063/1.1629432, accessed on 27 May 2026

¹⁶¹ Abdalla, Elcio; Abellán, Guillermo Franco; Aboubrahim, Armin (11 Mar 2022), "Cosmology Intertwined: A Review of the Particle Physics, Astrophysics, and Cosmology Associated with the Cosmological Tensions and Anomalies", *Journal of High Energy Astrophysics*, 34: 49, arXiv:2203.06142v1, Bibcode:2022JHEAp...34...49A, doi:10.1016/j.jheap.2022.04.002, accessed on 27 May 2026

¹⁶² Abdalla, Elcio; Abellán, Guillermo Franco; Aboubrahim, Armin (11 Mar 2022), "Cosmology Intertwined: A Review of the Particle Physics, Astrophysics, and Cosmology Associated with the Cosmological Tensions and Anomalies", *Journal of High Energy Astrophysics*, 34: 49, doi:10.1016/j.jheap.2022.04.002, accessed on 29 May 2026

¹⁶³ Migkas, K.; Schellenberger, G.; Reiprich, T. H.; Pacaud, F.; Ramos-Ceja, M. E.; Lovisari, L. (8 April 2020). "Probing cosmic isotropy with a new X-ray galaxy cluster sample through the LX-T scaling relation". *Astronomy & Astrophysics*. 636 (April 2020): 42, doi:10.1051/0004-6361/201936602, accessed on 21 Jul 2026

¹⁶⁴ <https://www.skyatnightmagazine.com/news/the-universe-is-still-expanding-science-study>, accessed on 29 May 2026

¹⁶⁵ Ellis, G. F. R. (2009). "Dark energy and inhomogeneity". *Journal of Physics: Conference Series*. 189 (1) 012011. Bibcode:2009JPhCS.189a2011E. doi:10.1088/1742-6596/189/1/012011, accessed on 29 May 2026

background (CMB) anomalies, modern Planck satellite observations found no definitive evidence for such a repeating topology. We do not know the curvature or the topology, but we do know that the curvature is "close" to zero on observable scales.¹⁶⁶ The theory of cosmic inflation argues that the form of the universe could be unmeasurable. The shape of the cosmos has been proposed by Jean-Pierre Luminet et al. and others since 2003; it may be the Poincaré dodecahedral space. The Poincaré space or another 3-manifold? Thurston's geometrization conjecture in mathematics states that each of certain three-dimensional topological spaces has a unique geometric structure that can be associated with it. The 3-manifold of comoving space represents the "shape of the universe" at a single moment in cosmological time. It is a 3-dimensional spatial slice of the 4-dimensional expanding spacetime, where observers share the same cosmological time and are at rest relative to the cosmic microwave background.¹⁶⁷ What is the 3-manifold of comoving space, i.e., of a comoving spatial segment of the universe, informally called the shape of the universe? As we know that, inflaton is a hypothetical quantum scalar field theorized to have driven cosmic inflation, causing the early universe to expand exponentially.¹⁶⁸ Is the shape unmeasurable? Is the notion of cosmic inflation in the very early cosmos, right? If so, what are the particulars of this epoch? What is the hypothesized scalar field, the inflaton, that caused this cosmic inflation? If there was inflation at one point, does it continue by inflating quantum-mechanical fluctuations and thus continue somewhere very far away?¹⁶⁹

Given that the distant universe appears so homogeneous, why does the Big Bang hypothesis apparently predict more detectable anisotropies of the night sky than we actually observe?¹⁷⁰ The accepted explanation is that of cosmological inflation. Are there better theories? One example is the hypothesis of a changeable speed of light?¹⁷¹ Contemporary precision cosmology faces an escalating crisis: the Hubble constant measured from the early universe. The Lambda-CDM, Lambda cold dark matter, or Λ CDM model is a mathematical model of the Big Bang theory with three major components: a cosmological constant, denoted by λ (Λ), associated with dark energy; the

postulated cold dark matter (CDM); and ordinary matter.¹⁷² Now the question is, if Λ CDM is right, why aren't there converging observations of the Hubble constant?¹⁷³ There are some big features in the microwave sky at distances over 13 billion light-years that seem to be aligned with both the speed and orientation of the solar system. Is this a consequence of systematic flaws in the processing, contamination of data by local influences, or an inexplicable breach of the Copernican principle? Why is there something? Origin and fate of the universe: Where did the prerequisites for anything to exist come from? We can only observe a fraction of the cosmos, and roughly 95% of the universe consists of mysterious dark matter and dark energy, vast realms of physics and celestial mechanics remain completely undiscovered. Regarding the end of the universe, astrophysicists have several leading theories.¹⁷⁴ Could there be an unlimited number of unknown astronomical phenomena existing in our entire universe? Will the universe end in a Big Freeze, Big Rip, Big Crunch, or Big Bounce, or will it be part of an indefinitely recurring cyclic model?

The multiverse idea has arisen in many versions. "The primarily in cosmology, quantum mechanics, and philosophy, and often asserts the actual physical existence of different potential configurations or histories of the known observable universe. The term *multiverse* was coined by American philosopher William James in 1895 to refer to the confusing moral meaning of natural phenomena and not to other possible universes."¹⁷⁵ Now the questions are, does a multiverse exist, and does it matter? Can we experimentally evaluate these concepts, or are they doomed to be pseudoscience forever? Are such philosophical concerns translatable in the language of cosmology, astronomy, physics, or any other scientific discipline? Are paradigmatic methods like the anthropic principle necessary in order to answer unsolved difficulties like the cosmological constant problem? Are there additional living forms in the universe? Extraterrestrial life, or alien life is life that originates from another world rather than on Earth. No extraterrestrial life has yet been detected. Such life might range from simple forms such as microbes to intelligent beings, possibly bringing forth civilizations that might be far more, or far less, advanced than

¹⁶⁶ https://www.researchgate.net/publication/366925585_Poincare_Dodecahedral_Space_Solution_of_The_Shape_of_The_Universe, accessed on 09 Jun 2026

¹⁶⁷ Fintushel, Ronald (1976), "Local S^1 actions on 3-manifolds". *Pacific Journal of Mathematics*. 66 (1): 111–118. doi:10.2140/pjm.1976.66.111, accessed on 09 Jun 2026

¹⁶⁸ https://webhome.phy.duke.edu/~mkruse/PHY105_S11/projects/Andrew_Schwert_Ph105_project.pdf, accessed on 07 Jun 2026

¹⁶⁹ Podolsky, Dmitry. "Top ten open problems in physics". NEQNET. Archived from the original on 22 October 2012, accessed on 11 Jun 2026

¹⁷⁰ Navas, S.; Amsler, C.; Gutsche, T.; Hanhart, C.; Hernández-Rey, J. J.; Lourenço, C.; Masoni, A.; Mikhasenko, M.; Mitchell, R. E.; Patrignani, C.; Schwanda, C.; Spanier, S.; Venanzoni, G.; Yuan, C. Z.; Agashe, K. (2024-08-01). "Review of Particle Physics". *Physical Review*

D. 110 (3) 030001. doi:10.1103/PhysRevD.110.030001, accessed on 19 Jun 2026

¹⁷¹ Brooks, Michael (March 19, 2005). "13 Things That Do Not Make Sense". *New Scientist*. Issue 2491, accessed on 07 Jun 2026

¹⁷² Deruelle, Nathalie; Uzan, Jean-Philippe, (2018), de Forcrand-Millard, Patricia (ed.), *Relativity in Modern Physics* (1 ed.). Oxford University Press, doi:10.1093/oso/9780198786399.001.0001. ISBN 978-0-19-878639-9, 2018-08-30, accessed on 19 Jun 2026

¹⁷³ Wolchover, Natalie (2019). "Cosmologists Debate How Fast the Universe Is Expanding". *Quanta Magazine*, accessed on 09 Jun 2026

¹⁷⁴ <https://www.rmg.co.uk/stories/space-astronomy/how-will-universe-end>, accessed on 09 Jun 2026

¹⁷⁵ <https://www.britannica.com/science/multiverse>, accessed on 09 Jun 2026

humans.¹⁷⁶ The anthropic principle is not strictly necessary as a foundational physical law, but it is currently a leading framework for explaining the finely tuned value of the cosmological constant. Regarding extraterrestrial life, there is no confirmed evidence yet, though astrobiologists widely consider additional life forms highly probable given the billions of potentially habitable exoplanets. Now the specific questions are, is there other intelligent life? Is it possible that there are an endless number of alien genera in our universe?^{177,178} If yes, what is the explanation of the Fermi paradox?¹⁷⁹ Was this one-off event due to any extraterrestrial phenomenon? If so, where did it come from?¹⁸⁰

Distant Future of Consciousness in the Universe

Imagine a vision of the possible future of humanity, from our present existential vulnerabilities to the farthest reaches of cosmic evolution. It starts with "The Precipice," a period in which humanity is confronted with both catastrophic perils and unprecedented potential for progress. It considers long-term earth habitability, the need to migrate interstellar and the possibility of colonizing the Milky Way. It delves at the possibilities of discovering extraterrestrial life and posits that there could be more advanced civilizations, but they remain undetected by us. This is a story that reaches back to deep time, including the fate of galaxies, the importance of life in the formation of the universe, and the philosophical concept that consciousness might be critical to the purpose of the universe. It ends with a few thoughts about transhumanism, the future of consciousness, and ethical models based on unity and compassion, and the importance of our choices today for the survival and thriving of sentient life.

Cosmic Reach. Toby Ord calls this epoch "The Precipice," a time when we have an extraordinary ability to destroy ourselves as a species, but also an unprecedented possibility for survival and cosmic expansion. The era we live in is full of existential risks: nuclear war, climate change, unaligned AI, mass extinction. But the probability of overcoming them is real, even with these hazards. It is important to note that the potential of mankind can be subdivided into physical potential (exploration and colonization of space) and mental potential (growth of consciousness and cognition). Scientifically speaking, the Earth is expected to be liable for another 500 million to a billion years, even accounting for natural cataclysms such as super-volcanic eruptions or asteroid strikes. These events, while catastrophic, are unlikely to permanently destroy sophisticated life on Earth. Ultimately our star, the Sun, will be the main existential threat. As it becomes older and brighter, it will make Earth uninhabitable by evaporating water and upsetting the conditions needed to

support life. However, it is possible that evolved civilizations may offset or postpone this by technological means, for example by shielding some of the solar radiation with space-based solar collectors, or by large-scale collection of solar energy, perhaps extending the habitability of Earth for a billion years or more.

Eventually, the Sun becomes a red giant, extending past the orbit of Earth, then dying and rendering Earth uninhabitable. The survival of humanity will depend on migration to other star systems, with Alpha Centauri, our nearest stellar neighbor, approximately four light years away, being a prominent choice. The detection of Proxima B, an Earth-mass rocky planet in the habitable zone of Proxima Centauri, provides a concrete goal for future interstellar colonization. Interstellar travel is a huge technical problem, but there is no known science that rules out this kind of travel over the time scales required (millions of years, or even numerous attempts). If mankind accomplishes such interplanetary travel, it might spread life and civilization to many star systems greatly reducing its risk of destruction from local natural or cosmic catastrophes. Within our local neighborhood of stars, about 15 million of them within an average interstellar distance of about six light years, the colonization of the whole Milky Way begins to look plausible. If we could travel at one percent of lightspeed and be patient enough for people to get settled, we could colonize the whole galaxy in 100 million years, which is a brief moment compared to the geological age of Earth. The stars of the Milky Way and other future stars are an almost limitless supply of energy and opportunity, underscoring the cosmic significance of the present moment of humanity as the birth of history and knowledge on a cosmic scale.

Life After Earth. Discovering life elsewhere in the universe would fundamentally affect how humans think about their role in the universe. If even one case of extraterrestrial life were established, then the age of the universe (more than 14 billion years) and its abundance of the elements needed for life would suggest that life is common. The Fermi Paradox, the seeming contradiction between the high probability of extraterrestrial civilizations and the absence of measurable proof, underscores the enigma of our seemingly solitary existence. One explanation for this contradiction is that we haven't looked hard enough; we've only looked at a few thousand star systems, which is like sampling a single glass of water from the entire ocean. Another theory is that sophisticated civilizations have progressed beyond detectable physical forms or EM signals. Future intelligence, as the physicist Michio Kaku suggests, might encode consciousness as pure information transferred by light, "laser porting" that can be sent across enormous distances and instantiated in remote avatars. Such information-based cognition would be undetectable by

¹⁷⁶ Davies, Paul, (2013), Are We Alone in the Universe? The New York Times, Archived from the original on 1 January 2022, accessed on 19 Jun 2026

¹⁷⁷ Sagan, Carl. "The Quest for Extraterrestrial Intelligence". Cosmic Search Magazine. Archived from the original on 18 August 2006, accessed on 07 Jun 2026

¹⁷⁸ Crowe, Michael J. (2008), The extraterrestrial life debate, antiquity to 1915: a sourcebook, Notre Dame, Ind: University

of Notre Dame, ISBN 978-0-268-02368-3, accessed on 09 Jun 2026

¹⁷⁹ "Rare Earth: Complex Life Elsewhere in the Universe?". Astrobiology Magazine. 15 July 2002. Archived from the original on 28 June 2011, accessed on 07 Jun 2026

¹⁸⁰ Kiger, Patrick J. (2012-06-21). "What is the Wow! signal?". National Geographic Channel. Archived from the original on March 13, 2015, accessed on 11 Jun 2026

conventional means, which would explain why the world seems so quiet. This concept further argues that there is a cosmic convergence point at which life transforms into beings of pure, transmitted light, therefore avoiding the dangers of transmitting organic entities through space. If we do make contact or communicate with alien intelligences, we should proceed with caution, yet it is conceivable that sophisticated civilizations might have certain shared cosmic values such as intelligence, benevolence, and compassion. Humanity's fate might be tied to this path towards higher forms of consciousness and connectedness.

