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ОСОБЛИВОСТІ ВІДПРАЦЮВАННЯ ТЕХНОЛОГІЇ ВИРОЩУВАННЯ РЕДЬКИ ОЛІЙНОЇ В ЯКОСТІ СИДЕРАЛЬНОЇ КУЛЬТУРИ ЗА УМОВ МОДЕЛЮВАННЯ ТЕХНОЛОГІЧНОЇ СХЕМИ ПОСІВУ ЗА ДОПОМОГОЮ АГРОДРОНУ

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FEATURES OF DEVELOPMENT OF THE TECHNOLOGY OF GROWING OIL RADISH AS A SIDERAL CROP UNDER THE CONDITION OF MODELING THE TECHNOLOGICAL SCHEME OF SOWING USING AN AGRODRONE

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АНОТАЦІЯ

Сучасні темпи розвитку сільського господарства все більше схиляються до використання новітніх технологій, що потребують мінімального втручання людини. Передумовою цього стали ряд соціальних, економічних та екологічних проблем. Так, зокрема, все більше людей починають переселятися з сільської місцевості в міста, що створює дефіцит робочої сили, можливість мати кваліфікованих працівників та вчасно виконувати всі технологічні процеси вирощування сільськогосподарських культур. З економічної точки зору подорожчання палlivo мастильних матеріалів та технічних засобів, значно здорожчує ряд операційних технологій, що вцілому впливає на економічну ефективність вирощування тої чи іншої сільськогосподарської культури. Екологічний аспект є важливим напрямком в мінімізації негативного впливу на грунт та на навколишнє середовище, шляхом впровадження екологічно-безпечних технологій, що дають змогу з одного боку ефективно замінювати традиційні підходи та способи вирощування сільськогосподарських культур, а з іншого - покращувати екологічний стан довкілля, як окремо на конкретній сільськогосподарській ділянці (сівозміні), так і глобально в певному регіоні (громаді). Останнім часом, як у світовій аграрній практиці, так і в прогресивних сільськогосподарських підприємствах України почали активно впроваджувати в технологічний процес вирощування різних сільськогосподарських культур з використанням агродронів. Тому нами був проведений модельний дослід щодо можливості розширення потенціалу агродронів, не лише в якості дослідження та моніторингу полів, внесення хімічних засобів захисту, мікро та макродобрив, підживлення, дисикації, але й можливості відсіву мілконасінних культур, зокрема в якості сидеральної культури. Метою експерименту було відпрацювання різних норм та способів посіву сидеральних культур, зокрема редьки олійної.

ABSTRACT

The current pace of agricultural development is increasingly inclined to the use of new technologies that require minimal human intervention. A number of social, economic and environmental problems have become the prerequisite for this. In particular, more and more people are starting to move from rural areas to cities, which creates a shortage of labor, the ability to have qualified workers and to perform all technological processes of growing crops in a timely manner. From an economic point of view, the increase in the price of fuel, lubricants and technical equipment significantly increases the cost of a number of operational technologies, which in general affects the economic efficiency of growing a particular crop. The environmental aspect is an important direction in minimizing the negative impact on the soil and the environment, through the implementation of environmentally friendly technologies that allow, on the one hand, to effectively replace traditional approaches and methods of

growing crops, and on the other - to improve the ecological state of the environment, both separately on a specific agricultural plot (crop rotation) and globally in a certain region (community). Recently, both in world agricultural practice and in progressive agricultural enterprises of Ukraine, the cultivation of various agricultural crops using agrodrones has begun to be actively introduced into the technological process. Therefore, we conducted a model experiment on the possibility of expanding the potential of agrodrones, not only as a research and monitoring of fields, the application of chemical protection agents, micro and macro fertilizers, top dressing, desiccation, but also the possibility of screening small-seeded crops, in particular as a sideral crop. The purpose of the experiment was to work out various norms and methods of sowing sideral crops, in particular oilseed radish.

Постановка проблеми. Сучасні тенденції розвитку сільського господарства в Україні інтенсивно починають трансформуватися та впроваджувати світові трендові технології, які базуються на використанні різних видів агродронів, які передбачають підвищити точність і ефективність процесу посіву сільськогосподарських культур. Так, використання агродронів для посіву є новим технологічним підходом, що має значний потенціал у підвищенні ефективності агротехнічних заходів. Посіви редьки олійної в якості сидеральної культури можуть стати ефективним замінником традиційних органічних добрив, зокрема гною та ефективно поліпшити не лише якісні показники ґрунту, а й сприяти зниженню забур'яненості, шляхом процесу біологічного впливу на бур'янову рослинність. Все це вцілому сприятиме покращенню агроекологічного стану конкретної ділянки та в подальшому можливості підвищення її економічного потенціалу при вирощуванні різних видів сільськогосподарських культур. При цьому питання оптимальних норм висіву для таких культур залишається надзвичайно актуальним, оскільки точний висів є критично важливим для досягнення балансу між конкуренцією рослин та врожайністю.

Застосування агродронів для посіву сільськогосподарських рослин дозволяє реалізувати гнучкий та точний контроль норм висіву, що може сприяти оптимізації густоти сходів. Це, у свою чергу, дозволяє досягти стабільного врожаю сільськогосподарських культур (зеленої маси для заробки на сидерат), забезпечуючи високий рівень їх конкурентоздатності та сприяючи зниженню потреби у хімічних засобах захисту. Крім того, агродрони здатні працювати на важкодоступних ділянках та значно скорочують час проведення посівної кампанії.

Аналіз останніх досліджень та публікацій. Впровадження інноваційних технологій у сучасному сільському господарстві, спрямованих на підвищення ефективності виробництва та забезпечення високих врожаїв, передбачає застосування передових технологій, таких як агродрони. Агродрони, тобто безпілотні літальні апарати, виконують широкий спектр завдань у сфері сільського господарства, включаючи моніторинг полів, обприскування, посів насіння та зрошення [1].

Огляд досліджень та практичного досвіду свідчить про значні переваги та певні виклики у впровадженні цієї технології. Агродрони дозволяють знизити витрати на пальне та робочу силу завдяки

їх здатності працювати автономно [4]. Фермери відзначають зменшення витрат на застосування насіння та внесення добрив до 30 % порівняно з традиційними методами. Завдяки використанню агродронів сільськогосподарські товаровиробники можуть здійснювати точне розподілення насіння, що підвищує врожайність на полях із нерівномірним рельєфом [3]. Це особливо важливо для малих та середніх господарств, де кожен гектар землі має значення.

Агродрони використовуються для швидкого огляду великих площ полів, що дозволяє вчасно виявляти проблемні ділянки та реагувати на них [2]. Дрони забезпечують можливість точкового внесення добрив та засобів захисту рослин, що зменшує негативний вплив на ґрунти та водойми. Висока вартість придбання та обслуговування агродронів є бар'єром для невеликих фермерських господарств. Це підтверджується аналізом фінансових звітів малих агропідприємств, які вказують на відсутність достатніх коштів для інвестування в сучасні технології [4].

В Україні спостерігається дефіцит фахівців, які мають досвід управління та технічного обслуговування дронів [2]. Це ускладнює впровадження технології у віддалених районах, де доступ до навчання та технічної підтримки обмежений. Використання дронів регулюється нормативними актами, що стосуються безпеки польотів та дозволів на використання дронів у сільськогосподарській діяльності. Відсутність чітких правил часто створює перешкоди для масштабного використання агродронів.

Враховуючи міжнародний досвід, можна очікувати, що в Україні збільшиться підтримка держави у впровадженні технологій, включаючи субсидії та програми фінансової допомоги. Це підтверджується аналізом звітів Food and Agriculture Organization, які вказують на позитивний вплив державної підтримки на розвиток сучасних технологій у країнах, що розвиваються [3]. Загалом, літературний огляд підтверджує, що агродрони є перспективним інструментом для підвищення ефективності сільськогосподарського виробництва в Україні. Однак для повномасштабного впровадження потрібні значні інвестиції у навчання кадрів, фінансову підтримку фермерів, адаптацію законодавчої бази, а також розробку та відпрацювання діючих технологій вирощування сільськогосподарських культур.

Мета досліджень. Визначення оптимальних параметрів використання агродронів для посіву

сільськогосподарських культур з різними нормами висіву в умовах Полісся, що дозволить збільшити ефективність вирощування, зменшить витрати ресурсів та сприятиме гнучкості підходу щодо стійкості агровиробництва до змін клімату.

Методика досліджень. Дослідження проводилися в рамках реалізації пілотного міжнародного проєкту в умовах дослідного поля Поліського національного університету, що розташоване поблизу с. Велика Горбаша Черняхівської селищної територіальної громади Житомирського району Житомирської області (28°41'33"B50°26'24"C). Підібрана для закладки експерименту ділянка механічно не оброблялася більше 3 років, була вкрита змішаною дикорослою рослинністю, мала добре сформовану дернину та за класифікацією підлягала під категорію – переліг. Ґрунти дослідної ділянки – ясно-сірі лісові, що характеризуються низьким вмістом гумусу і основних елементів живлення та підвищеною кислотністю.

Результати досліджень. Варто відмітити, що у модельному досліді використовувалася ділянка, яка була вкрита бур'яновою рослинністю та попередньо механічно не оброблялася. Метою наших досліджень було визначення можливості використання дрону для відсіву різних норм та динаміки розвитку посівів олійної редьки. Також в рамках експерименту визначалася можливість її адаптації і конкурентоспроможності в умовах високого природного рівня забур'яненості. При цьому нами було відпрацьовано два технологічні напрямки: безгербіцидна та гербіцидна технології. Так, за умов безгербіцидної технології посів здійснювався безпосередньо у бур'янову рослинність та дернину, а за умов гербіцидного обробітку - попередньо була проведена обробка препаратом Раундап у нормі 2 л/га (діюча речовина гліфосат).

В рамках проведення досліджень вирощування редьки олійної в якості сидеральної культури ми використовували такі норми висіву: 80 шт/м², 320 шт/м², 560 шт/м² та 800 шт/м². Повторність досліджень трьох кратна. Посів здійснювався 06.06.2024 року. Відбір та аналіз стану посіві проводився з інтервалом в 20 днів.

Таблиця 1

Динаміка розвитку рослин олійної редьки за різних норм висіву, 06.06.2024 (середнє, 3 кратна повторність)

Культура	Технологія	Норма висіву насіння (шт/м²)	густота рослин, шт/м²	% виживабельності
Редька олійна	Без застосування гербіциду	80	68	85,0
		320	284	88,8
		560	477	85,2
		800	702	87,8
	Обробка гліфосатом	80	75	93,8
		320	296	92,5
		560	498	88,9
		800	743	92,9

Як видно з таблиці 1, за контрольної технології (без застосування гербіциду) з нормою висіву 80 шт/м², густота рослин на момент сходів становила 68 шт/м², що становило 85 % виживабельності, а це в свою чергу був найнижчий показник. Найвища виживабельність спостерігалася за умов посіву 320 шт/м², де відсоток складав 88,8. За умов обробки гліфосатом найнижчий показник щодо схожості був відмічений 560 шт/м² при цьому густота рослин на момент сходів становила 498 шт/м², а це відповідно складало 88,9 % виживабельності. Найвищий показник за даної технології був нами зафіксований за норми висіву 80 шт/м² при цьому густота рослин склала 75 шт/м², що відповідає 93,8 %.

Таблиця 2

Динаміка розвитку рослин олійної редьки за різних норм висіву, 26.06.2024 (середнє, 3 кратна повторність)

Культура	Технологія	Норма висіву насіння (шт/м²)	густота рослин, шт/м²	% виживабельності
Редька олійна	Без застосування гербіциду	80	21	26,3
		320	83	25,9
		560	94	16,8
		800	223	27,9
	Обробка гліфосатом	80	63	78,8
		320	187	58,4
		560	192	34,3
		800	295	36,9

Через 20 днів нами повторно було проведено обстеження дослідних ділянок та виявлено як видно з таблиці 2, що за цей період за умов безгербіцидної технології, тобто прямого посіву у бур'янову рослинність, при нормі висіву 560 шт/м², спостерігалася найбільша кількість випадання рослин і їх густота склала 94 шт/м², що становило відповідно 16,8 % виживабельності. Найвищий від-

соток виживабельності рослин за даною технологією склав 27,9 % за максимальної норми висіву, що становила 800 шт/м².

На ділянці з гербіцидною обробкою показники виживабельності були значно вищими, хоча певні тенденційні залежності повторювалися. Так, зокрема найбільше випадання рослин спостерігалося за умов норми висіву 560 шт/м². При цьому виживабельність рослин становила 34,3 % або відповідно 192 шт. рослин на 1 м². Найвищі показники нами були зафіксовані за умов висіву 80 шт/м², де густота рослин через 20 днів становила 63 шт/м², що відповідно складало 78,8 %.

Таблиця 3

Динаміка розвитку рослин олійної редьки за різних норм висіву, 12.07.2024 (середнє, 3 кратна повторність)

Культура	Технологія	Норма висіву насіння (шт/м²)	густота рослин, шт/м²	% виживабельності
Редька олійна	Без застосування гербіциду	80	0	0,0
		320	0	0,0
		560	46	8,2
		800	108	13,5
	Обробка гліфосатом	80	38	47,5
		320	121	37,8
		560	150	26,8
		800	233	29,1

Третій відбір та аналіз виживабельності рослин нами був проведений 12.07.2024 року, тобто через 40 днів від сходів або 20 днів від проміжного відбору. За цих умов при безгербіцидній технології ми бачимо, що бур'янова рослинність повністю призвела до загибелі висіяних рослин редьки олійної на двох варіантах з нормою висіву 80 шт/м² та 320 шт/м². При цьому за умов норми висіву 560 шт/м² виживабельність склала 8,2 %, що становить 46 шт. рослин на 1 м², а за умов максимальної норми посіву 800 шт/м² цей показник відповідно став 13,5 % або 108 шт/м².

Висновки. За результатами досліджень на ділянках, де застосовувалася гербіцидна технологія, динаміка розвитку рослин була дещо іншою. Повної загибелі рослин ми не спостерігаємо на жодному варіанті з досліджуваних норм висіву. При цьому найнижчий показник виживабельності рослин становить 26,8 %, за умов норми висіву 560 шт/м², а найвищий зафіксований на варіанті з нормою висіву 80 шт/м² і складає 47,5 %. Загалом аналізуючи отримані результати дослідження, ми можемо говорити про можливість та високу ефективність використання агродрону при посіві редьки олійної, навіть за умов високого ступеня забур'яненості ділянки або ж посіву в переліг (не проводився механічний обробіток ґрунту більше ніж 3 роки). Однак чітко прослідковується технологічна перевага за умов попередньої хімічної обробки ділянки, спостерігаються достатньо високі показники виживабельності та розвитку рослин. Отримані результати можуть бути ефективно використані в важкодоступних районах на ґрунтах, які потребують відновлення та еродованих територіях, що значно скорочує економічні та енергетичні витрати на їх ефективне відновлення.

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РІСТ ТА РОЗВИТОК РОСЛИН КАРТОПЛІ ЗА РІЗНИХ СИСТЕМ УДОБРЕННЯ

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GROWTH AND DEVELOPMENT OF POTATO PLANTS UNDER DIFFERENT FERTILIZER SYSTEMS

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АНОТАЦІЯ

В статті розглянуто результати впливу варіантів удобрення: гною, 50 т/га та мінеральних добрив з по-закореневим внесенням біологічних препаратів Триходермін, Гаупсин, Azoter F® на ріст і розвиток рослин картоплі. В ході дослідження встановлено, що картопля позитивно відгукується на внесення добрив, так період вегетації картоплі за варіанту удобрення $N_{50}P_{40}K_{70}$ збільшився на 6 діб. Використання біологічних препаратів, зокрема Azoter F® сприяло зростанню вегетації за різних варіантів удобрення на 9-10 діб. Площа листкової поверхні картоплі, найкраще формувалася за варіанту удобрення $N_{50}P_{40}K_{70}$. Так у фазу повних сходів вона зростала на 1-3% залежно від варіанту удобрення та біологічних препаратів, а за фази цвітіння площа листкової поверхні зростала на 40-47% порівняно до варіанту без використання добрив.