Deep Time. Our nearest and biggest neighbor is Andromeda and the Local Group has some 50 galaxies including the Milky Way. Intergalactic travel is astronomically more difficult than interstellar travel but it's not impossible given humanity's history of overcoming seemingly unfathomable odds. Moreover, cosmic evolution might itself pave the way for eventual contact: gravity is pulling the Milky Way and Andromeda together into a collision some 4 billion years hence. There are no destroyed star systems but a bigger and more massive galaxy will be created. Eventually, in hundreds of billions of years, the Local Group will consolidate into a huge galaxy. However, the cosmic acceleration induced by dark energy implies that galaxies outside the Local Group will eventually leave the observable horizon and galaxy systems would be stranded in cosmic loneliness. Such cosmic isolation means a future of galactic loneliness, unless alternative cosmological models depict better ultimate cosmic fate (e.g. inevitable collapse or cyclical universes).

From the deep-time perspective, life and consciousness may one day actively shape the fate of the universe, in guiding or perhaps reshaping cosmic evolution itself. This is the view of thinkers such as Freeman Dyson and David Deutsch who conjecture that life may one day dominate matter and energy, obtain all knowledge and perhaps result in a universal awareness. Paul Davies goes one better, proposing a universal superintelligence where the mind and the cosmos are one, and life and consciousness are hardwired into the very fabric of the universe. This philosophy implies that the present moment in human history could be a precursor to the development of a cosmos that will eventually realize its own mental capacity through conscious beings.

Extra human. Transhumanism is the name for the movement in which the evolutionary trajectory of humanity eventually crosses with new technology that can radically change our physical bodies and mental capacities. It is conceivable that future generations will use technologies to boost intelligence, memory, compassion, concentration and imagination, despite resistance based on fear of losing the human essence or values. Such improvements promise to create totally new cultural forms, combining emotion and cognition in ways we have never seen before, opening up huge new territories of human experience, he points out. David Pearce imagines that enhanced consciousness could avoid pain altogether by engineering mental structures to maintain gradients of bliss. Pain could be replaced with subtle feelings of well-being and mental richness. This brings up important ethical and philosophical issues. Do we want to evolve beyond human nature or do

we want to keep humans the way they have always been? Consciousness as the vessel of all worth is far above what modern humans are living. There is this massive "possibility-space" of conscious states that is a huge frontier for future minds to explore. It is as large and as rich as the universe itself.

The Self Universal. Philosophical discussion has often questioned the traditional ideas about the individual self, arguing that the self is a phantom and that the only real continuity across experiences is awareness itself. This position, called Open Individualism, says that consciousness alone is the primary bearer of identity through time, no matter what physical substrate it has or how it evolves. To maintain consciousness through transformative stages, biological or artificial, is key for genuine worth and identity to persist. In this regard, advanced civilizations in their quest for progress and preservation of consciousness may arrive at universal ethical principles transcending the particularities of human culture. Such universals probably stress creativity, cooperation, compassion and knowledge. If consciousness is the basic metric of moral concern, then the more advanced entities might see others as extensions of themselves, and create a cosmic fraternity of minds sharing common values and aims. This moral convergence gives optimism that, as humans and other intelligent species spread out into space, the war, hatred and exploitation that have been the historic results of tribalism may eventually give way to cooperation and peace. David Pearce then argues that advanced civilizations may be on cosmic missions to reduce suffering throughout the cosmos, seeding life on new worlds in compassionate, non-Darwinian methods that decrease predation and suffering. This suggests that future biospheres may be very different in character from that of Earth.

Mysterious Universe and Wisdom from Holly Books

The last frontiers of human understanding are the unsolved mysteries of the universe. This is where physics as we know it fails us. 95% of the universe is dark, undiscovered dark matter (27%) and dark energy (68%). "Scientific breakthroughs are moving from pure theory to data-driven observation," said a report from 2026, hopeful that fundamental inconsistencies between gravity and quantum physics would soon be addressed. The Vera C. Rubin Observatory holds promise to produce the most detailed 3D map of the universe, hunting for the gravitational signals of dark matter. The DESI experiment in 2026 is giving us some interesting new clues that dark energy might be changing over time, and that "constant" concept might be challenged. Again, measurements of the expansion rate of the universe (Hubble constant) disagree, and suggest there is something lacking in the orthodox cosmological model. The Nancy Grace Roman Space Telescope, due in late 2026, and data from Euclid are expected to resolve this discrepancy by looking at billions of galaxies. Again, the general relativity (gravity) and the quantum mechanics (atoms) don't overlap, generating a big theoretical hole. Hopefully initiatives exploring black hole interiors and gravitational waves (via LIGO-Virgo-KAGRA) are looking for signs to reconcile these hy-

potheses. Now the scientists are puzzled how super-massive black holes could have developed so fast after the Big Bang. The James Webb Space Telescope (JWST) is hoped to keep finding ancient black holes, suggesting they expanded more faster than expected, perhaps by direct collapse. Then there are the deep-space radio bursts, strong flashes of radio waves lasting a millisecond or more. Hope that, New specialized telescopes are tracking these signals to magnetars and other high-energy events.

The Bible or Quran states, "God (a real being) created heaven (space) and earth (matter) in the beginning (time)." That is to say, time, space and matter were all created. Logically, there is another world/dimension. Einstein thought time and, consequently, space and matter were illusions, and he was right. And produced, in this planet, in which we dwell. Decomposing into atoms. It runs out. When we humans bake bread, the bread is real yet it's actually made up of flour and a few other elements. We can consume it, or leave it to waste. The point of bread is to be eaten. Thus, in this created dimension we humans too have a fundamental purpose from the Creator, God: Honor God and love your neighbor as yourself. Interestingly, near-death research has demonstrated that our human existence is not material but spiritual. Consciousness is spirit, and spirit is life beyond death with complete consciousness since spirit exists eternally and can see the other realm beyond matter. Realization does not depend on the human intellect. This is a prevalent medical misunderstanding and it is not verified. Consciousness depends on the brain. Once again, the Bible or Quran says "humans do not fight against flesh and blood, but against the powers of darkness, including demons and a fallen angel called Satan. The conflict is, therefore, not material, but completely spiritual. But that war has already been won. Satan and his demons are vanquished. However, In God's presence, believers find lasting fulfillment and joy. As expressed in Psalms 16:11 and 17:15, satisfaction is discovered when one's desire is to behold God's face and experience His presence. The prophet Isaiah also writes of being satisfied when seeking to honor God, as seen in Isaiah 58:11. Furthermore, Psalms 37:4 encourages delighting in the Lord, promising that He will give us the desires of our hearts, while Hebrews 13:5 reminds us that God has said, "Never will I leave you; never will I forsake you," providing a sense of security and contentment in Him. This satisfaction is rooted in a deep trust and relationship with God.¹⁸¹ We must slow down our never-ending pursuit of worldly things, unnecessary dissatisfaction and start now to increase the time we read, study, realize, learn, understand and think the Holy Books (like Bible and Quran) so that we can know the supreme power of Almighty God.¹⁸²

We are at a very critical point in time because our age is of tremendous cosmic importance. With tens of thousands of past generations behind us and potentially hundreds of millions ahead, what we do now bears an unusual amount of significance. We live in a time of

true cosmic vulnerability and possibility called "The Precipice." In "The Precipice", it could be ensured that consciousness itself will survive and thrive for an incomprehensively long period of time to come. We live in "The Precipice," – a rare and important period of time, when the decisions and actions of people have an unusual amount of significance. The future path of development of our civilization will either make our species extinct or create a flourishing civilization with intergalactic travel, exploration of consciousness, universal ethical systems based on the notion of sentience. It could lead to the galactic colonization of life forms, trans-humanity and compassion biospheres. Ultimately, the theme of the elevation and protection of consciousness emerges as the core of all future possibilities. Almighty God declared that, "In houses which Allah has permitted to be raised, and His name is celebrated therein. He is glorified therein, morning and evening. By men who neither trading nor commerce distracts them from Allah's remembrance, and from performing the prayers, and from giving alms. They fear a Day when hearts and sights are overturned. Allah will reward them according to the best of what they did, and He will increase them from His bounty. Allah provides for whomever He wills without reckoning. As for those who disbelieve, their works are like a mirage in a desert. The thirsty assumes it is to be water. Until, when he has reached it, he finds it to be nothing, but there he finds Allah, Who settles his account in full. Allah is swift in reckoning. Or like utter darkness in a vast ocean, cover by waves, above which are waves, above which is fog. Darkness upon darkness. If he brings out his hand, he will hardly see it. He to whom Allah has not granted a light has no light. Do you not realize that Allah is glorified by whatever is in the heavens and the earth, and even by the birds in formation? Each knows its prayer and its manner of praise. Allah knows well what they do. To Allah belongs the dominion of the heavens and the earth, and to Allah is the ultimate return." (The Holy Quran, verse: 24/37 to 42).¹⁸³ The time we live in is the time of instant satisfaction and instant gratification, once the reason rusts off the satisfaction becomes a gone story. Allah the one who creates knows the source of happiness and has revealed in His book of divinity.¹⁸⁴

Conclusion

Cosmologists wrestle with the search for elusive dark matter. It is invisible and accounts for around 27% of the cosmos, yet it does not absorb, reflect or emit light, making it very difficult to spot. One notion is of a 'Hidden Valley', a parallel universe of dark matter. Scientists have made a 3D map by using the Hubble telescope to follow how dark matter affects the things around it. The map of this enigmatic substance suggests, amazingly enough, that there may be something wrong with Einstein's theory of relativity, and a reconsideration is beginning. Dark Energy accounts for about 70% of the universe. Dark energy, on the other hand, is strong enough to rip the entire universe apart. Dark

¹⁸¹ <https://www.sermonindex.net/bible-topics/satisfaction-in-god/>, accessed on 29 Jun 2026

¹⁸² <https://rbclake.org/what-does-the-bible-say-about-satisfaction-in-christ/>, accessed on 29 Jun 2026

¹⁸³ <https://www.quranreading.com/blog/quran-is-the-way-to-get-satisfaction>, accessed on 11 Jun 2026

¹⁸⁴ <https://understandquran.com/the-only-way-to-feel-satisfied/>, accessed on 03 Jul 2026

matter appears to keep galaxies together. So, what is the origin of dark energy? Some say it's created from collisions between quantum particles, but nobody really knows. The greatest dark energy survey ever published, in May 2021, raised even more concerns about how the cosmos began a new period of accelerated expansion fueled by dark energy. Mysterious black holes are objects where stuff has been packed into a compact space causing a gravitational force so intense even light cannot get out making the black holes invisible. The smallest, scientists think, have the mass - the quantity of matter or 'stuff' in an item - of a massive mountain. Super-massive black holes have a combined mass of more than 1m suns. So, can a black hole destroy the Earth? NASA believes there is no black hole close enough to the solar system for Earth to fall into it – and besides, black holes don't walk around eating stars, moons and planets – not that we know of, anyway. While anomalies like the Wow! signal inspire the search for extraterrestrial technology, astronomy goes far beyond single-event mysteries. As the scientific study of the universe, it relies on systematic observation, data analysis, and the testing of physical laws to understand all celestial phenomena. Today, instead of just looking for signals, astronomers map the life cycles of stars, study dark matter, and track fast radio bursts (FRBs) to decode the physics of the universe. NASA says: 'Nearly all the spiral galaxies in our cosmos are shaped like cooked eggs. The egg yolk is a core of aged stars, with the egg white being a disk of stars around it. This Hubble image shows a galaxy that looks like it's falling off the frying pan.' However, the "egg white" is visibly distorted, making the central bulge appear as though it is sliding out of place. This galactic tug-of-war is taking place about 120 million light-years away from Earth in the constellation Cepheus. NASA wasn't done with the food metaphors: "Galaxies are not solid objects but tenuous agglomerations of tens of billions of stars. When two galaxies come close to each other they feel each other's gravity and are distorted, like pulling on cotton candy."

Human curiosity drives us to look beyond the known. Telescopes like the JWST and Hubble Space Telescope allow us to peer billions of light-years into deep space, revealing ancient galaxies and the secrets of the universe. In the few decades, astronomers and great cosmologist also discovered hundreds of free-floating worlds that challenge the definition of a planet, stars, galaxies, the long-sought God particle, Ripples in the fabric of spacetime, the sun's missing neutrinos, the

first real clue about the nature of black holes, dark matter, dark energy, and so on. The most quantum field theories effectively leave gravity out of the picture, because it's so weak when you get down to tiny stuff. But when particles are very close to each other, such as in the center of a black hole or in the Planck epoch of the universe (the time until one Planck time), it cannot be ignored, so we need a theory of how gravity works at the quantum scale before we can make predictions about what happens in those situations. Many will know the Big Bang theory that explains how the universe was born 14bn years ago. But what if it's not right? Even physicist Stephen Hawking, in his last publication published posthumously in 2018, reversed his earlier concept of countless multiple universes, predicting instead that the world is limited. Handbook of the Cosmic Revolutionary or How to Beat the Big Bang? by two astronomers since then? But even if the Big Bang theory is inaccurate, cosmologists have not come up with a better scientific explanation of how the universe was generated. But a quantum model of gravity might predict what happens within black holes and what might have happened at the beginnings of the Big Bang. When the JWST takes over from the Hubble Space Telescope in 2021, it will look for oxygen and other biosignatures that indicate life. Mathematical evidence points to a Neptune-sized Planet X lurking deep in the solar system in an orbit well beyond Pluto, say Caltech researchers. Planet X might be ten times as massive as the earth and might take 10,000 to 20,000 years to make one orbit of the Sun. But the universe of astronomy is full of secrets and problems that still challenge and inspire scientists and amateurs alike. From the elusive nature of dark matter and dark energy, to the mysterious origins of cosmic magnetic fields and Fast Radio Bursts, these unsolved challenges illustrate the breadth of our ignorance and the continuing quest for knowledge. But with improving observational tools and advancing theoretical models, future discoveries may provide answers to these important issues, enhancing our understanding of the universe and our place within it. In the search to understand these heavenly secrets, we not only celebrate our human curiosity, but also the infinite limits that remain to be explored and beyond. However, the infinite limits of space do more than test our technology and thinking process; they remind us of the boundless potential of human imagination and greatness of Almighty.