Найвищий фотосинтетичний потенціал картопля формує за варіанту з використанням гною, де він становив 916 тис. м²/га *діб. Внесення позакоренево біологічних препаратів Гаупсин і Azoter F® за даного варіанту удобрення було найбільш ефективним, показники фотосинтетичного потенціалу варіювали в межах 1009 та 1032 тис. м²/га *діб.

ABSTRACT

The article discusses the results of the influence of fertilization options: manure, 50 t/ha and mineral fertilizers with foliar application of biological preparations Trichodermin, Haupsin, Azoter F® on the growth and development of potato plants. The study found that potatoes responded positively to fertilization, so the growing season of potatoes in the fertilizer variant $N_{50}P_{40}K_{70}$ increased by 6 days. The use of biological preparations, in particular Azoter F®, contributed to the growth of vegetation under different fertilization options for 9-10 days. The area of the leaf surface of potatoes was best formed in the fertilizer variant $N_{50}P_{40}K_{70}$. Thus, in the phase of full germination, it increased by 1-3% depending on the fertilizer and biological products, and in the flowering phase, the leaf surface area increased by 40-47% compared to the variant without fertilizer.

The highest photosynthetic potential of potatoes is formed in the variant with the use of manure, where it was 916 thousand m²/ha *day. The foliar application of biological preparations Haupsin and Azoter F® under this fertilization option was the most effective, the photosynthetic potential indicators varied within 1009 and 1032 thousand m²/ha *day.

Ключові слова: варіанти удобрення, біологічні препарати, позакореневе внесення, картопля.
Keywords: fertilizer options, biological products, foliar application, potatoes.

Постановка проблеми. Однією з найпродук-тивніших сільськогосподарських культур помірної кліматичної зони є картопля. Картоплю, на сьогод-нішній день, вирощують у більше ніж 130 країнах світу, особливу перевагу культура надає районам північної півкулі, які характеризуються помірним кліматом та легкими за гранулометричним складом ґрунтами [9-10]. Майже в цілому 300 млн. т бульб збирають щорічно. Основними країнами, які займа-ються її вирощуванням є Китай, США, Німеччина, Індія і Україна [1, 2]. Частка виробництва картоплі для нашої країни становить приблизно 6% від сві-тового виробництва картоплі, це зумовлено в пе-ршу чергу сприятливим кліматом та попитом на

дану продукцію серед населення. Картопля в Україні вирощується, як в традиційно районових зонах, зокрема Поліссся, так і в Степу України, який характеризується несприятливими умовами для її вирощування [4].

Аналіз останніх досліджень та публікацій. Картóпля (Solanum tuberosum L.) належить до родини пасльонових та є дуже поширеною сільськогосподарською культурою, яку в народі ще називають «другим хлібом». Вона є однією з найважливіших продовольчих, кормових та технічних культур. Картопля є однорічною культурою в промисловому вирощуванні та багаторічною культурою, коли зростає у дикому стані, трав'яниста рослина родини пасльонових [5-7].

Слід чітко розумітися на біологічних та екологічних основах продуктивності картоплі. Формування високого врожаю картоплі залежить від факторів, які можливо умовно поділити на дві групи:

регулюванні та нерегульовані [3, 9]. До регульованих факторів належить: якість і фізіологічний стан насіннєвого матеріалу, скоростиглість сорту, ґрунтові особливості, удобрення, ураження шкідниками і хворобами, густота садіння, вологозабезпечення, щільність ґрунту тощо. До нерегульованих факторів відноситься температура повітря та ґрунту, вологість повітря, інтенсивність сонячного світла, швидкість вітру [8, 11].

Мета досліджень полягала у вивченні впливу варіантів удобрення та позакореневого підживлення біологічними препаратами на формування площі листкової поверхні та фотосинтетичного потенціалу.

Результати дослідження. Нами проаналізовано результати досліджень, щодо сходів картоплі сорту «Повінь» протягом 2023-2024 рр.. Згідно результатів досліджень сходи картоплі з'являлися впродовж 15-16 діб (рис.1).
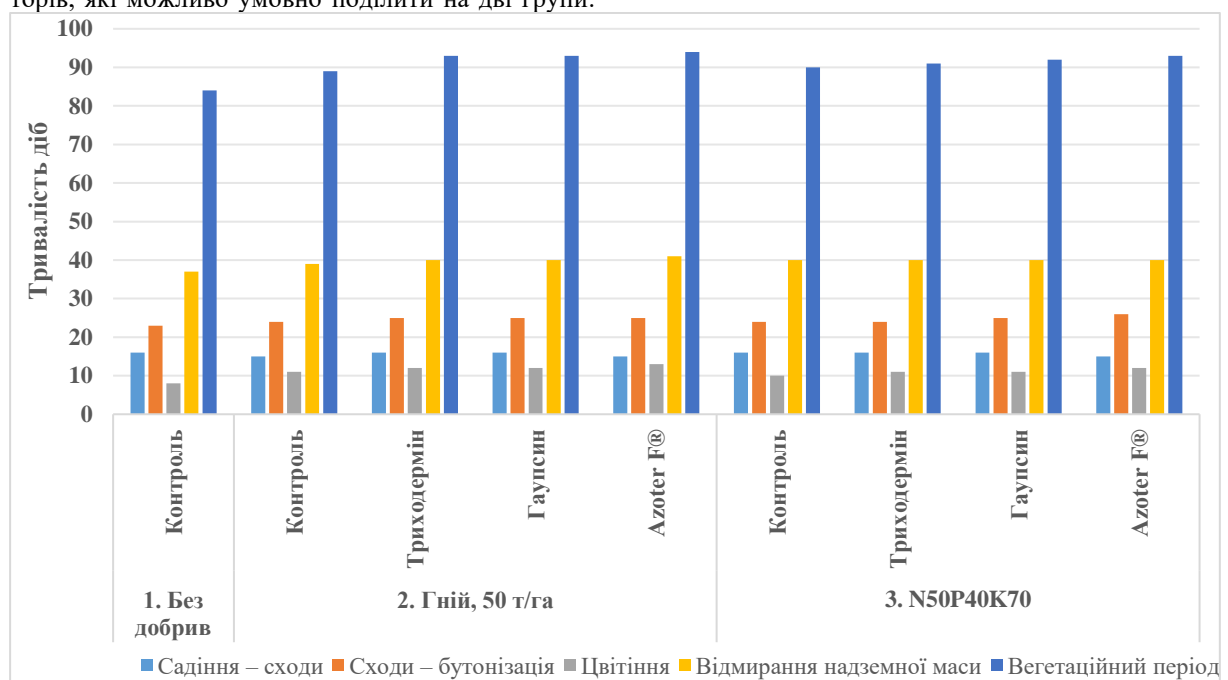
Рис. 1. Фенологічні фази росту й розвитку рослин картоплі сорту Повінь залежно від впливу добрив і біологічних препаратів (середнє за 2023-2024 рр.), діб.

Картопля у фазу бутонізація вступила через 23-26 діб, що для даного сорту є типовим.

Цвітіння картоплі тривало від 8 до 13 діб. Найкоротшим цвітіння було за біологічного контролю та скло 8 діб. Найдовше цвітіння тривало за умов органічної системи удобрення при використанні біологічного препарату Azoter F® та скло 13 діб.

Відмирання надземної маси рослин картоплі було найкоротшим за варіанту без добрив – 37 діб, за варіанту гній, 50 т/га – 38 діб та за варіанту $N_{50}P_{40}K_{70}$ – 40 діб.

В наших дослідах період вегетації картоплі тривав у середньому 84-94 доби.

Кількість стебел картоплі у фазу бутонізації за роки дослідження склала 244 тис. шт./га та була за варіанту без внесення добрив (рис. 2). Це є найменший показник, щодо формування стеблостою.

Найвищі показники, щодо формування стеблостою відмічені за мінеральної системи удобрення – 329 тис. шт./га.
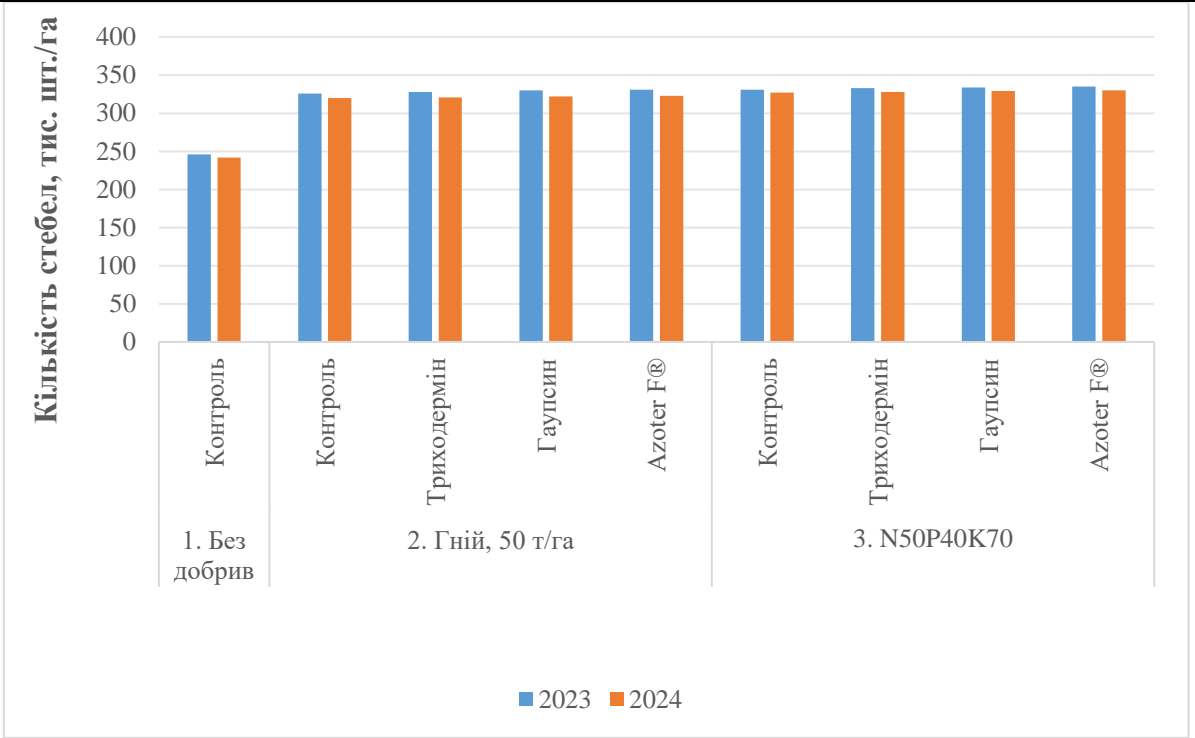
Рис. 2. Вплив добрив та біопрепаратів на кількість стебел в агроценозі картоплі у фазу бутонізації, тис. шт./га (середнє за 2023-2024 рр.)

Використання добрив при вирощуванні картоплі мало позитивний вплив на формування величини площі листкової поверхні, як видно з рис. 3. У фазу повних сходів площа листкової поверхні збільшувалася на 1-3% залежно від варіанту удобрення та біологічних препаратів. Площа листкової поверхні за фази цвітіння, на удобреному фоні збільшилась на 40-47% у порівнянні з біологічним контролем.
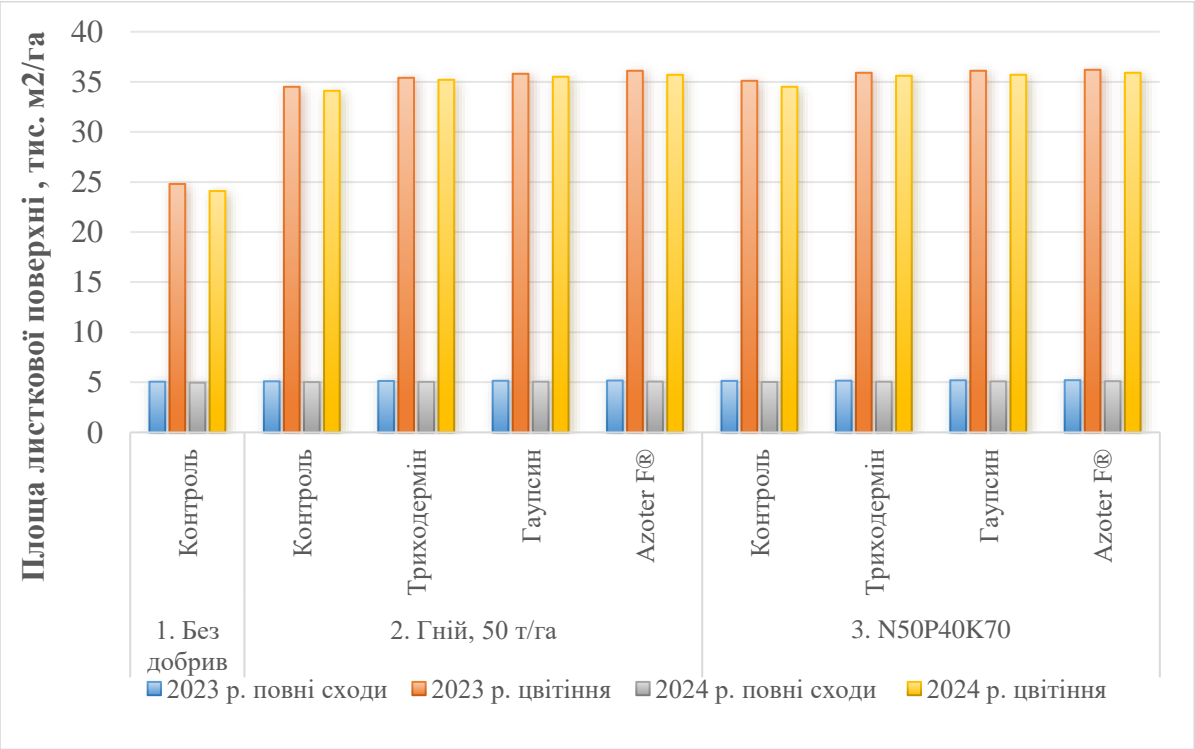
Рис. 3. Вплив добрив та біологічних препаратів на формування площі листкової поверхні картоплі за фази повні сходи та цвітіння, тис. м²/га.

Важливим показником, який безпосередньо впливає на продукційний процес рослин картоплі є фотосинтетичний потенціал посіву.

Згідно результатів наших досліджень рис. 4, встановлено, що фотосинтетичний потенціал картоплі був найвищим за варіанту з використанням

гною та склав 916 тис. м²/га *діб. За даного варіанту позакореневе внесення біологічних препаратів було найбільш ефективним та становило 1032 тис. м²/га