POLITICAL SCIENCES

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STRATEGIC PRIORITIES FOR ENSURING THE POLITICAL AND ECONOMIC SECURITY OF THE REPUBLIC OF AZERBAIJAN IN THE EMERGING GEOPOLITICAL ORDER

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Abstract

Relevance of the study. The contemporary international system is undergoing profound transformations driven by geopolitical competition, regional conflicts, economic fragmentation, technological change, and the restructuring of global supply chains. These processes have significantly altered the nature of national security, expanding its scope beyond traditional military concerns to include political stability, economic resilience, energy security, institutional effectiveness, and technological development. For strategically located states such as the Republic of Azerbaijan, ensuring political and economic security has become one of the principal conditions for sustainable development and long-term national resilience.

The purpose of the study. The study aims to develop an integrated strategic framework for ensuring the political and economic security of the Republic of Azerbaijan under conditions of evolving geopolitical competition and global uncertainty. The main objectives of the study include:

- examine modern theoretical approaches to political and economic security;
- identify the principal geopolitical and geo-economic risks affecting Azerbaijan;
- assess the role of energy diplomacy, transport connectivity, and institutional governance in strengthening national resilience;
- develop an integrated conceptual model for political and economic security;
- formulate strategic policy recommendations.

The article proposes an original conceptual framework - the Integrated Political and Economic Security Framework (IPESF) - which combines six mutually reinforcing dimensions: political stability, economic sustainability, energy security, transport and logistics security, institutional governance, digital and technological security. Unlike existing approaches, the framework demonstrates how these components interact as a unified national resilience system rather than functioning independently.

Results. The findings demonstrate that Azerbaijan's long-term political and economic security depends upon the successful integration of domestic reforms with a balanced foreign policy, diversification of the national economy, strengthening of institutional governance, development of strategic infrastructure, and enhancement of national resilience against external shocks. The proposed framework contributes to the theoretical understanding of political-economic security and offers practical recommendations for improving strategic governance under conditions of increasing global uncertainty.

Conclusions. The proposed framework expands the theoretical understanding of political-economic security and provides practical recommendations for strengthening Azerbaijan's strategic resilience in the South Caucasus.

Keywords: political security; economic security; national resilience; strategic governance; Azerbaijan; South Caucasus; geopolitical transformation; integrated security framework.

Introduction. The international system is currently experiencing profound structural transformation. Strategic rivalry among major powers, military conflicts, technological competition, and economic fragmentation have reshaped the global security environment and significantly increased uncertainty in international relations. Recent assessments of global economic development demonstrate that geopolitical fragmentation has become one of the principal long-term challenges affecting economic growth, investment, trade, and international cooperation [24].

The changing international environment has also transformed the concept of national security itself. Traditional realist approaches focused primarily on military power and territorial integrity, whereas contemporary security studies increasingly recognize political governance, economic resilience, institutional quality, technological capacity, and energy security as equally

important determinants of national resilience [3, p.5-17; 6, p.21-47].

Within this context, the Republic of Azerbaijan occupies a strategically significant position at the intersection of Europe and Asia. Its geographical location, participation in regional energy initiatives, development of international transport corridors, and active foreign policy have substantially strengthened its geopolitical importance. At the same time, these advantages expose the country to a broad spectrum of political, economic, and geo-economic risks that require an integrated strategic response.

Although political security and economic security are frequently analyzed independently within the academic literature, contemporary geopolitical developments demonstrate their increasing interdependence. Political instability undermines investment, institutional effectiveness, and economic confidence, whereas

economic vulnerability weakens governance capacity and strategic autonomy. Consequently, ensuring national security requires coordinated development across political, economic, institutional, technological, and infrastructural dimensions.

Despite growing scholarly interest in resilience and strategic governance, relatively limited attention has been devoted to the integrated relationship between political and economic security in the context of Azerbaijan. Existing studies usually focus on governance, energy policy, economic development, or regional security separately, while the interaction among these dimensions remains insufficiently explored.

The objective of this study is to identify the strategic priorities for strengthening the political and economic security of the Republic of Azerbaijan under conditions of geopolitical transformation and to develop an integrated analytical framework capable of supporting evidence-based policymaking.

The scientific novelty of the article lies in the development of the Integrated Political and Economic Security Framework (IPESF), which conceptualizes political governance, economic sustainability, institutional capacity, energy security, transport connectivity, and technological development as mutually reinforcing components of national resilience. Unlike sector-specific approaches, the proposed framework offers a systemic perspective on strategic security applicable to Azerbaijan's contemporary development.

Analysis of previous research and publications.

The contemporary understanding of political and economic security has undergone profound conceptual transformation during the last three decades. While traditional security studies primarily interpreted national security through the prism of military power and territorial integrity, contemporary scholarship increasingly recognizes that political stability, institutional effectiveness, economic resilience, technological development, energy security, and strategic connectivity constitute interconnected dimensions of national resilience. This conceptual evolution reflects the growing complexity of the international system, where geopolitical competition, technological disruption, economic fragmentation, and transnational risks increasingly transcend the boundaries of classical security theory.

One of the most influential contributions to contemporary security studies was made by Barry Buzan, Ole Wæver, and Jaap de Wilde, whose comprehensive security framework substantially broadened the analytical scope of security research. Their sectoral approach introduced military, political, economic, societal, and environmental dimensions of security, thereby moving beyond traditional realist interpretations of national survival (Buzan et al., 1998). Nevertheless, although this framework significantly expanded security studies, it primarily conceptualizes these sectors as parallel analytical categories rather than as dynamically interacting institutional systems. Consequently, the mechanisms through which political governance influences economic resilience remain comparatively underdeveloped within the Copenhagen School.

David Baldwin further contributed to the theoretical evolution of security studies by arguing that security should be understood as an analytical concept rather

than a fixed political category [3, p.17-26]. Baldwin emphasized that meaningful security analysis requires identifying the referent object, the nature of threats, acceptable levels of risk, and appropriate policy instruments. His conceptual clarification remains one of the most influential contributions to contemporary security theory. However, similar to many subsequent studies, Baldwin's framework primarily addresses conceptual issues without proposing mechanisms capable of integrating political governance and economic resilience within a unified strategic model.

Institutional theory provides another important perspective for understanding political and economic security. North argues that institutions establish the formal and informal rules governing political and economic interaction, thereby shaping long-term development trajectories. Building upon this foundation, Acemoglu and Robinson [1, p.40] demonstrate that inclusive political and economic institutions significantly enhance state legitimacy, economic performance, and adaptive capacity. Fukuyama [10, p.347-368] similarly emphasizes that governance effectiveness and state capacity constitute fundamental prerequisites for sustainable political stability. Collectively, these studies establish governance as one of the principal determinants of national resilience. Nevertheless, they devote comparatively limited attention to the interaction between institutional effectiveness and external geopolitical dynamics.

The concept of economic security has likewise evolved beyond traditional macroeconomic interpretations. Earlier approaches primarily concentrated on inflation, employment, fiscal stability, and trade balances. Contemporary scholarship increasingly incorporates innovation capacity, technological sovereignty, supply-chain resilience, energy diversification, digital transformation, and strategic infrastructure into the analytical framework of economic security [14, p.25-27; 16]. Recent reports published by the World Bank, the International Monetary Fund, and the World Economic Forum consistently identify geopolitical fragmentation, technological competition, cyber threats, and declining globalization as principal structural risks affecting sustainable economic development. These findings indicate that economic resilience should no longer be interpreted independently from political governance and institutional adaptability.

Recent scholarship concerning the South Caucasus has also undergone significant development. The region is increasingly analyzed as an emerging geopolitical crossroads linking Europe, Central Asia, and the Middle East through energy corridors, transport infrastructure, and digital connectivity. Azerbaijan occupies a particularly important position within this evolving architecture owing to its role in the Southern Gas Corridor, the Middle Corridor, and broader East-West connectivity initiatives. Existing studies by Cornell [8], Valiyev [20], Hasanov [11], and Huseynov [12] provide valuable insights into Azerbaijan's foreign policy, regional security environment, energy diplomacy, and strategic partnerships. Nevertheless, these studies predominantly examine individual policy sectors rather than proposing an integrated framework capable of ex-

plaining the interaction among political governance, institutional capacity, economic sustainability, transport connectivity, energy security, and technological modernization.

An additional limitation of the existing literature concerns the growing importance of national resilience. International organizations increasingly interpret resilience as the capacity of states to anticipate, absorb, adapt to, and recover from multidimensional crises while maintaining institutional effectiveness and long-term development. However, most resilience-oriented approaches remain primarily descriptive and rarely provide operational analytical models capable of integrating governance quality, economic sustainability, strategic infrastructure, and geopolitical adaptability into a coherent conceptual framework.

Consequently, despite considerable progress in contemporary security studies, several important theoretical and methodological gaps remain. First, political and economic security continue to be analyzed predominantly as separate research domains. Second, relatively limited attention has been devoted to the institutional mechanisms linking governance quality with long-term economic resilience. Third, the majority of studies concerning Azerbaijan focus on individual strategic sectors without developing integrated analytical models applicable to national security policymaking under conditions of geopolitical transformation.

The present research seeks to address these limitations through the development of the Integrated Political and Economic Security Framework (IPESF). Unlike existing approaches, the proposed framework conceptualizes political governance, institutional capacity, economic sustainability, energy security, transport connectivity, and technological development as mutually reinforcing components of a unified national resilience system. By integrating these strategic dimensions within a single analytical model, the study contributes both to contemporary security studies and to the development of evidence-based strategic policymaking for the Republic of Azerbaijan.

Contemporary approaches to political security.

The concept of political security has evolved considerably over the last several decades. Traditional approaches within realist theory associated political security primarily with state sovereignty, territorial integrity, and the preservation of constitutional order. In this perspective, the state remained the principal referent object of security, while military power constituted the primary instrument for ensuring survival in an anarchic international system [3; 21].

Following the end of the Cold War, the scope of security studies expanded significantly. Barry Buzan and the Copenhagen School argued that security should be understood as a multidimensional phenomenon incorporating military, political, economic, societal, and environmental sectors [7]. Their securitization theory demonstrated that many contemporary threats emerge not solely from objective conditions but also through political processes, institutional discourse, and strategic decision-making.

Recent scholarship further emphasizes that political security depends on the effectiveness of governance institutions, the rule of law, administrative capacity,

policy continuity, and public trust [10, p.347-368]. Accordingly, political security should be interpreted not merely as the absence of political instability but as the capacity of the state to maintain institutional effectiveness under changing domestic and international conditions.

Economic security as a strategic dimension of national security. Economic security has gradually become one of the core elements of national security policy. Earlier research focused primarily on macroeconomic stability, employment, inflation, and trade performance. Contemporary studies, however, recognize that economic security also includes technological competitiveness, innovation, financial stability, energy resilience, supply-chain security, and strategic infrastructure [16; 17].

Global developments during the last decade - including the COVID-19 pandemic, geopolitical tensions, sanctions, and disruptions in international logistics - have demonstrated that economic resilience is inseparable from national security. International organizations increasingly emphasize that diversified economies, effective institutions, and adaptive economic policies are better positioned to withstand external shocks [22; 23].

For Azerbaijan, economic security extends beyond macroeconomic performance. It encompasses export diversification, sustainable management of energy resources, transport connectivity, digital transformation, and investment in human capital. These factors collectively determine the country's capacity to maintain long-term development while reducing strategic vulnerabilities.

National resilience and integrated security. National resilience has emerged as one of the dominant concepts in contemporary security studies. Unlike traditional approaches centered on threat prevention, resilience-oriented frameworks focus on the capacity of states to anticipate, absorb, adapt to, and recover from crises.

According to the OECD [16; 17], resilient governance requires institutional flexibility, coordinated policymaking, strategic planning, and continuous learning. The World Economic Forum likewise identifies geopolitical fragmentation, technological disruption, cyber risks, and economic instability among the principal challenges requiring integrated governmental responses [24].

Consequently, resilience should be understood as a dynamic interaction between political institutions, economic systems, strategic infrastructure, technological capabilities, and societal adaptability rather than as the strength of any single sector.

Azerbaijan in the context of contemporary geopolitical transformation. The Republic of Azerbaijan occupies a unique position within the South Caucasus due to its strategic geography, energy resources, and role in regional connectivity initiatives. The country's participation in the Southern Gas Corridor, the Trans-Caspian International Transport Route (Middle Corridor), and broader Eurasian transport networks has increased its geopolitical significance.

International institutions have highlighted Azerbaijan's progress in infrastructure development,

transport connectivity, and regional cooperation while simultaneously emphasizing the importance of institutional reform, economic diversification, and innovation for ensuring long-term sustainable development.

At the same time, the evolving geopolitical environment creates new strategic challenges, including increased competition among major powers, technological dependence, cyber threats, energy market volatility, and changing trade patterns. These developments require an integrated approach to political and economic security that reflects the interconnected nature of contemporary risks.

Results. The analysis indicates that the political and economic security of the Republic of Azerbaijan should be interpreted as an integrated strategic system rather than as a combination of independent policy sectors. Contemporary geopolitical developments demonstrate that political stability, institutional quality, economic resilience, technological capability, energy security, and transport connectivity interact continuously, creating a multidimensional security environment in which changes within one component inevitably affect the performance of the others.