*діб при застосуванні Azoter F® та 1009 тис. м²/га *діб при застосуванні Гаупсин.
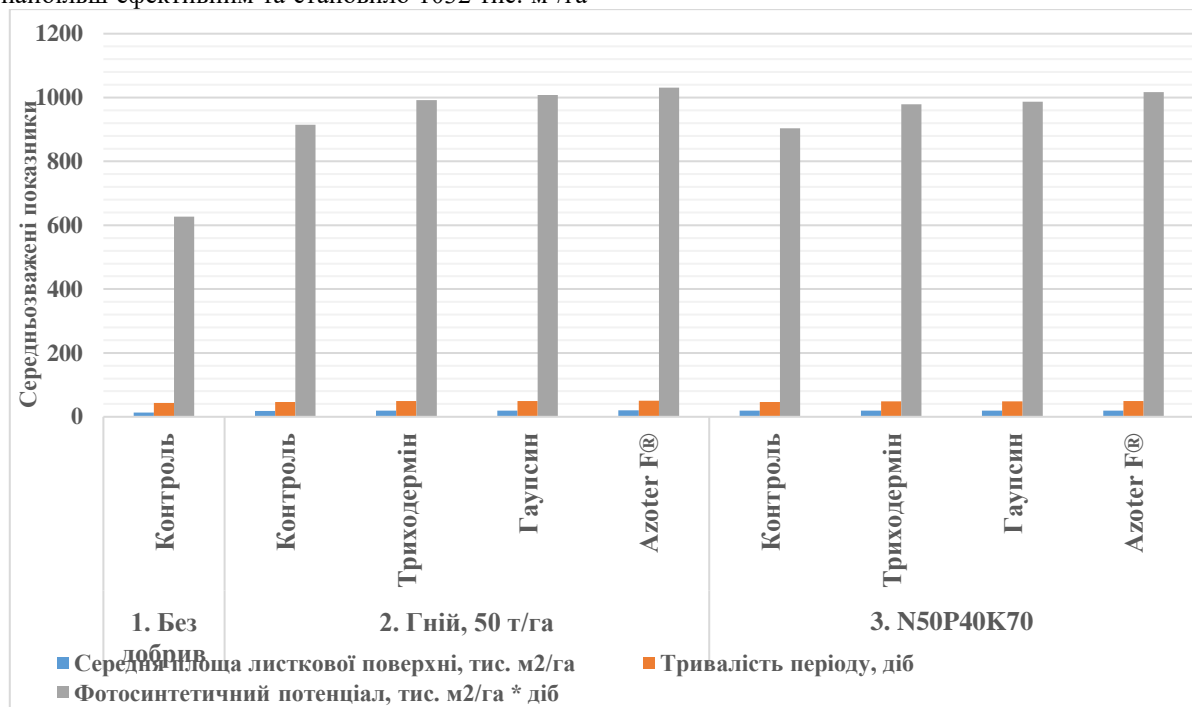
Рис. 4. Формування фотосинтетичного потенціалу картоплі сорту Повінь в міжфазні періоди «повні сходи – цвітіння», середнє за 2023-2024 рр.

Висновки. Отже, результати дослідження підтверджують, що картопля сорту Повінь дуже добре зростає при внесенні органічних видів добрив, зокрема гною. Так найвищий фотосинтетичний потенціал вона формує за варіанту з використанням гною, 50 т/га, де показник фотосинтетичного потенціалу становив 916 тис. м²/га *діб. Позакореневе внесення біологічного препарату Azoter F® сприяло найвищому зростанню фотосинтетичного потенціалу та склало 1032 тис. м²/га *діб.

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ART STUDIES

POINT OF VIEW, PLOT, AND STRUCTURE: REGIONAL CULTURAL EXPRESSION STRATEGIES IN INNER MONGOLIAN NATIONAL FILMS OF THE 21ST CENTURY

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ABSTRACT

Since the beginning of the 21st century, inner Mongolian films have decisively explored and portrayed the vibrant cultural life of ethnic regions. These films leverage distinct perspectives, compelling plots, and well-structured narratives to powerfully convey their histories. This article reveals that viewpoints can be explored for purposes beyond merely reflecting a region's culture, inviting us to expand our understanding and appreciation of diverse experiences. An appropriate and dramatic plot will evoke national and regional culture into the audience's mind with the plot, giving a lasting impact. The linear causality structure allows for establishing and expanding regional culture alongside its framework, which becomes an organic component of the structure and an object for latent expression. The plot structure emphasizes regional culture as a central theme in the film, contributing to a "documentary" style. The best structure for showcasing a region's culture depends on the filmmaker's creative intent, communicative goals, and other relevant factors.

Keywords: inner Mongolian national film, national culture, actions, viewpoint, structure.

In general, "minority regional culture" refers to a particular cultural heritage with a lengthy history, distinct personality, and lasting influence in a minority territory. This includes local ecology, folklore, traditions, practices, and other material and natural culture types. Ideas like "inner inner Mongolian national cinema" have been continuously discussed in scholarly forums. Wang Zhimin proposed three principles, namely "one fundamental principle" (culture principle) and "two guarantee principles" (author principle, subject matter principle), to judge whether a film can be classified as a "minority film." [1] The inner Mongolian films discussed in this article were written, directed, and acted by inner Mongolians, and they reflect their culture in terms of culture and content.

Since the new century, as globalization and modernity have permeated present life conditions, the inner Mongolian people's lifestyle, cultural appearance, folk practices, and other regional cultures have faced significant challenges. Since the turn of the century, inner Mongolian national cinema has focused greatly on expressing divisions between cultures and has done an excellent job of reminding the general public to be mindful of the preservation and transmission of the country's culture. Inner Mongolian films should depict the local culture when conveying cultural problems in the twenty-first century. This article examines each region's performance and role in inner Mongolian cinema from various angles, plots, and structures to obtain a more comprehensive and in-depth understanding of regional cultural expression tactics in inner Mongolian cinema.

1. Point of View: Introducing an Object and Exploring Its Hidden Function

Point of view denotes the distinct perspective and angle from which the object in a film is observed. It manifests throughout the narrative, often remaining unarticulated. By reading with a keen awareness of this concept, one can recognize the pervasive influence of point of view in various story elements. [2] There are usually two points of view to consider when editing a film: the narrative and the physical. [3] Reading the movie from its narrative point of view, examining it from an inward viewpoint, and comprehending its performance and function are all considered forms of "visionary observation."

Narrative points of view come in a variety. According to Todorov's classification, narrative point of view can be broadly divided into three types: omniscient point of view (narrator > character), internal point of view (narrator = character), and external point of view (narrator < character) [4]. The omniscient narrator always knows more than the characters: the secret desires of the characters, the thoughts of several characters, and the events that the characters do not understand. This point of view might be thought of as a method of "from behind" observation. From the internal point of view, the narrator is just as knowledgeable as the characters; therefore, if the characters are unable to explain the occurrences, the narrator is unable to provide the reader with an explanation. A method of observing "together" (narrator and character), sometimes in the first person and other times in the third, is called an internal point of view. The narrator's reaction to an omniscient point of view that is less knowledgeable than any of the characters in the work is known as the external point of view. This method of witnessing "from the outside" (the narrator) allows him to just describe the characters' speech and actions to the reader while remaining unaware of their innermost thoughts or feelings. [4] Drama and suspense are the traits or benefits of the external point of view, which are useful for engrossing the reader in the reconstruction but unsuitable for accurately capturing the characters. In contrast to the omniscient point of view, both the outward and internal points of view are "points of limited knowledge."

Inner Mongolian films have distinct natural ecosystems, folk rituals, and historical and cultural inheritance, all of which combine to offer a novel experience for viewers. The way the film is seen has a direct impact on the communication outcome, allowing the audience

to see, feel, and experience the distinct culture of that ethnicity or place. In contrast to literature, film is a method of presenting information that primarily impacts the viewer's visual, auditory, and other sensory organs, rather than the cognitive perspective. This frame of view allows for direct and thorough information gathering while remaining subject to sensory limits. For example, if you are at home, you can not look outside without opening the doors and windows. In this scenario, employing an omniscient viewpoint in the narrative might result in a more accurate and realistic image of national and regional cultures. Since the turn of the century, the omniscient point of view has been the most commonly employed narrative premise in inner Mongolian cinema.

Inner Mongolian regional culture consists primarily of natural scenery, historical and cultural landmarks, and folk practices. Being omniscient, the film may express various cultural forms in a comprehensive and relevant way, resulting in improved communication outcomes. In the film "Urtiin Duu," for instance, the inner Mongolian countryside was frequently portrayed as a panorama, sometimes as a long shot with a blank frame and other times as a background, creating an uncomfortable visual impression. had a profound effect on the crowd. Additionally, the audience is shown inner Mongolian cuisine customs, wedding and burial rites, and festivals from the perspective of cognition. The same omniscient but limited point of view is used in "Grey of Time," which shows the same desert scenery, shamans begging for rain, horse-herding ceremonies, fire rituals, and other regional cultural patterns one after the other. For instance, in "Heavenly Grassland," a Chinese child named Huzi portrays the "other." The nature, festivals, fire sacrifices, customs, and straightforward and giving humanity to the herdsmen of the inner Mongolian grasslands are all depicted in great detail by Huzi, who plays the first-person character in this movie from his limited point of view. Huzi needed medical attention because he was mentally "ill" when he got to the steppes of Mongolia. The beautiful grasslands, the straightforward and devoted folk traditions of the inner Mongolian people, and the generosity of herdsmen all helped to heal him. When he eventually won the horse race, he was unable to speak and yelled "Tenger" in inner Mongolian. In this sense, the movie presents regional culture from the narrow viewpoint of the "other," which is not merely a performance and is better able to examine the hidden function of national regional culture than a straightforward omniscient point of view. It is an omniscient effect. As a result, the point of view that is shown in the movie has to do with both the study of the object's function and its real portrayal.

1.   The cultural expression of national regions and events

Themes and events that convey regional and national culture are also necessary for inner Mongolian national cinema. "All the events that are given to us or that we can deduce" is what history is. "An arrangement or construction of multiple events in some form or structure" is what is meant by an event.[5] Film is a narrative art form, and its main purpose is to tell a tale from beginning to end. According to Forster's definition, a plot is similarly an account of events, and a story is generally a chronological record of occurrences. For instance, the narrative "The king died, and shortly the queen also passed away" is an example. Furthermore, the plot of "The king died, and soon the queen too died of grief" [5] In contrast to narrative works like novels, cinema screenplays are more focused on event organization and have a more condensed period. Strive to complete the story within the time frame given, expressing the author's goal completely at the end.

For certain inner Mongolian films, the primary and fundamental goal is to promote and depict the ethnic nation's vibrant culture. But these kinds of performances and ads cannot be as simple as documentaries. Therefore, as the plot develops naturally, the majority of creators expose national and regional cultures. The audience will be able to apply the author's subjective ideas, comprehend the knowledge associated with the story, and identify the effect of the regional culture of a few ethnic groups while they enjoy it. Since the creative planning of events is primarily responsible for achieving this intentional ethos of the inner Mongolian national cinema, it is worthwhile to investigate how the events might be organized to better convey them. There are two broad categories into which inner Mongolian national films from the new century can be categorized in terms of plot and performance impact. One is that narrative hints are quite obvious, the film's plot goes forward, and the depiction of regional culture lacks cohesion and subjectivity. The other type is characterized by imprecise plot hints and a sluggish plot, but the presentation of regional culture is dominant and has excellent continuity.

In the first scenario, a film with a relatively clear storyline shows the audience a clear story with clear characters, ups and downs, plot, development, climax, and ending that are relatively complete. For example, in the film "Urtiin Duu" (inner Mongolian Long Song), Chitsige and her husband Bat visited Beijing to promote inner Mongolian melodies. He was a veterinarian in the Bat Plains, so he moved to Beijing and worked at an equestrian club. In the second situation, for example, a film with ambiguous narrative hints and an unfinished story chain lacks a coherent plot capable of holding the audience's interest. Then, other aspects of the depiction, such as the expression of national and regional culture, might capture the audience's attention and highlight its features. Shilinfu, for instance, is frequently depicted in "Mother" from a diverse perspective and consistently feels cut off from the local cattlemen. Only during the horse-feeding scene does she engage with the local herdsmen. From a narrative perspective, the plot is incomplete, lacks a distinct plot chain, and resembles a "thrust culture" story, which is insufficient to evoke interest in audiences. The character is comparable to a visitor who has arrived in a distant country in this regard. Through his findings and observations, he assesses Mongolia's natural beauty, human emotions, humanity, and traditional practices. Their fate only has significance if it is tied to their national culture. They function as a way to depict regional and national cultures in movies. While the novel is complete, its organization is no longer apparent, compact, cohesive, and

dominant since the events that comprise it are not bound to a certain period.

2. Structure: linear structure, text structure, and national and regional cultural expression

The structure is a key component of Inner Mongolian national films that reflect the culture of the region. In general, structure refers to the location, arrangement, and organization of the different parts of objects; its qualities and integrity serve as the group's means of connection. The film's structure is partly isomorphic to that of real life, making it challenging to categorize into a single, set pattern because it is as intricate and varied as life itself. But in the end, living structures and high-resolution creative structures are not the same. Only a few number of structural shapes are prevalent among the many different kinds. The chronological type, memory type, and time-space intermediate type are examples of basic types from the perspective of time and space. It makes sense to say that there are plays, variations, books, and other genres. Furthermore, even though one structural form dominates the movie, it is impossible to ignore how other structural forms contribute to the script's weaving and create a hybrid structure.

Traditional linear causal, novel, and plot structures are the most often employed structural techniques in movies. A dramatic structure is another name for a linear causal structure that is based on a dramatic conflict and adheres to the rule of cause and effect. The process of conflict development is one of the narrative hints that may be found in structural aspects including beginning, development, the culmination, and ending. [6] However, dramatic structure is not restricted by causality and can take many other shapes. The terms "dramatic" and "causal" cannot be used interchangeably, particularly considering the distinctions between stage plays and movies. Consequently, some scholars think that a "linear causal structure" is a clear definition of the movie's dramatic structure. [7] The novel-style structure is more adaptable to shifts in time and space, with a concentration on gradual structural development rather than chasing great drama. Essay structure is also known as documentary structure or topic change structure, and its defining element is documentary. A single theme rules the entire tale and events, as opposed to variations on a musical theme; it avoids dramatic conflict and does not employ artistic techniques such as metaphors, connections, or flashbacks.

The inner Mongolian film's structure has presented a complex form since the beginning of the century. More linear causal and plot structures are typically employed. Regional cultural presentation will be impacted differently by various structural forms. A common movie with a linear cause-and-effect framework is "Gray of Time." The film tells the narrative of the Urigen family's horse purchase, highlighting the contrast between living on the prairie and life in the city. Finally, to send their son to school, the Urigene family sold their remaining sheep, destroyed their homesteads, and moved to the city. This is a very common linear causal pattern. On the one hand, this form emphasizes the clash between contemporary civilization and livestock farming culture. On the other hand, the rich customs of the national culture and regional characteristics are perfectly displayed. Also, many inner Mongolian films with script structure may be related to the director's "first" presentation goal. The structural feature of the novel is that the theme is clear but the narrative is not strong, which means that the causal relationship between the plots is unclear or nonexistent. As a structuring force to drive the development of the novel, the plot is inadequate, lacking compactness and coherent dramatic tension, and the prose and poetry. For example, in The Sky, the narrative is still told chronologically but seems linear. However, the play as a whole lacks clues to a specific event that could create a dramatic conflict, and the causal connection between events and scenes is very weak. The entire play describes the rural life of Huzi, the son of Han. Therefore, the film does not have a clear and strong dramatic conflict, as is characteristic of the novel. Still, various plots, scenes, and paragraphs are united under a theme and serve as an explanation of the theme. However, because the story is no longer the primary focus in this form, some aspects of the inner Mongolian culture—such as festivals, marriages, and fire rituals—will be emphasized, and the characters' actions will be largely substituted. Structure and size turn into additional forces.

As shown by the two structuring approaches analyzed in this article, national and regional cultural representations appear as structures that emerge in films that adopt a linear causal structure. It is not a structural force that drives the development of the story, but an important factor in the structure and an object of expression implicit in the structure. In a film with a plot structure, the causal connections between the plots are weak and broken, the drama is not strong, and the overall plot is prose and poetry. The area culture is a significant structural element that gives the film a particular "documentary" feel, although the novel is not always an effective structuring force in films. It is challenging to determine which structural approach is more suitable and expressive for inner Mongolian films. It mostly depends on elements like the film's artistic purpose and the reasons behind its release.

3. Conclusion

Inner Mongolian films have always been deeply impacted by the traits and distinguishing features of the national culture. Since the start of the century, as globalization and modernization have increased, cultural conflict and identity anxiety have grown more intense. This video depicts the current state of national culture in the context of globalization and modernity, as well as the uneasy connection with modernism that is central to inner Mongolian films in the new century. This article provides an analysis of the use of perspective, plot, and structure in inner Mongolian national films, emphasizing their relevance to the narrative art of ethnic regional culture. It posits that these elements play a crucial role in the effective dissemination of both national and regional culture. This technical analysis is pertinent to understanding the overall communication impact of films and therefore warrants the attention of both creators and scholars in the field.