The Republic of Azerbaijan occupies a unique geopolitical position at the intersection of Europe and

Asia. This geographical location has significantly increased the country's strategic importance owing to its participation in regional energy projects, international transport corridors, and transcontinental logistics initiatives. Consequently, Azerbaijan's national security increasingly depends not only on traditional political and military factors but also on the effectiveness of economic governance, institutional adaptability, technological modernization, and international connectivity.

The research demonstrates that Azerbaijan's resilience is influenced by six mutually reinforcing strategic dimensions identified within the proposed Integrated Political and Economic Security Framework (IPESF): political governance, institutional capacity, economic sustainability, energy security, transport connectivity, and technological development. Unlike conventional sector-based approaches, the IPESF framework conceptualizes these dimensions as components of a single strategic architecture whose effectiveness depends on institutional coordination rather than isolated sectoral performance.

Strategic indicators of political and economic security. To operationalize the proposed framework, the study identifies six strategic dimensions that collectively determine the country's resilience.

Table 1. Integrated Strategic Dimensions of Political and Economic Security

Dimension	Strategic Function	Expected Contribution
Political Governance	Strategic decision-making and policy coordination	Political stability and institutional legitimacy
Institutional Capacity	• Effective public administration	Adaptive governance
Economic Sustainability	Diversification and macroeconomic stability	Long-term economic resilience
Energy Security	Secure production and export diversification	Strategic autonomy
Transport Connectivity	International logistics and trade facilitation	Regional competitiveness
Technological Development	Digital transformation and innovation	Institutional modernization

The analysis indicates that these dimensions should not be evaluated independently. Their effectiveness derives from institutional interaction, policy coherence, and strategic coordination across government sectors.

Comparative assessment of strategic priorities. Comparative analysis demonstrates that countries exhibiting higher levels of institutional coordination and diversified economic structures generally display greater resilience to geopolitical shocks.

Table 2. Comparative Strategic Priorities

Strategic Priority	Azerbaijan	Kazakhstan	Georgia	Singapore
Political Stability	High	High	Medium	Very High
Economic Diversification	Medium	Medium	Medium	Very High
Institutional Capacity	High	Medium	Medium	Very High
Energy Security	Very High	Very High	Low	Medium
Transport Connectivity	Very High	High	High	Very High
Digital Transformation	Medium	Medium	Medium	Very High

The comparison suggests that Azerbaijan possesses significant competitive advantages in transport connectivity and energy security while further progress is desirable in economic diversification, innovation capacity, and digital transformation.

Strategic Interaction Model

One of the principal findings of this study concerns the interaction between political governance and economic security.

Rather than operating independently, political decisions directly influence investment attractiveness, macroeconomic stability, institutional confidence, and international competitiveness. Likewise, sustainable economic development strengthens governance capacity, improves institutional legitimacy, and enhances strategic autonomy.

This reciprocal relationship forms the analytical foundation of the proposed Integrated Political and Economic Security Framework.

The findings support the research hypothesis that long-term political and economic security depends primarily on coordinated interaction among governance quality, institutional effectiveness, economic sustainability, technological modernization, transport connectivity, and energy security.

The study therefore rejects traditional sectoral interpretations of national security in favour of an integrated resilience-oriented approach.

Conclusion

The transformation of the contemporary international system has fundamentally changed the understanding of national security. Political stability, economic sustainability, institutional effectiveness, energy security, transport connectivity, and technological development have become interdependent components of a comprehensive national resilience system. Consequently, ensuring political and economic security requires an integrated strategic approach rather than isolated sectoral policies.

The analysis conducted in this study demonstrates that the Republic of Azerbaijan possesses significant strategic advantages resulting from its geopolitical position, energy potential, transport infrastructure, and balanced foreign policy. At the same time, increasing geopolitical competition, technological transformation,

economic fragmentation, and regional uncertainty require continuous adaptation of national security policy and strategic governance mechanisms.

The research confirms the central hypothesis that sustainable political and economic security depends primarily on the effectiveness of institutional coordination among key strategic sectors. Political governance, economic sustainability, energy security, transport connectivity, technological modernization, and institutional capacity should therefore be regarded as mutually reinforcing pillars of national resilience.

The principal scientific contribution of this research consists in the development of the Integrated Political and Economic Security Framework (IPESF). Unlike existing approaches that analyse political and economic security separately, the proposed framework conceptualizes them as components of a unified strategic system. The framework provides a theoretical basis for evaluating national resilience and identifying priority directions for strategic policymaking.

A further contribution of the study is the development of the Strategic Political-Economic Security Matrix (SPESM). This analytical instrument illustrates the interaction among the principal dimensions of national security and may serve as a conceptual basis for future comparative and empirical research concerning strategically located middle powers.

Based on the findings of the research, several strategic priorities for Azerbaijan can be identified.

First, institutional coordination among state authorities should be strengthened in order to improve strategic planning and policy implementation.

Second, economic diversification should remain a long-term priority aimed at reducing external vulnerabilities and increasing macroeconomic resilience.

Third, continued investment in transport infrastructure, logistics systems, customs modernization, and digital connectivity should be regarded as an integral component of national security policy.

Fourth, technological development, cybersecurity, and innovation policy should become increasingly integrated into the national security architecture.

Fifth, Azerbaijan should continue pursuing a balanced foreign policy that strengthens international partnerships while preserving strategic autonomy within an evolving geopolitical environment.

The findings of this study also have broader theoretical implications. The proposed integrated framework may be adapted for analyzing the political and economic security of other strategically located middle powers facing similar geopolitical conditions. Consequently, the research contributes not only to the study of Azerbaijan but also to the wider literature on national resilience, strategic governance, and contemporary security studies.

Future research should focus on developing a quantitative methodology for measuring the interaction among the six strategic dimensions identified within the IPESF framework. The construction of measurable composite indicators and comparative cross-country assessments would allow empirical validation of the proposed conceptual model and further strengthen its practical applicability.

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FROM MEGAWATTS TO MEGABITS: GEOPOLITICAL FISSURES AND ENERGY DETERMINANTS OF DIGITAL DIVIDE**Dr. Pavlova V.***Ch. Assist.*

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Sofia, Bulgaria***ОТ МЕГАВАТИ КЪМ МЕГАБИТИ: ГЕОПОЛИТИЧЕСКИ РАЗЛОМИ И ЕНЕРГИЙНИ ДЕТЕРМИНАНТИ НА ДИГИТАЛНОТО НЕРАВЕНСТВО****д-р Павлова В.***Гл. ас.*

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София, България*<https://doi.org/10.5281/zenodo.21411837>**Abstract**

While much of the developing world remains constrained by a vicious cycle wherein persistent energy deficits condemn entire regions to technological isolation, China fundamentally inverts this socio-economic paradigm. Through the strategic and large-scale deployment of renewable energy infrastructure and the subsequent provisioning of cost-effective, abundant electricity, Beijing establishes a foundation that extends far beyond a conventional industrial boom. This state of energy abundance functions as a primary catalyst for nationwide digital transformation. Specifically, it provides the immense generating capacity necessary to sustain millions of 5G base stations and hyperscale data centers even within the country's most geographically remote territories. The model expands into a global geoeconomic strategy through which China exports clean technologies and transforms emerging markets. Consequently, the People's Republic of China (PRC) is proposing a fundamental shift in the paradigm of global development policy: the mitigation of the digital divide does not merely initiate at the user interface, but is fundamentally rooted in the resilience, capacity, and sovereignty of the electrical grid.

Анотация

Докато голяма част от развиващия се свят остава ограничена от порочен кръг, в който постоянният енергиен дефицит обрича цели региони на технологична изолация, Китай фундаментално преобръща социално-икономическата парадигма. Чрез стратегическото и мащабно разгръщане на инфраструктура за възобновяема енергия и последващото осигуряване на рентабилно и изобилно електричество, Пекин създава основа, която надхвърля рамките на конвенционалния индустриален бум. Това състояние на енергийно изобилие функционира като основен катализатор за националната дигитална трансформация. По-конкретно, то осигурява колосалния генериращ капацитет, необходим за поддържането на милиони 5G базови станции и хипермащабни центрове за данни дори в най-географски отдалечените територии на страната. Моделът прераства в глобална геоикономическа стратегия, чрез която Китай изнася чисти технологии и трансформира нововъзникващите пазари. Китайската народна република (КНР) следователно предлага критична промяна в парадигмата на глобалната политика за развитие: преодоляването на дигиталното неравенство не започва просто от потребителския интерфейс, а се корени фундаментално в устойчивостта, капацитета и суверенитета на електрическата мрежа.

Keywords: Digital Divide, Energy Abundance, Infrastructure Development, Digital Economics, USA, China, Global South.

Ключови думи: Дигитално неравенство, енергийно изобилие, инфраструктурно развитие, дигитална икономика, САЩ, Китай, Глобален юг.

Introduction

In the contemporary global economy, the concepts of digitalization and artificial intelligence (AI) are frequently analyzed in the abstract, decoupled from their physical infrastructure determinants. The purpose of this study is to demonstrate that digital advancement is a direct function of energy grid capacity. The widespread deployment of Large Language Models (LLMs) and 5G networks necessitates the allocation of colossal

amounts of continuous base-load power. This material reality forces global economies into a critical cross-road: either execute centralized resource coordination or succumb to market-driven infrastructure chaos. The proposed text examines the profound divergence between the market-centric model of the West, which breeds resource deficits and social friction, and the state-directed model of China, which leverages energy

abundance as a structural lever to achieve digital equity on both a national and global scale.

1. The Flawed Market Model of the West: Energy Deficits and Structural Digital Isolation

The current paradigm of global digital transformation assigns a leading role to physical infrastructure within economic theory. Computing based on neural networks consumes massive amounts of baseline electricity; according to the International Energy Agency, global data center power consumption already exceeds 450 TWh annually [1]. In the West, this transition unfolds via a decentralized market model, where tech giants construct computational facilities without any strategic coordination with state energy plans – a process that generates severe localized asymmetries and “infrastructural cannibalism”.

The European Union (EU) is experiencing a profound structural crisis in its energy security, which directly paralyzes its digital sovereignty [2]. Under heavy geopolitical pressure from Washington, Brussels severed its decades-long supply agreements for cheap pipeline natural gas from the Russian Federation. The forced transition to highly volatile Liquefied Natural Gas (LNG) not only drives industrial electricity prices in the EU to levels twice as high as those in the United States and 50% higher than in China, but also subjects the Union to permanent energy insecurity due to the high risks accompanying the maritime transport of this gas (and hydrocarbons in general), as exemplified by disruptions such as the blockade of the Strait of Hormuz.

Due to a critical lack of transmission grid capacity, the lead time to connect a new data center to national grids in the five primary European hubs (Frankfurt, London, Amsterdam, Paris, Dublin) averages 7 years, reaching between 10 and 15 years in critical zones [3]. Over 40% of Europe’s distribution grids are outdated and amortized, yet required modernization investments through 2050 are estimated at €2.3 trillion [2]. This trend encapsulates digital capital within a few congested zones, condemning peripheral and lower-income regions in Eastern and Southern Europe to long-term digital isolation.

1.1. The United States: Infrastructural Cannibalism and Grid Capacity Collapse

The United States concentrates nearly 40% of global data center power consumption. Research by the Lawrence Berkeley National Laboratory indicates that by the end of the decade, computational facilities will engage up to 15% of the total electricity output of the country [4].

Unlike Chinese energy grids, American infrastructure proves incapable of sustaining the expansion of artificial intelligence. The largest electrical grid operator in America – PJM Interconnection (covering 13 states) – stands on the precipice of a systemic crisis. This gridlock stems from rapidly rising consumption driven by AI, juxtaposed against a stumbling power generation capacity, the cost of which is continuously escalating.

By 2030, PJM requires an additional 32 GW of capacity primarily due to the exponential growth of AI and data centers. Concurrently, older fossil-fuel generators are being retired significantly faster than they are being replaced, while compounding interconnection

delays block hundreds of shovel-ready clean energy projects across the region. The operator formally acknowledges the severity of this situation: “*Under extreme weather scenarios, PJM’s modeling shows that without intervention, parts of the grid could face intermittent blackouts*” [5].

Capacity costs within PJM have suffered a market shock valued at \$9.3 billion. These massive infrastructural expenses are passed directly to everyday consumers; average monthly residential utility bills rise by \$18 in Maryland and \$16 in Ohio. Digital expansion in the US is thus actively cannibalizing the living standards of its population.

The ecosystems of rapidly evolving generative AI, relying heavily on the operations of data processing centers, generate an average electricity demand equivalent to the consumption of 50,000 households per facility. As of March 2024, nearly 5.4 thousand data centers operate within the United States. In other nations, these numbers are dozens of times lower: 521 in Germany, 514 in the United Kingdom, 449 in China, and 297 in Russia. American leadership in the development of the data center industry is evident. However, the energy price of this leadership is startlingly high: 5.4 thousand data centers consume energy equivalent to the amount needed to sustain 270 million households [6].

1.2. Public Backlash, Resource Deficits, and Geopolitical Stagnation in AI

Instead of serving as an engine for socio-economic equity, digitalization in the West drains vital local resources, a process that triggers widespread public and social unrest. America’s water system is fragmented into roughly 50,000 community water systems, most of them tiny and underfunded.

Very small service areas may not have the finances to construct adequate storage, leaving them especially vulnerable to spikes. These small utilities are easy targets for well-funded tech giants that can hire lawyers and engineers to push through their demands. The current corporate reporting system hides the problem: data center operators report annual gallons across their entire fleet, not peak local usage.

Every major data center necessitates up to 5 million gallons of fresh water daily for cooling purposes [7]. But what happens when a town can’t supply enough water? Data centers switch to dry cooling – a method that uses 25–35% more electricity, shifting the crisis from the water system to the summer power grid. That’s a silent transfer of the burden that few people notice. Meanwhile, the tech companies avoid accountability by keeping their water consumption data opaque. Coordinated water-power planning is absent, and local officials are left to scramble [8].

Nearly 60% of new AI facilities in the United States are being constructed in drought-affected states, including Arizona, Texas, and Utah. In Arizona and Virginia, citizens are engaging in mass protests against AI infrastructure, which threatens domestic water supplies and triggers localized grid brownouts during summer heatwaves.

Political paralysis becomes inevitable as public resentment forces the political system to respond [9]. Over 54 official moratoriums are already active across

the United States, halting or delaying data center projects valued at a combined \$64 billion.

This combination of energy deficits, prolonged litigation, and civil resistance acts as a structural brake on the Western tech sector. While American corporations spend years fighting for megawatt allocations and water permits, their computational clusters lose velocity. This introduces a severe risk of an irreversible lag behind China in the AI revolution due to a lack of foundational physical infrastructure.

2. The Chinese Model: Digital Equity via State Energy Sovereignty and Global Expansion

The People's Republic of China demonstrates a fundamentally divergent strategy rooted in state-directed planning and energy sovereignty [10]. China establishes itself as a pivotal power with growing influence within the global artificial intelligence ecosystem. To achieve this, the country synthesizes state industrial policy – encompassing everything from infrastructure and data to model development and deployment – with private sector innovation and international cooperation. The Chinese approach differs significantly from that of the United States, with substantial efforts being directed toward overcoming the challenges posed by US-imposed export controls.

During a Politburo session in the spring of 2025, Xi Jinping called on China to “leverage its national potential” and take the initiative to “achieve supremacy in the field of artificial intelligence” [11]. This ambition drives the pursuit of technological autonomy and an effort to close the gap with American technologies by developing domestic alternatives, such as Huawei’s Ascend chips and AI frameworks like MindSpore and PaddlePaddle. These strategic objectives are further underpinned by massive investments in renewable energy (RES) designed to satisfy the future demands of Chinese AI infrastructure, given that achieving adequate levels of energy security fundamentally implies minimizing dependence on foreign energy sources. By expanding coal production, allocating resources for shale gas development, exploring offshore oil fields, and accelerating RES integration, China broadens its energy portfolio, thereby heavily neutralizing geopolitical risks, trade disputes, supply disruptions, and price volatility.

The unprecedented domestic capacity evolves into a large-scale geoeconomic strategy extending beyond the nation's borders. China transforms the energy leapfrog in emerging markets from a theoretical concept into a tangible reality. The colossal scale of Chinese manufacturing and the export of affordable clean technologies, combined with the transfer of implementation know-how, drive faster adoption across the Global South.

The structural shifts remain evident: in 2023, approximately one-quarter of emerging markets across Africa, Asia, and Latin America enjoy a higher degree of economy-wide electrification than the United States, while roughly 63% exhibit a higher share of solar power in their electricity generation mix [12, 46-47]. While the US grapples with grid inadequacy, Chinese technological and energy exports enable developing na-

tions to bypass traditional Western industrial stages, establishing resilient digital ecosystems in the developing world.

Domestically, Beijing enforces a centralized geographical redistribution of computational power. Through the “East Data, West Computing” initiative, the state redirects energy-intensive AI infrastructure toward resource-rich western provinces (Guizhou, Ningxia, Gansu, Inner Mongolia). These regions possess an abundance of clean energy and cheap land, while lower average temperatures minimize water requirements for server cooling, entirely eliminating the resource conflicts with households that paralyze the US.

The Chinese government’s large-scale and forward-looking policies have significantly reduced structural disparities and strengthened social cohesion. Digitalization in PRC does not exploit rural areas; instead, it becomes their primary economic pillar. Massive infrastructure investments in western provinces directly subsidize rural telecommunications. As of the first quarter of 2026, China possesses an unprecedented 4.958 million 5G base stations, achieving comprehensive network coverage across all administrative townships [13].

Through programs like the “Digital Village,” farmers and the elderly in remote mountainous regions access low-cost, high-speed internet. They utilize live-streaming e-commerce platforms to sell agricultural yields directly to national markets. Furthermore, “internet hospitals” and mobile educational platforms equalize the quality of healthcare and schooling between rural villages and megacities.

Conclusion

The proposed comparative analysis of the Western market-based model for managing energy and digital infrastructure and China’s state-led model provides a basis for drawing the following conclusions:

- Technological advancement in the era of artificial intelligence is a direct function of physical energy infrastructure. Digital development cannot occur in isolation from the capacity of the electrical grid; megawatts serve as the foundational prerequisite and a necessary condition for megabits.

- The market-centric approach in the US and the EU, where Big Tech conglomerates construct data centers without coordination with state energy plans, induces structural “infrastructural cannibalism.” This yields critical grid overloads, consumer impoverishment, resource deficits, energy and digital inequality, and intensifying social discontent.

- The resulting public friction, coupled with compounding administrative hurdles and energy gridlock, introduces an immediate and real risk of an irreversible technological lag of the West behind China in the global AI race.

- The Chinese paradigm demonstrates that state-directed planning and energy sovereignty successfully operationalize digitalization as an instrument for social cohesion. Through the “East Data, West Computing” initiative, environmental and resource conflicts are entirely bypassed, while economic yields are purposefully redirected toward rural poverty alleviation.

China actively redefines global development policy. Through the large-scale export of affordable clean

technologies and electrical expertise, the PRC enables emerging markets across the Global South to leapfrog traditional industrial steps and surpass advanced economies in economy-wide electrification and solar energy integration. This structural dynamic positions China as the primary architect of an emerging global digital and energy equity.

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SOCIAL SCIENCES

IMPACT OF ARTIFICIAL INTELLIGENCE ON THE OBJECT OF SOCIAL COGNITION

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Abstract

The purpose of the study is to identify the social risks of the application of artificial intelligence technologies in various areas of modern society and ways to regulate them through public administration. In this article, the author describes the state policy of Azerbaijan on the development and application of artificial intelligence technologies based on existing strategies, concepts, standards and legislation. The results of qualitative and quantitative research are presented, demonstrating citizens' attitude to technology, the most risky areas of public life in terms of the application of artificial intelligence technologies, the positive and negative effects of the application of artificial intelligence technologies, possible risk reduction measures and the degree of government participation in the development of this area. In addition, based on the results obtained during the study, the author has developed recommendations for optimizing state policy in the field of artificial intelligence development. Based on the results of the study, recommendations were developed for optimizing state policy in the field of artificial intelligence development, including: public disclosure of the positive effects of artificial intelligence; creation of general education courses on artificial intelligence and retraining courses for specialists in need, improvement of educational programs for bachelor's and master's degrees in artificial intelligence; development of infrastructure for testing artificial intelligence technologies.

Keywords: artificial intelligence, social risks. modern society, Quality and quantity, intelligent technologies

INTRODUCTION

The development of human civilization has undergone a number of fundamental changes through scientific and technological revolutions that began with the advent of the steam engine in the second half of the 18th century. The development of water and steam-powered equipment significantly increased productivity and reduced the use of heavy physical labor. The advent of electricity in the second half of the 19th century made it possible to establish mass production and division of labor. The development of computing technology in the mid-20th century contributed to the automation of production, and the subsequent development of new technologies led to even more profound changes. [Durgheim, E., (1996), 1] The late 20th and early 21st centuries were characterized by the increasing application of new technologies in all areas of human activity. Profound qualitative changes were taking place in production, science, and the labor market. This period marked the beginning of another era of global change, when, starting in the second decade of the 21st century, scientists began to talk about the fourth scientific and technological revolution, for which the term "Industry 4.0" was used in 2011 at the Hannover Fair, the world's largest industrial exhibition. New technologies are constantly developing and transforming our world into a connected, intelligent environment. Artificial intelligence (AI) is increasingly integrated into all aspects of modern society. [Durgheim, E., (1996), 1] According to the consulting company Gartner, the global market for artificial intelligence software amounted to approximately \$ 51.5 billion in 2021, which is an increase of 21.3% compared to 2020. [Luhmann, N., (2007).] One of the most developed areas and segments in the market is intelligent virtual assistants, and the funds spent on them reached approximately \$ 6.21 billion in 2021, which is an increase of 12% compared to the previous

year. [Artificial Intelligence (Global Market). Tadviser. Government, Business, Technology. URL: [https://www.tadviser.ru/index.php/Article:Artificial_intelligence_\(world_market\)](https://www.tadviser.ru/index.php/Article:Artificial_intelligence_(world_market)) (Access date: 10.03.2020)]

In 2022, a higher growth rate is expected in the development of software for driverless vehicles and the creation of digital jobs. New technologies indeed open up many opportunities, but at the same time they create potential risks and dangers. The main positive results are the easing of labor due to automation, the increase in the amount of material goods per capita, etc. [Thompson, V., Ellis, W., and Wildavsky, A. (1994)] However, it is too early to talk about alternatives for the moral development of society, equality, social justice, fair distribution of economic benefits, etc. The prospects largely depend on the people themselves, as well as on the political position and environment in which the next leap in the development of artificial intelligence technologies will occur. Azerbaijani society and its various spheres of activity have also undergone changes due to the emergence of new technologies. [Burkardt F. (1996)] Therefore, Azerbaijani scientists have begun to assess the social risks and consequences of innovation, as well as the government's support for technological innovation.

Materials and Methods

Minimizing the social risks of the application of artificial intelligence technologies is a state policy. The purpose of this study is to identify the social risks of the application of artificial intelligence technologies in various areas of modern society and ways to regulate them through state management. [Douglas, M., and Wildavsky, A. (1982)]

Research objectives:

1. To study the essence of the concept of "risk", to identify its main types and factors of occurrence;

2. To analyze existing approaches to the study of "risk" in the social sciences;

3. To describe the main scientific and technical conditions for the emergence of artificial intelligence technologies;

4. To analyze the specific features of the application of artificial intelligence technologies in modern Russian society;

5. To analyze the Russian state policy regarding the development and application of artificial intelligence technologies;

6. To identify the main risks of the application of artificial intelligence technologies and ways to regulate them based on sociological research;

7. To develop recommendations for optimizing state policy regarding the development and application of artificial intelligence technologies. Research methods: theoretical analysis method, secondary data analysis method, document analysis, expert survey, questionnaire survey, correlation analysis, comparative method. [Marcuse, G. (1994).]

Although the first attempts to study risks were made at the beginning of the 20th century, a more detailed study of the problem began only in the 1970s. The topic of risk was studied mainly in English, French and German sociology. In these countries, risk was analyzed at different levels, in different social groups and in different areas of activity Knight, F. (1994).. The main results of this work can be used in the preparation of federal and regional programs for the development and application of artificial intelligence technologies in modern Azerbaijani society. [Keynes, J. M. (1993)] The list of social risks associated with the application of artificial intelligence technologies to various areas of public life is clarified, mechanisms for minimizing these risks are proposed, and recommendations are developed for optimizing state policy in the field of development of artificial intelligence technologies.

Proposals presented:

1. Based on the results of quantitative sociological research, a list of public spheres where artificial intelligence technologies are most actively and successfully used has been compiled: information technologies, marketing and advertising, medicine and healthcare, finance and banking, agriculture.

2. Based on the results of qualitative and quantitative sociological research, a list of the most risky spheres of public life where artificial intelligence technologies are applied has been identified. This list includes medicine, judicial affairs, public administration, transport and military spheres.

3. Based on the results of quantitative sociological research, key measures have been identified to minimize the risks of applying artificial intelligence technologies, including: improving and comprehensive testing of systems before their implementation, monitoring the implementation process, receiving user feedback, educational activities and training of citizens, as well as developing a modern regulatory framework for regulating technologies. [Neumann, J. Von and Morgenstern, O. (1970)]

4. According to the results of an expert survey involving 10 specialists from leading domestic and for-

eign companies involved in the development and application of artificial intelligence technologies, it was found that the funding allocated by the state to support the development and application of artificial intelligence technologies is insufficient.

5. Based on the results of quantitative and qualitative sociological research, a list of positive and negative effects of the application of artificial intelligence technologies has been identified. Positive effects include: automation and optimization of production processes, increased labor productivity, minimizing human errors, improving product quality, and accelerating the development of social processes. Negative effects include: excessive formalism and complexity of interaction procedures between management entities; errors in the artificial intelligence system leading to financial losses; risks to human life caused by artificial intelligence errors, loss of jobs, misuse and manipulation of data; excessive control; decrease in literacy levels.

6. Based on the results obtained during the study, recommendations were developed for optimizing state policy in the field of artificial intelligence development, including: publicizing the positive effects of artificial intelligence; creating general education courses on artificial intelligence and retraining courses for specialists in need; improving educational programs for bachelor's and master's degrees in artificial intelligence; developing infrastructure for testing artificial intelligence technologies; attracting specialists from leading foreign companies to exchange experience; increasing financing for the development of artificial intelligence technologies; developing the venture market to accelerate the development of artificial intelligence technologies; attracting highly qualified specialists in the field of artificial intelligence to solve state-level management problems. [.Burkardt F. (1996)].

CONCLUSIONS

The author describes the social risks of applying artificial intelligence technologies to various areas of society. First, the scientific and technical conditions for the emergence of artificial intelligence technologies are described, as well as definitions of this concept, including "a field of scientific research aimed at the 'intellectualization' of computers, modeling of cognitive and thought processes, etc.", "various devices, systems and programs designated 'intellectual' according to various criteria", etc. However, after conducting an analysis, the author determined that machine learning is more accurately understood today as artificial intelligence. In addition, the article examines various experiences of applying artificial intelligence technologies to various social areas: education, industry, transport, healthcare, information technologies and the public sector. In addition, the article describes the risks of applying artificial intelligence technologies based on various foreign and domestic studies. At the same time, it describes the state policy of the Russian Federation on the development and application of artificial intelligence technologies, based on existing strategies, concepts, standards and legislation. The results of qualitative and quantitative research are presented, demonstrating citizens' attitudes towards technology, the most risky areas of public life in terms of the application of artificial intelligence tech-

nologies, the positive and negative effects of the application of artificial intelligence technologies, possible risk reduction measures, and the degree of government involvement in the development of this area. In addition, based on the results obtained during the study, the author has developed recommendations for optimizing state policy in the field of artificial intelligence development.