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ECONOMIC SCIENCES

ANALYSIS OF FACTORS DESCRIBING AND EXPLAINING THE STANDARD OF LIVING IN ARMENIA USING A VECTOR AUTOREGRESSIVE MODEL[1]

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ABSTRACT
The purpose of the study is to determine the nature and significance of the influence of the main internal and external economic factors (including revenues and expenditures of the state budget) on indicators characterizing the standard of living. In the current study, an attempt was made to assess the role of various macroeconomic factors, including internal and external economic factors influencing changes in living standards, using a vector autoregressive model. The study used quarterly data of individual indicators for 2008-2024. The growth patterns of indicators describing the standard of living were also touched upon, in particular, they were derived, to what extent the observed changes in the factor are explained by internal and external indicators included in the system. Within the framework of the factors considered, the share of consumer loans in GDP and a relatively lower unemployment and inflation level has the most tangible impact. Inflation and its expectations can also lead to changes in the current reduction in consumption or its dynamics, changing the behavior of households, including reactions to budget revenues and expenditures, GDP per capita, and indicators characterizing the standard of living, in general, are relatively not noticeable. As a result of the study, the order of importance of the role of the observed internal and external factors in changes in indicators characterizing the standard of living was revealed under a decrease in the overall effect over 4 years.

Keywords: standard of living, GDP per capita, poverty level, Gini coefficient, wages, consumption, internal and external factors.

Introduction

The standard of living is a pivotal determinant of population well-being, which includes several socio-economic indicators, including income, employment, education, health, and housing. The standard of living is often characterized by indicators such as gross domestic product (GDP) per capita, unemployment, poverty, income, consumption, and access to basic services. These indicators are influenced by many interrelated factors: The economic development in Armenia has not gone smoothly. The country's economic environment has been shaped by several challenges, including post-Soviet economic restructuring, financial crises, global epidemics, and regional conflicts. This has resulted in fluctuations in living standards, which are characterized by significant differences between urban and rural areas and various socio-economic groups. Income is a principal factor influencing the standard of living, which directly affects purchasing power and the quality of household consumption. The development of the Armenian economy, which depends on transfers, agriculture, and, more recently, the IT sector, represents a distinctive system of intricate problems and opportunities in this regard. The availability of employment opportunities and the level of remuneration are of paramount importance in determining household income. Inequality in income distribution serves to reinforce socioeconomic inequality, which, in turn, exerts a considerable influence on the volume, quality, and structure of consumption. It is therefore evident that the

government's fiscal policy plays an important role in the reduction of inequality. Consequently, policymakers and stakeholders must gain a comprehensive understanding of the factors involved to develop effective strategies aimed at improving the quality of life of the population. The objective of this study is to ascertain the nature and significance of the impact of the principal internal and external economic factors (including revenues and expenditures of the state budget) on indicators that characterize the standard of living.

Literature review

Identifying the factors that influence the formation of living standards has always been a focus of attention for various researchers and policymakers. Identifying the causes of inequality and increasing the inclusiveness of policies are the main objectives. The choice of the range and composition of factors considered depends on the characteristics of the country or countries, existing trends and the methods used in the study: Some modern researchers consider it important to assess the impact of economic freedom on living standards. Pelayo Moricel and others, in their study on the impact of economic freedom on living standards and economic growth, try to analyse how economic decisions taken by governments in emerging economies, based on economic freedom, affect economic growth and human development [1]. The analysis is based on panel data for the period 2013-2022, comprising 53 developing countries in Latin America and Asia. The results indicate that there is a statistically insignificant relationship between economic freedom and human development. This research contributes to a more nuanced understanding of the functioning of free market-based policy models and enhances the quality of policy implementation. In economies that rely on external currency flows, it is crucial to assess the influence of foreign exchange reserves and flows on the standard of living and the underlying factors that shape it. In their study, V. Kanishka and V. Lakmal examine the impact of foreign exchange reserves on the standard of living of Sri Lankan citizens [2]. In order to elucidate the underlying causes of the crisis situation in Sri Lanka, a number of economic variables have been identified for further analysis. These include exports, external debt, transfers and foreign exchange reserves. The authors consider gross national income per capita to be a factor that characterises the standard of living. The results demonstrated that exports, external debt and foreign exchange reserves exerted a positive and statistically significant influence on the standard of living of Sri Lankan citizens. Conversely, foreign transfers did not exhibit a notable impact. H. Jingwe and colleagues seek to conceptualise shifts in living standards in developing countries as analogous to carbon dioxide emissions in the context of economic growth [3]. The challenge facing developing countries, defined as low- and middle-income countries with rapid population and GDP growth, is to improve living standards while stabilizing carbon dioxide emissions. The authors quantify the emissions required to achieve a satisfactory standard of living in emerging economies. The findings indicate that, in comparison to other regions, the attainment of a satisfactory quality of life in emerging market countries will result in incremental emissions that do not pose a threat to the global climate. However, an alarming trend is emerging, with more than half (62 out of 121) of emerging market countries facing significant challenges in achieving the expected growth in emissions.

This is to certify that: In their analysis of the challenges facing humanity in recent years, Kucheryava and A. Karalev highlight the necessity for a more comprehensive approach to ensuring a decent standard of living. They argue that this should encompass not only material needs but also the spiritual dimensions of human existence [4]. An evaluation of the principal characteristics and indicators of living standards in the most developed countries in the world reveals that the countries in the eurozone lead in most parameters. However, the impact of the coronavirus pandemic and the Russian-Ukrainian war has significantly constrained the capacity of governments to maintain these standards. The authors posit that the foundation for sustaining a consistently elevated standard of living in leading countries is the income policy pursued by their governments. This primarily entails maintaining a high level of labour and, consequently, high wages. In their article, N. Gerasimchuk, O. Pashchenko and O. Zharikova examine the structure of income and expenditure of the rural population in Ukraine and its impact on living standards [5]. The authors posit that, despite the favorable trends in wage growth, the remuneration received by those employed in the agricultural sector remains at a markedly low level. Ultimately, it is shaped by a multitude of factors, including inflationary pressures, the broader economic context within the country, government regulations, and other considerations. This is due to the absence of requisite financial resources for consumption. Consequently, rural households engage in the production of foodstuffs to satisfy their personal requirements. The deficit in essential food consumption is offset by an increase in the consumption of oil, other vegetable fats and flour products. An increase in the proportion of expenditure on non-food products is indicative of an improvement in the standard of living experienced by rural households. The low wages of the working-age population, coupled with cultural and household needs, and the lack of developed infrastructure, have a detrimental impact on the standard of living of the rural population, leading to a significant exodus to urban areas. The ongoing conflict between Russia and Ukraine has further exacerbated the situation, resulting in a notable decline in the standard of living of households. The reduction in income and the rise in household expenditure were influenced by several factors, including job loss, a lack of stable income, the necessity for unplanned expenditure and the migration of the population, as well as the threat to life and the resulting fear. In a separate study based on the Thai economy, the authors demonstrate that, despite historically high GDP growth rates, the country experienced a recession following the global pandemic caused by the global crisis and trade tensions [6]. The authors examine the role of sectoral investments, underscoring the preponderant influence of services and industries in which agriculture plays a diminished but nevertheless substantial role. The study analyses a number of key economic indicators, including the level of investment,

government spending, net exports and industrial products, and their impact on GDP. The majority of the analysis is dedicated to an examination of public policy, infrastructure development, trade and investment, as well as social considerations that have an impact on economic performance and living standards. The authors highlight the intricate interrelationship between economic growth and living standards in Thailand. The necessity for continued political reform, investment in infrastructure and the resolution of socio-economic issues is emphasised in order to guarantee sustainable development and enhance living standards.