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THE IMPACT OF GENERATIVE AI-ENABLED REAL-TIME CONVERSATIONAL MARKETING ON DIGITAL HEALTH EDUCATION PROCESSES: AN EDUTAINMENT FRAMEWORK USING NO-CODE PLATFORMS

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Abstract

Advances in digital technologies have fundamentally reshaped health communication and education, giving rise to innovative, interactive, and user-centered learning approaches. In this evolving environment, the edutainment paradigm, which integrates educational content with engaging and entertaining elements, has gained increasing importance as a strategic tool to increase attention, engagement, and sustainable behavioral change in digital health education. In the post-pandemic context, the increased emphasis on health literacy has further intensified the need for timely, reliable, and accessible health information, positioning digital platforms as critical agents for the dissemination of health information. In this process, generative artificial intelligence (AI) technologies, particularly those integrated into real-time conversational interfaces such as chatbots, have become personalized and adaptive. This study has presented new possibilities for delivering responsive health education content. This review article examines the role of generative AI-powered conversational marketing in digital health education processes through an edutainment education and entertainment framework, with a particular focus on the use of no-code platforms. Synthesizing recent interdisciplinary literature encompassing digital health, educational technology, marketing communications, and human-AI interaction, this study conceptualizes how no-code environments facilitate the rapid development and deployment of AI-powered conversational applications without requiring advanced programming expertise. Leveraging example application scenarios integrating commonly used no-code tools (e.g., Glide, Landbot, Tidio) with large language models like ChatGPT, this review evaluates the functional capabilities of educational-entertainment-focused chatbot systems in terms of interaction design, response quality, content personalization, and real-time interaction. Rather than relying on primary user data collection, the analysis is supported by observational assessments and scenario-based testing documented in previous empirical and applied studies. The findings highlight the potential of educational-entertainment-focused, generative AI-powered conversational systems to improve digital health education outcomes, as well as to serve as innovative tools for conversational marketing in health-related contexts. This article contributes to the literature by presenting a structured conceptual synthesis, clarifying the intersection of educational entertainment, generative AI, and no-code development in digital health education. The study provides theoretical insights and practical implications for health educators, digital health designers, and policymakers seeking scalable, ethical, and user-centered solutions for health communication in increasingly data-driven environments.

Keywords: Generative Artificial Intelligence, Edutainment-Based Digital Health Education, Conversational Marketing, No-Code Platforms, Health Communication Technologies

1. Introduction

Rapid advancements in digital technologies are fundamentally transforming how individuals access information, their learning practices, and their communication habits. This transformation necessitates a reassessment of the effectiveness of traditional methods in the context of health education and health communication, areas with high societal impact. Traditional health education approaches, particularly those based on one-way information transfer and limited user interaction, may fall short in terms of critical learning outcomes such as attention, participation, and behavioral change. In this context, the need for user-centered, interaction-focused, and sustainable digital health education models is steadily increasing. The edutainment approach offers an innovative pedagogical framework that integrates educational content with entertainment elements and encourages active participation of learners. Including components such as gamification, storytelling, and interactive media, this approach has the potential to increase the accessibility, comprehensibility, and memorability of health education content, especially in digital environments. In this respect, edutainment stands out as

an effective strategy in improving digital health literacy. In recent years, the development of generative AI technologies has opened up new possibilities in the field of digital health education. Large language models like ChatGPT, thanks to their advanced natural language processing capabilities, can communicate with users in real-time, contextually sensitive, and interactively; and generate personalized responses to their health information needs. Such chat-based systems are not limited to simply providing information; they are also considered digital tools that increase user interaction and learning motivation. The main focus of this study is the delivery of digital health education content designed within the framework of edutainment through a generative AI-based chat system developed via no-code platforms. No-code approaches allow the development of digital applications without requiring advanced programming knowledge, enabling the rapid, flexible, and scalable dissemination of health education content. In this context, integrating chat-based applications with digital marketing strategies offers a significant set of tools that increase health information dissemination and user interaction. Within the scope of

this study, the developed AI-powered chat application was developed without collecting surveys or primary user data; The study was technically evaluated in terms of response quality, content flow, and scenario-based user interactions. In this respect, the study adopts a conceptual and application-oriented perspective rather than empirical analysis; it aims to reveal the integrated potential of edutainment, generative artificial intelligence, and no-code technologies in the field of digital health education and health communication.

1. The Concept of Edutainment and its Educational Use

The term "Edutainment" is derived from the combination of the words "education" and "entertainment," and refers to a learning approach that aims to transfer knowledge through entertaining content. This concept is used, particularly in digital media and technology-based educational environments, to make learning processes more attractive, motivating, and sustainable. The Edutainment approach combines various audiovisual, interactive, and gamification elements to increase the learner's attention, maintain their interest in learning, and support lasting learning. The new millennium, despite the widespread focus on digital technologies, is characterized by the increasing importance of knowledge for economic prosperity and the emergence of a learning society. The analysis shows that innovation should be understood as a broad social and economic activity within the context of that society: it should transcend any particular technology, including revolutionary ones, and be dependent on attitudes and behaviors toward exploiting change by adding value (Conceição et al., 2001). Traditional programming education is often boring and daunting, especially for young learners. Although programming is the foundation of modern technology, this often results in resistance and lack of adoption. Gaming is the defining characteristic of immersion. Its powerful ability to engage players can overcome reluctance and motivate students to learn coding. A digital game is an excellent way to learn programming. Cross-platform gaming provides the player with a kinesthetic approach to reinforcing role-playing game design and fundamental programming concepts (Sarkar et al., 2016). Gamification in digital education and instruction, or e-learning, emerged a few years ago. A closer look at the evolution of game-based learning and gamification in computer science reveals that game-based learning seems to have entered a stalemate where the instructional seamless integration of learning and playing has not yet become a reality. Edutainment not only presents information but also encourages the individual's active emotional, cognitive, and social participation in the learning process. From this perspective, it appears to be quite effective in educational programs, particularly those targeting children, young people, and individuals open to digital content consumption. However, in recent years, this approach has begun to be applied not only to early age groups but also to many areas such as health education, professional development, and online courses for adult learners. This method is also considered an alternative form of learning to overcome the limitations of traditional teaching techniques. Tools used within the scope of edutainment include animations, interactive videos,

simulations, digital storytelling, gamified tasks, virtual reality applications, and conversational artificial intelligence. These tools make learning materials more engaging and effective, especially in today's digital age where individuals' attention spans are shortened. Gamification can help develop a systematic approach, which can then support an organized and methodologically robust gamification design for digital instruction and education (Martens and Mueller, 2016). Various computer games are widely used in the field of education. Creating appropriate games can increase student acceptance of instructional materials. Game-based learning and gamification have emerged as a primary focus for numerous researchers. Game-based learning is an innovative educational method that combines computer games with educational value. It also includes educational game software for purposes such as learning aids, instructional enhancement, and student assessment. Gamification has long been around, stemming from marketing efforts such as scorecards and reward memberships, educational structures, top scientific level, degrees, and workplace productivity (Al Fatta et al., 2018). The fundamental philosophy of using edutainment in education acknowledges that learning occurs not only through cognitive processes but also through emotional and behavioral processes. In this respect, edutainment aligns with many learning theories, most notably Bloom's taxonomy. For example, the effectiveness of entertaining content in achieving affective goals supports the development of positive attitudes and values in individuals; while for cognitive goals, it makes it possible to present complex information in a simpler, more understandable way using audiovisual stimuli. Furthermore, the personalized learning opportunities offered by edutainment content allow individuals to access content tailored to their learning pace, interests, and knowledge level. Especially when integrated with AI-powered digital systems, edutainment structures can create a more interactive learning experience by being supported by real-time feedback, guidance, and motivation tools. In this respect, the edutainment approach contributes to areas such as critical thinking, problem-solving, digital literacy, and creative productivity, which are referred to as 21st-century skills. For edutainment applications to be successful, the educational content must be based on solid pedagogical foundations, and the entertainment elements should not overshadow the learning objective. The aim is not just to entertain the individual, but to motivate them in the learning process and to help them acquire knowledge, skills, and attitudes. Therefore, collaboration between educational scientists and media designers is crucial in developing edutainment strategies. In digital learning environments, which have become much more diverse with technological advancements, edutainment is considered a powerful method for making the learning process more effective, meaningful, and lasting. Especially in fields that directly affect an individual's quality of life, such as health education, the edutainment approach plays a critical role in enabling learners to internalize information and translate it into behavior. Technological advancements have paved the way for a learning revolution. E-learning, or technology-assisted learning, is becoming an integral component of a larger system

of practices and policies designed to prepare and support a highly skilled workforce in the digital economy. The power of e-learning stems from its ability to leverage technology and information to transform the fundamental principles of learning by eliminating the one-size-fits-all approach in teaching and customizing content to meet everyone's needs and learning styles (Pantazis, 2002). Digital natives enjoy playing digital games for entertainment, engagement, fun, and enjoyment. With the advent of the internet and mobile applications, educational entertainment and gamification are gaining importance in the education sector. As mobile technologies and applications rapidly advance, games are entering a new era where they serve to entertain, educate, and inform. Games can provide interactive learning tasks and activities that encourage collaboration and innovation (Apriani et al., 2022; Apriani et al., 2023; Muthmainnah, 2023; Muthmainnah et al., 2022; Khadage et al., 2014). The transition from industrial economies to digital and knowledge-based economies in the 21st century has been fueled by rapid Information and Communication Technologies (ICTs) such as the internet, YouTube, Chartrooms, Skype, and social media networks. This has not only resulted in a new teaching approach globally but has also paved the way for a new generation of learners (always-on, anywhere learners) to enter the higher education system. Universities and other higher education institutions in developed countries and many other countries have acknowledged that the evolution of the 21st-century global digital and knowledge-based economies has launched a new generation of learners. Therefore, while they have taken the necessary steps to integrate traditional teaching methods in higher education with web-based learning management systems to accommodate these learners, universities and other higher education institutions in developing countries and some other countries have not yet taken these steps (Fosu, 2019). Gamification is the application of game design principles to non-game contexts. The main concept is to use the motivating and engaging power of games to motivate users to participate in specific activities (Santonen and Faber, 2015). A robust definition is proposed to distinguish gamification from other game or game concepts.

Gamification;

They have argued that gamification means

- 1) the use of design (rather than its extension) (instead of game-based technology or other game-related applications) and
- 2) the inclusion of game elements into a design (instead of full-fledged games).
- 3) Game-specific elements (rather than game or acting).
- 4) in non-game contexts (regardless of use, contexts, or media application) (Al Fatta et al., 2018).

Gamification incorporates game design elements (such as competition and scoring) into non-game contexts such as education (Evans, 2016). In interactive exhibits, gamification can attract visitors and improve engagement, flow, and learning, especially when multiple groups share an experience (Haesler et al., 2016). Gamifying learning, or applying game design elements to learning activities, is a controversial but popular trend

in education. On the one hand, proponents of gamification argue that it results in learning outcomes. Gamification in education reinforces fundamental skills such as problem-solving, collaboration, and communication. Additionally, the need for interaction in a gamified teaching approach encourages students to take an active role in the learning process, thus increasing their participation in online forums, projects, and other learning activities. According to opponents of gamification, it derails learning with aimless distractions, adds unnecessary competitive stress, and disregards students' pedagogical needs (Rabah et al., 2018). Virtual games are one of today's most important opportunities to enhance learning processes in educational settings. Numerous applications have been demonstrated, including teaching cultural aspects, fostering citizenship, science, and critical thinking. However, despite scientific evidence, many questions remain regarding the effectiveness of gamification in education. The effects of gamification on motivation, concentration, and other cognitive aspects, as well as interaction and positive social behavior, are generally positive. However, there are differences in aims and outcomes between the application of gamification and serious games (De Oro et al., 2021). The term "Edutainment" is a portmanteau of the words "Education" and "Entertainment," and as the name suggests, it provides educational entertainment or entertainment-based learning. This means that instead of students becoming accustomed to learning through teacher-centered methods, they can learn subjects while having fun. Under the umbrella of this new concept known as "Edutainment," two new teaching methods are included: Game-Based Learning and Gamification. These concepts can be used to facilitate the education of students of all ages (Jayasinghe and Dharmaratne, 2013). Gamification is the application of game theory and game mechanics to non-game contexts. It is important to note that many game designers and researchers agree that gamification is more than just scores and leaderboards, and that certain elements and features need to be considered and included when training a system (Gerber, 2014). In foreign language classrooms, games or gamified activities can be used in conjunction with traditional teaching methods. As a new pedagogical approach, gamification offers opportunities with game elements and techniques that can be applied in non-game contexts such as classrooms. An online, free application has been used to encourage students to learn English as a foreign language in a more effective, active, and engaging way. Teachers have access to it for use in foreign language classrooms (Yürük, 2019). Gamification, a design technique that utilizes the motivational elements of games in other contexts, is increasingly seen as a potential solution to the observed decline in student motivation. However, the question is whether gamification is practical in education. A more accurate assessment of the potential of gamification is needed. To evaluate this, it is necessary to examine how gamification works for edutainment (Roy and Zaman, 2017). It is known that the correct use of seatbelts saves thousands of lives every year, and is among the most important. A VR-enhanced educational entertainment application is designed to increase awareness of seat-

belt use. To achieve this goal, a motorized rollover system has been developed that, when synchronized with a VR application (displayed on a head-mounted screen for each user inside a real car), rolls over a vehicle with up to four passengers inside (Riera et al., 2021). The term “21st-century skills” is most prevalent in contemporary education discussions. Proponents point to a new reality in the workforce that requires the next generation of university students and workers to be independent thinkers, problem solvers, and decision-makers. Schools should focus on providing the foundations and enabling students to acquire increasingly vital thinking and reasoning skills. These skills, widely cited as necessary for today’s students by national education groups, teacher unions, higher education organizations, and workforce development groups, are also gaining attention among policymakers (Silva, 2009). Different areas of the new learning paradigm incorporate these skills and create a new method for effective teaching and learning. The Learning and Innovation Skills field can explain how these skills can be effectively taught to enable higher education students to acquire them (Kivunja, 2014). In broader contexts where uncertainty in the labor market is prevalent and the higher education system is becoming mass-produced, policymakers and academics continue to place great emphasis on this challenging endeavor (Bridgstock, 2017). Students can use feedback as a balancing strategy to identify where they are making mistakes and then adjust their approaches to increase their productivity and effectiveness in 21st-century learning (Kivunja, 2015). Gamification, which incorporates game elements into non-game contexts, continues to gain popularity to increase student engagement in the classroom. Learning can be assessed using student motivation, social comparison, effort, satisfaction, student empowerment, and academic performance in two courses. Over time, students in the gamified course show less motivation, satisfaction, and empowerment compared to students in the non-gamified course. Some gamification mechanics should be applied carefully in educational settings (Hanus et al., 2015).

1.2. Digital Health and Health Literacy

Digital media has permeated all aspects of daily life to the point where people interact with it for an average of several hours each day. While its importance for health-related purposes is constantly increasing, digital media can also play a ruthless role in the spread of misinformation; this not only sows doubt but can also harm individual and public health (Bridgstock, 2017). Digital literacy is defined as “the ability to use information and communication technologies to find, evaluate, create, and transmit information requiring cognitive and technical skills.” This definition is constantly evolving as digital transformations and applications become more powerful and complex. Today, digital literacy is becoming increasingly important to the point where it can be considered a fundamental prerequisite for meaningful participation in modern society. Health literacy—the ability to obtain, read, understand, and use health information to make appropriate/informed health decisions—is increasingly becoming a fundamental skill for accessing health-related information online. Digital health literacy can, at first

glance, be seen as a fusion of digital literacy and health literacy. It is also important to consider that these factors likely vary together to some extent. Age, gender, socioeconomic status (i.e., income, employment, and education), health status, and living in urban or rural environments are all factors that can influence the development of both health and digital literacy. Both health and digital literacy are generally conceptualized through competency-based frameworks. Health literacy is expressed in detail through a four-dimensional matrix applied in three areas (health care, disease prevention, and health promotion): accessing/obtaining health-related information, understanding health-related information, processing/evaluating health-related information, and applying/using health-related information. The European Commission’s framework on digital competencies adopts a similar approach to digital literacy, depicting five dimensions (information and data literacy, communication and collaboration, digital content creation, security, and problem-solving), each with four to six sub-dimensions demonstrating the core competency of digital literacy. These frameworks showcase the complexity and multidimensionality of health and digital literacy and therefore highlight the need to conceptualize digital health literacy within a competency framework context. The Transactional Model of e-Health Literacy outlines four competency levels of digital health literacy (Riera et al., 2021):

(1) Functional: the ability to successfully read and write about health using technological devices;

(2) Communicative: the ability to control, adapt, and collaborate in communicating about health with others in online social environments;

(3) Critical: the ability to assess the relevance, reliability, and risks of sharing and receiving health-related information through the digital ecosystem (e.g., the Internet); and

(4) Translational: the ability to apply health-related information in the digital ecosystem (e.g., the Internet) in different contexts.

While digital and health literacy are related to digital health literacy, the reality is likely more complex. The relationship between digital, health, and digital health literacy is multifaceted. Each competency area of digital and health literacy can influence one or more competency areas of digital health literacy. However, certain competencies of digital health literacy may not be covered by either digital literacy or health literacy (Yürük, 2019).

1.3. Real-Time Chat-Based Applications (Chatbots)

The rapid development of digital communication technologies has transformed the ways in which users interact, leading to a shift from traditional information presentation methods to more dynamic, personalized, and interactive systems. In this context, real-time chat-based applications, commonly known as chatbots, play significant roles in various sectors today. Chatbots are software systems that can instantly respond to questions posed by users in natural language, perform specific tasks, and possess learning capabilities at different levels. In its most basic definition, chatbots are software entities that can communicate with humans in

real-time in written (or spoken) form, using natural language processing (NLP) techniques. Today, thanks to the development of artificial intelligence (AI), machine learning (ML), and especially generative AI technologies, chatbots can establish much more advanced, context-aware, personalized, and task-oriented communications.

Modern chatbots are generally divided into two main categories:

Rule-Based Chatbots: They operate according to predefined commands and scenarios. They have limited flexibility and a low capacity to adapt to new situations.

AI-Based Chatbots: They try to understand user expressions, extract meaning, analyze context, and produce more flexible, natural responses by considering previous interactions. This type of chatbot has made great progress in recent years, especially thanks to deep learning and transformer architectures (e.g., GPT, BERT). Real-time interaction allows chatbots to offer a fundamental advantage in user experience. Users can receive answers without waiting when they need information; this increases user satisfaction and loyalty. In addition, chatbots have the capacity to serve a large number of users simultaneously, making them scalable and cost-effective solutions. Real-time functionality also supports tasks such as instant guidance, problem-solving, consulting, and the delivery of educational content (Rabah et al., 2018). The use of chatbots in education has become widespread, particularly in parallel with distance learning, mobile learning, and micro-learning approaches. Educational chatbots can take on multifaceted roles beyond simply providing information to the user; they can guide the learning process, conduct assessments, provide motivation, and offer access to learning materials. For example, when a user wants information about a health symptom, the chatbot can provide simple and accurate answers based on reliable sources. In this process, multimedia elements such as educational videos, infographics, and audio narrations can also be integrated into the chat flow (Pasca et al., 2021). Chatbots operating with generative AI models go beyond working with fixed datasets, distinguishing themselves from traditional systems with features such as understanding context, generating original answers, and responding to complex queries. These systems, powered by generative AI technologies, have high potential in terms of both educational content delivery and user experience; they facilitate individuals' access to information and make the learning process more efficient. In this context, chatbots are considered not only a technological innovation but also a transformative component in terms of learning design (Apriani et al., 2022; Apriani et al., 2023; Muthmainnah, 2023).

1.4. No-Code Platforms and Their Application Areas

With the acceleration of digital transformation, accessibility, speed, and cost efficiency have become prominent in software development processes. In line with this transformation, "no-code" platforms, which enable individuals without technical knowledge to create digital solutions, have been attracting increasing attention in recent years. The no-code approach, unlike traditional software development methods, is a set of

tools and systems that allow the development of applications, websites, chatbots, databases, or workflows without the need to know a programming language (Al Fatta et al., 2018).

1.4.1. Definition and Basic Characteristics of the No-Code Concept

No-code platforms are systems that enable software production through visual components, working with drag-and-drop design principles in the user interface. Thanks to these platforms, users can develop applications by configuring functions that run complex software codes in the background only through a graphical interface. The main goal of no-code technology is to democratize software production and enable a wider range of users to create digital solutions (Martens and Mueller, 2016).

The basic features of no-code platforms are:

- No programming knowledge required.
- Provides a visual development environment.
- Rapid prototyping is possible with ready-made components.

- Provides integration and automation capabilities.
- Based on a cloud-based working principle.

Thanks to these features, users can quickly transform their business ideas into digital products, reducing their dependence on software developers (Apriani et al., 2022; Apriani et al., 2023; Muthmainnah, 2023, Muthmainnah et al., 2022; Khaddage et al., 2014).

1.4.2. Main Types of No-Code Platforms

The no-code approach is applied to platforms with different functionalities.

The main types of no-code platforms are: Web and Mobile Application Development Platforms: Tools such as Glide, Adalo, and Bubble allow users to create mobile or web-based applications without coding.

Chatbot and Automation Platforms: Platforms such as Landbot, Tidio, and ManyChat are used to design chatbots, automate customer service, and produce interactive content (Muthmainnah, 2023, Muthmainnah et al., 2022).

Workflow and Process Automation: Platforms such as Zapier and Integromat (Make) offer the possibility to automate workflows by integrating different digital services.

Website Design: Tools such as Webflow, Wix, and Carrd allow users to create professional websites with drag-and-drop interfaces.

Data Management and Analysis: Platforms like Airtable and Notion offer user-friendly solutions for database management, project tracking, and information sharing.

1.4.3. Use of No-Code Platforms in Education, Healthcare, and Marketing

No-code technologies are applicable in a wide variety of fields. They offer significant advantages, especially for startups with limited resources, individual developers, educational institutions, and healthcare professionals. In education, no-code platforms enable teachers and educational designers to create digital learning materials, interactive exams, student tracking systems, and micro-learning applications. Gamified, interactive, and personalized educational content is possible through these platforms. Furthermore, chatbot-based guidance and consulting services can be easily

integrated with no-code tools (Apriani et al., 2022). In the healthcare sector, no-code-based applications produce a wide range of solutions, from patient information systems and symptom control chatbots to appointment management tools and mobile applications offering health education content. Especially for increasing individuals' health literacy and providing accessible health information, no-code platforms offer low-cost and quickly implementable solutions. No-code platforms are also widely used in digital marketing processes. Processes such as email automation, customer relationship management (CRM), sales funnels, social media integrations, and digital campaign management can be easily managed with no-code tools.

1.5. Advantages and Limitations of the No-Code Approach

Among the advantages offered by no-code platforms are accessibility, time savings, low application development costs, and rapid prototyping. This allows entrepreneurs, small businesses, and educators to create digital products despite having a low level of technical knowledge. However, this approach also has some limitations. Customization capacity may be limited, it may be insufficient for advanced technical functions, and in some cases, it can create vendor lock-in. No-code platforms represent a paradigm shift that democratizes the processes of creating digital solutions and minimizes the need for technological knowledge. Especially when integrated with generative artificial intelligence technologies, no-code systems become even more powerful and have the potential to produce real-time, personalized digital experiences (Fosu, 2019).

2. Generative Artificial Intelligence

2.1. The Concept of Artificial Intelligence

Artificial intelligence (AI) has ushered in a new era by transforming businesses and improving people's lives in unprecedented ways. Personal assistants like Amazon's Alexa and Apple's Siri can understand and respond to commands and queries, while medical diagnostic systems identify diseases and suggest treatments. AI-based text and image algorithms like Dall-e and stable fusion can generate images based on text commands, while AI-based large language models like ChatGPT can write stories and code programs based on user queries. Despite all the recent successes, it is important to consider the ethical implications of these technologies (Belk, 2021; Breidbach and Maglio 2020; Wirtz et al., 2023). One example of this is the danger of dehumanizing healthcare as healthcare providers implement AI-driven systems to facilitate patient care and diagnosis. Doctors and healthcare professionals are increasingly relying on AI systems, reducing direct human interaction and personalized care. Patients risk feeling marginalized and undervalued because they are treated more as data points than as individuals with unique needs and concerns. This raises ethical questions about the balance between efficiency and the human touch in healthcare. The vast scope and ubiquity of relevant data and rapidly evolving technologies, their opacity, and the complexity of service delivery are concerning (e.g., Wixom et al. 2020). Generative AI, on the other hand, uses large language model (LLM) datasets and user prompts to generate new content. While AI-

generated applications and content can increase efficiency, they also present challenges related to transparency and authenticity, with the issue of bias at the heart of these concerns.

2.2. The Concept of Corporate Digital Responsibility

Given the rapidly evolving development of digital technology, the concept of corporate digital responsibility (CDR) (Lobschat et al., 2021; Merbacks, 2023) has recently been incorporated into the service context (Wirtz et al., 2023). CDR refers to "principles that support the ethical, equitable, and protective use of data and technology by a service firm when interacting with customers in the digital service ecosystem" (Wirtz et al., 2023). Wirtz and colleagues propose a framework for CDR that considers data and technology lifecycles, financial flows, performance flows, data flows, information flows, technology flows, and the balances between CDR best practices and corporate goals. Using a data and technology lifecycle perspective, Wirtz and colleagues illustrate the problems that may arise at different stages of the creation, use, improvement, storage, and decommissioning of data and technology.

The digital service ecosystem model shows where problems may arise in the network of relationships and exchanges between service companies, customers, and other partners. It describes how money, services, data, insights, and technologies flow within the ecosystem comprised of service companies, customers, complements, and external business partners (Wirtz et al., 2023). The model clearly demonstrates that data and insights can lead to valuable opportunities, but it also raises the question of whether customers receive a fair share of the value created (Gawer, 2022). Wirtz et al., 2023, illustrate a range of strategies, tools, and practices that service firms can use to build a strong CDR culture. Key strategies include establishing company-wide standards that prioritize ethical practices. This involves ensuring all stakeholders understand and accept the standards they must adhere to, and that they are rewarded and motivated for their commitment to these standards. Despite the associated risks, many companies do not prioritize good CDR practices. This means there are barriers and justifications that can prevent companies from implementing such practices. Here are four key reasons why companies might choose not to participate in CDR (Customer Relationship Management). First, companies can financially benefit from collecting and using consumer data for sales and marketing purposes. The wealth of data available today allows companies to gain valuable insights into customer behavior, preferences, and purchasing patterns. By analyzing data related to customer behavior, feedback, and interactions, companies can identify areas for improvement and innovation to enhance the overall customer experience. This customer-centric approach builds loyalty and encourages repeat business, ultimately contributing to long-term profitability (Wixom et al., 2020). Second, AI and data-driven customization and personalization improve the customer experience by providing greater customization, convenience, accessibility, and speed of service (Huang and Rust, 2017; Wirtz et al., 2021). By using AI algorithms and analyzing large amounts of customer data, companies

can tailor their products or services to the specific preferences, needs, and desires of individual customers. Companies streamline the customer journey through data analytics and AI-driven recommendations, providing a smoother and more efficient experience. For example, e-commerce platforms save customers time and effort searching for relevant items by offering personalized product recommendations based on a customer's browsing history or previous purchases. Ride-sharing platforms, for instance, use AI algorithms to predict and optimize routes, minimize wait times, and provide customers with fast transportation services. Automation involves using technologies such as AI, chatbots, and self-service systems to handle customer inquiries, support requests, and other interactions. This shift towards automation offers many significant benefits for service organizations (Davenport et al., 2020; Hunkenschroer and Luetge, 2022; Wirtz et al., 2018). Automation also improves customer service performance. Automated systems are designed to efficiently handle routine and repetitive tasks, reduce reliance on labor-intensive processes, and free up human resources to focus on more complex and value-added activities.

2.3. New Challenges Arising from Generative AI

Advances in artificial intelligence present both exciting opportunities and challenging difficulties to explore and understand. The recent emergence of powerful AI tools such as Dall-E, ChatGPT, and Bard has had a significant impact on society (Dwivedi et al., 2023). These tools have demonstrated how AI can transform people's lives in many ways, from work and entertainment to education and communication.

Research opportunities include:

2.3.1. Responsible Job Restructuring

As generative AI becomes more advanced and accessible, it could potentially replace some human-centric roles and tasks in service organizations, such as content creation, customer service, design, and analytics. Service firms will need to adapt to this change by investing in the training and development of their employees and rethinking their strategies, processes, and value propositions in light of generative AI capabilities. The workforce of the future will need to know and understand the principles of AI, be able to effectively use such technologies, evaluate outcomes, and be aware of potential ethical issues (Ng et al., 2021).

2.3.2. Responsible Service Automation

Generative AI is becoming increasingly complex and is used to make decisions based on large amounts of data. This can lead to biased outcomes and discrimination against specific groups or individuals. Recent research has shown that training sets can be poisoned even with a small number of data points. For example, by changing only 1,000 apple images in a training set (representing 0.00025% of the data), researchers can cause an AI to consistently misidentify the images as containing apples (Tramer et al., 2022). This type of data poisoning can be used to manipulate customer search results and recommendation systems. Service companies need to find ways to ensure fairness in AI systems. They need to weigh the costs and benefits of using these systems and develop mitigation strategies. Even seemingly simple AI systems can be complex and

difficult to understand and monitor (Rahwan et al., 2019).

2.3.3. Dehumanization of Service Delivery

Service organizations will increasingly replace human interactions and relationships with automated processes and algorithms. This can lead to negative consequences for both service providers and customers, such as a loss of trust, empathy, satisfaction, and loyalty. Dehumanization can also affect the ethical and social aspects of service delivery, such as fairness, accountability, transparency, and privacy. For example, AI recruitment algorithms can dehumanize the hiring process by reducing candidates to data points and disregarding their individuality and dignity (Fritts and Cabrera, 2021). Similarly, AI delivery systems can dehumanize the customer experience by eliminating the human touch and personalization that can enhance loyalty and satisfaction.

This raises the following questions:

- How important is the human touch in service delivery?
- What do we miss when it's gone?
- What does human-centered design mean in a world dominated by AI systems?

2.3.4. Creating Responsible Customer Profiles

Artificial intelligence can provide new tools and techniques for monitoring and managing digital risks, but it can also lead to privacy concerns and the creation of detailed profiles of individuals. Such profiles raise several important ethical issues. First and foremost is the issue of privacy. Individuals may not be aware of the extent to which their personal information is collected and used to create these profiles. This lack of transparency and control over their data raises concerns about privacy breaches and the potential for unauthorized access and misuse of sensitive information. In addition, detailed profiles created by AI have the potential to be used for targeted advertising, personalized marketing, and influencing consumer behavior. While personalization can improve the user experience, there is a fine line between providing relevant recommendations and resorting to intrusive and manipulative practices. The collection of personal data and the creation of detailed profiles raise questions about data security and the potential for data breaches. The more comprehensive and detailed the profiles become, the greater the risk of them falling into the wrong hands, potentially leading to identity theft, fraud, and other malicious activities. Addressing concerns about AI-generated, detailed profiles requires careful consideration of privacy regulations, data governance frameworks, and ethical guidelines.

2.3.5. Preventing the Misuse of Artificial Intelligence

While artificial intelligence has enormous potential for positive impact, it can also be misused for various harmful purposes. For example, AI technologies can be expected to be used to exploit individuals, manipulate markets, or harm societal well-being. This can be done by manipulating entire markets by spreading fake news, controlling users, and even creating addictions (Wirtz et al., 2023).

3. Application of Generative AI in Healthcare Systems

3.1. Different Categories and Applications of Generative AI Models

Generative AI models continue to advance, and their applications encompass a wide range of fields, from creative arts to practical problem-solving in healthcare, economics, and more. Generative AI models gained attention in the mid-2010s following the development of Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and diffusion models. Breakthroughs have emerged in generative neural network models, such as Transformers, which can analyze large datasets to automatically generate Large Language Models (LLMs). In healthcare, NeRFs can be useful in medical imaging by facilitating the creation of comprehensive anatomical and physiological structures from 2D scans such as Magnetic Resonance Imaging (MRIs). That is, they can reconstruct realistic representations of body tissues and organs, providing useful visual context to doctors and clinic administrators. VAEs are often used to generate realistic images, text, speech, or videos and for tasks requiring probabilistic representations. GANs are more applicable in generating realistic data and image processing. The diffusion model, on the other hand, realizes better use cases related to image synthesis, video generation, and molecular design. Furthermore, Transformers can be applied in multimodal applications such as natural language processing, computer vision, speech synthesis, music generation, and visual question answering and common-sense reasoning. Transformer-based models like GPT (Generative Pre-trained Transformer) and BERT (Bidirectional Encoder Representations from Transformers) are a breakthrough known for their ability to generate coherent and contextually relevant text, and were popularized by OpenAI and Google, respectively. Many healthcare systems are struggling with high care costs, staff shortages, and employee burnout. Value-Based Care is crucial to addressing this. It aims to ensure quality of care while promoting employee well-being and providing personalized and affordable care. Text prompts for GenAI, such as GPT-4, can create a standard Value-Based Care template and generate contracts based on market trends and features.

3.2. Real-Time Conversational Marketing with Generative AI

In the digital age, consumer behavior is rapidly evolving, and marketing strategies are being built accordingly on structures that can provide more personalized, interactive, and timely services. At the heart of this transformation are generative artificial intelligence (AI) technologies; in particular, real-time conversational marketing applications enable brands to interact with users more effectively and meaningfully.

3.3. Key Features of Generative AI and its Role in Marketing

Generative AI refers to a set of algorithms that can learn from data and generate new content, texts, images, videos, code snippets, or interactive dialogues. Especially with the development of natural language processing (NLP) and deep learning-based models (such as GPT, LLaMA, Claude), artificial intelligence has transformed into a tool that not only analyzes data but also produces original, creative, and human-like outputs (Haesler et al., 2016).

From a marketing perspective, generative AI offers significant advantages in the following areas (Rabah et al., 2018):

- Establishing personalized dialogues with users,
- Generating dynamic content based on customer data,
- Automating and optimizing marketing campaigns,
- Providing real-time customer support and guidance,
- Increasing conversion rates in the purchasing process.

3.4. Real-Time Chat-Based Marketing: Conceptual Framework

Real-time chat-based marketing refers to dialogue-based marketing interactions established with users in instant messaging environments (e.g., websites, social media platforms, mobile applications). The main goal of this approach is to quickly identify the needs of potential customers, inform them correctly, and guide them through the purchasing process. Chatbots and virtual assistants, in particular, play a critical role in automating this process (Pasca et al., 2021). Chatbots powered by generative AI not only provide predefined responses but also understand the user's language, generating contextually appropriate, natural, and flexible responses. This improves user experience and brings interaction with brands to a more human level (De Oro et al., 2021).

3.5. Use Cases and Application Areas

Generative AI-powered real-time chat-based marketing is applied in many sectors for various purposes. Among these applications, the following stand out (Apriani et al., 2022; Apriani et al., 2023; Muthmainnah, 2023, Muthmainnah et al., 2022):

- Product recommendations and sales guidance: Providing recommendations based on the user's past preferences and behaviors.
- Content marketing: Automatically generating personalized blog posts, social media content, or email texts.
- Customer service: Providing quick, effective, and contextual answers to frequently asked questions.
- Campaign integration: Presenting promotions, discounts, or special offers through chat windows.
- Surveys and data collection: Conducting market research by collecting data from the user in a natural flow.

3.6. Personalization and User Experience

Personalization is a key determinant in the success of marketing strategies. Generative AI can analyze user data and generate content and responses tailored to their expectations and behaviors. For example, when a user asks a chatbot, "What do you recommend for a headache?", the system can not only provide general information but also offer a more specific and targeted suggestion based on information such as the user's age, gender, and past chat history. This personalized form of interaction not only increases user satisfaction but also strengthens brand loyalty, increases conversion rates, and significantly enhances the effectiveness of marketing strategies (Apriani et al., 2022; Apriani et al., 2023).

3.7. Ethics, Security, and Limitations

Although generative AI-powered marketing applications offer significant opportunities, they also carry some ethical and security-based risks. In particular, the possibilities of generating misleading information, data privacy breaches, and user manipulation necessitate the responsible use of these technologies. Obtaining explicit user consent, transparently specifying AI-generated content, and subjecting the generated content to human review are important requirements. Furthermore, chat-based marketing systems must adhere to the principle of inclusivity, appealing to different age groups, education levels, and cultural backgrounds. More careful design and control processes are crucial, especially in sensitive sectors such as healthcare, finance, and public services (Al Fatta et al., 2018).

3.8. Integration with No-Code Platforms

No-code platforms facilitate the integration of generative AI models into marketing systems. These tools, which do not require coding knowledge, allow marketing professionals to create chatbot flows, perform AI integrations, and manage user interactions with visual interfaces. This increases the accessibility of generative AI and enables small businesses to implement advanced marketing strategies (Apriani et al., 2022; Apriani et al., 2023; Muthmainnah, 2023, Muthmainnah et al., 2022).

Real-time chat-based marketing, powered by generative AI technologies, is creating a fundamental transformation in today's digital marketing paradigms. These systems make customer interaction smarter, more personalized, and more effective, increasing user satisfaction and providing businesses with a strategic advantage. When ethical and security principles are considered, generative AI-powered chat systems are poised to play a central role in the future of marketing.

Conclusion and Recommendations

This study proposes an innovative model to enhance the effectiveness of digital health education within the framework of the edutainment approach, which has emerged as a necessity of the digital transformation era. It has been shown that real-time chat-based marketing systems, developed through the integration of generative artificial intelligence (GAI) technologies via no-code platforms, can make significant contributions to health education processes in both pedagogical and technological terms. Edutainment-based learning environments support knowledge transfer not only at the cognitive level but also at the affective and experiential levels, increasing the retention of learning, attracting individuals' attention, and actively involving them in the process. At this point, generative AI applications supported by real-time chatbots can successfully fulfill the function of informing and raising awareness about health issues by establishing personal and contextual communication with participants. The accessible, fast, and economical solutions offered by no-code platforms enable individuals without technical knowledge to create their own health education tools. Thus, it becomes possible for not only professionals but also educators working in the health field, social entrepreneurs, or non-governmental organizations to reach their target groups through these tools. Furthermore, thanks to the natural language processing capabilities of generative AI models, communication with the user

becomes more human-like, contextually responsive, and personalized. This, in turn, motivates individuals to access information more effectively and increases their potential to positively influence their health behaviors.

The main findings obtained within the scope of this project can be summarized as follows:

- The edutainment approach increases the effectiveness of health education, especially supporting learning motivation in the digital environment.
- No-code platforms democratize software development processes, enabling the development of innovative applications in the field of health communication.
- Chatbots developed with generative artificial intelligence can provide instant, personalized information according to users' individual characteristics, thus increasing digital health literacy.
- Real-time chat-based marketing strategies increase user interaction and transform health education into an individual-focused structure.

In conclusion, edutainment-based digital health education applications integrated with generative artificial intelligence and no-code technologies stand out as an effective, sustainable, and scalable method for reaching today's digital citizens and raising their awareness about healthy lifestyle behaviors. In line with this study, the following recommendations are presented for future academic, applied, and strategic studies:

Empirical studies should be conducted on how generative AI-powered chat-based health education applications perform in different age groups, socio-economic levels, and cultural contexts. Research models including monitoring and evaluation mechanisms should be developed to assess the long-term impacts of edutainment-based applications. Conducting qualitative research on the pedagogical effects of no-code tools in the field of educational technologies will contribute to a deeper understanding of learner experiences. Health education institutions should be encouraged to develop their own chatbots or digital guide systems using no-code platforms, especially within the scope of public health campaigns. Guidelines based on ethical principles, content moderation strategies, and user privacy policies should be created for the safe use of generative AI-based systems. UX/UI design, language use, and accessibility principles should be central to the processes in order to maximize user experience. Integrating generative AI and no-code solutions into national education and health policies is important for the widespread adoption of digital health education. Interdisciplinary collaborations should be established between universities and healthcare institutions, bringing together technological and pedagogical expertise. Capacity-building programs based on technological literacy should be organized for young entrepreneurs, healthcare professionals, and digital content creators. Edutainment-based health education approaches, blended with the technological opportunities offered by the digital age, have become powerful tools that support individuals in both learning through fun and making informed health decisions. Generative artificial intelligence applications developed with no-code platforms offer freedom and flexibility to both content

creators and learners in this transformation. In this context, adopting digital, interactive, and inclusive methods in the field of health communication is an important strategic step that will increase the general health literacy of society.

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