Additionally, the Armenian researchers addressed the analysis of the factors that determine the standard of living. In their article on the analysis of incomes and expenditures of the population of the Republic of Armenia, R. Ghazaryan and S. Levonyan examine the composition and structure of household incomes and expenditures, as well as their dynamics over the past decade. The indicators were also subjected to analysis at the level of ten decile groups, which serves to indicate the degree of concentration of income among the population. In conclusion, the authors posit that the growth rate of the population's income in Armenia exceeds the growth rate of expenses. In 2018, the lowest decile group experienced a significant increase in income, largely attributable to wage income. The proportion of expenditure on services across all decile groups in the country is increasing year on year. In his dissertation on the economic and mathematical assessment of ways to increase the standard of living of the population of the Republic of Armenia [7], R. Ghazaryan evaluates the standard of living of the population of the Republic of Armenia and the ways of its growth. The primary indicators of living standards identified were GDP per capita, human development and the level of inequality within the country. The paper identifies the primary factors contributing to the wage gap in Armenia and assesses the influence of various economic and social determinants on wage levels. The paper analyses the relationship between economic growth and human development in Armenia, and reveals the nature of this mutual connection through empirical methods. The employed methods allow for the investigation of the relationship between the level of inequality in Armenia and foreign direct investment, as well as the assessment of the impact of these and a number of other factors on the level of inequality through the utilization of empirical methods [8].

Methodology

During the study, an attempt was made to assess the role of various macroeconomic factors, including internal and external factors influencing changes in living standards, using a vector autoregressive model. In the first stage, the following 3 groups of indicators were selected. *Internal factors:* Consumer price index compared to the same month last year, Unemployment rate, The share of consumer loans in GDP, State budget revenues, Expenditures of the state budget, The share of household consumption in total consumer spending. *External factors:* The average monthly exchange rate of the US dollar, Personal money transfers to Armenia, the balance of the financial account in accordance with the balance of payments, million US dollars. Factors characterizing the standard of living: GDP per capita, The level of poverty, Gin coefficient, Average monthly nominal salary.

The study used quarterly data for the selected indicators for the years 2008-2024. For those indicators for which quarterly data were not available (Gini coefficient and poverty level), their annual series, converted to quarterly using the linear interpolation method, were used.

Table 1

Designations used in the model and their meaning.

Designation	Meaning
d_cpicomparedtosamemonth	CPI compared to the same month last year (differenced)
d_unemployment	Unemployment rate (differenced)
d_consumerloanstogdpdollar	Share of consumer loans in GDP (differenced)
d_expensesstatebudget	State budget revenues (differenced)
d_statebudgetrevenues	State budget expenditures (differenced)
fevd_d_householdconsumptionshar	Share of household consumption in total consumption (differenced)
d_exchangerate	Average monthly USD exchange rate (differenced)
d_moneytransfers	Personal money transfers to RA (differenced)
d_financialaccountbalance	financial account balance (differenced)

At the subsequent stage of the analysis, the stationarity of the series was evaluated, specifically through the application of the Dickie-Fuller and Phillips-Perron tests, which demonstrated that a subset of the series exhibited non-stationary characteristics. In order to ascertain whether the ranks were stationary, the differences between the ranks, as well as the discrepancies between each quarterly cost and its preceding one, were calculated. The subsequent step was to construct a vector autoregression (VAR) model utilising the statistical software application Stata. In order to ensure the correct ordering of the factors within the VAR system, the endogeneity/exogeneity levels of the indicators were evaluated using the Granger causality test. The indicators included in the system, which are influenced by numerous factors and/or explain a smaller number of indicators, are relatively more endogenous; thus, they are placed at the end in the order of the VAR indicator table. The indicators that exert a greater influence on other indicators and are to a lesser extent influenced by them, that is, those that are relatively exogenous, were included at the outset of the process. As a result of the tests, the indicators were included in the model in a

clear order, from those that are relatively exogenous to those that are endogenous, from those that are less influenced by other indicators in the system to those that more strongly determine other indicators in the system:

1. Average monthly nominal salary
2. Gin Coefficient
3. GDP per capita
4. The share of household consumption in total consumer spending
5. Expenditures of the state budget
6. State budget revenues
7. The share of consumer loans in GDP
8. Unemployment rate
9. The level of poverty
10. Financial account balance
11. Personal money transfers to Armenia
12. The average monthly exchange rate of the US dollar
13. Consumer price index compared to the same month last year

The results of the test indicate that the internal and external factors selected in the system have a relatively minor impact on changes in the standard of living. Furthermore, the indicators characterizing the standard of living are primarily exogenous, exerting a greater influence on the selected internal and external factors than vice versa. The VAR was reconstructed in accordance with the specified order of indicators, ranging from exogenous to endogenous within the developed system. The resulting outcome is presented below.

Table 2.

VAR summary

```
Sample:  2009q3 - 2024q1                    Number of obs   =          59
Log likelihood =  -3149.536                 AIC             =   120.5266
FPE         =    4.52e+35                    HQIC            =   126.1073
Det(Sigma_ml)  =    1.30e+29                 SBIC            =   134.8229
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
d_montlyaverag~y	29	10356.7	0.6437	106.5866	0.0000
d_giniincagg	29	.002103	0.6283	99.65353	0.0000
d_gdppercapita	29	30.8174	0.7636	190.6235	0.0000
d_householdcon~e	29	2.96166	0.6093	92.02978	0.0000
d_expensesstat~t	29	522927	0.7426	170.2378	0.0000
d_statebudgetr~s	29	439176	0.7343	163.0607	0.0000
d_consumerloan~r	29	.302626	0.7312	160.5269	0.0000
d_unemployment	29	1.19086	0.7421	169.7825	0.0000
d_poverty	29	.299423	0.8306	289.3385	0.0000
d_studentenroll	29	.446888	0.7116	145.5731	0.0000
d_financialacc~e	29	143.448	0.7846	214.9532	0.0000
d_moneytransfers	29	87.9469	0.8299	287.7685	0.0000
d_exchangerate	29	9.1588	0.7378	166.0211	0.0000
d_cpicomparedt~h	29	1.4801	0.6624	115.7539	0.0000

Having checked whether the selected lag is the optimal one, it can be stated that, according to most criteria, the preferred lag for the model is the second.

Table 3.

Information criteria for choosing the optimal lag

```
Selection-order criteria
Sample:  2009q3 - 2024q1                              Number of obs      =       59
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-3701.48				2.8e+37	125.948	126.141	126.441*
1	-3380.68	641.6	196	0.000	4.7e+35	121.718	124.604*	129.113
2	-3149.54	462.28*	196	0.000	4.5e+35*	120.527*	126.107	134.823

When choosing higher lags, the model does not satisfy the stability condition, which is fulfilled for the second lag.

Table 4.

Results of the stability (stationarity) test of the model

Eigenvalue stability condition

Eigenvalue	Modulus
-.01566573 + .9132698i	.913404
-.01566573 - .9132698i	.913404
.8477589	.847759
.8086671 + .1818223i	.828856
.8086671 - .1818223i	.828856
-.8213125	.821313
-.03853367 + .7927021i	.793638
-.03853367 - .7927021i	.793638
.6407414 + .4202478i	.766262
.6407414 - .4202478i	.766262
-.1094916 + .7455759i	.753573
-.1094916 - .7455759i	.753573
-.5895003 + .3382293i	.679639
-.5895003 - .3382293i	.679639
-.2910119 + .5853081i	.653662
-.2910119 - .5853081i	.653662
.4621341 + .4055992i	.614881
.4621341 - .4055992i	.614881
-.5110774 + .3378116i	.612631
-.5110774 - .3378116i	.612631
.2463385 + .4945919i	.552543
.2463385 - .4945919i	.552543
-.3038084 + .4339559i	.529733
-.3038084 - .4339559i	.529733
.4448725	.444873
-.1833738 + .09049429i	.204488
-.1833738 - .09049429i	.204488
.1079315	.107932

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

In order to consider the constructed VAR significant, it is necessary that the selected delayed model does not have autocorrelation, which documents the test result shown in the figure.

Table 5.

Autocorrelation test results

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	311.9951	196	0.00000
2	170.9149	196	0.90172

H0: no autocorrelation at lag order

Analysis and results:

Moreover, the responses of five indicators that characterise the standard of living to the shock from selected internal and external factors were revealed. The graph illustrates the impact of a positive shock in the amount of one standard deviation unit in the corresponding indicator line on GDP per capita over the subsequent 16 quarters. The results demonstrate that among the factors considered, the share of consumer loans in GDP, as well as relatively lower unemployment and inflation, have the most pronounced impact. In particular, an increase in the proportion of consumer loans relative to a standard deviation has a negative impact on GDP per capita over the following two years. The initial shock has a detrimental impact on income distribution, poverty levels, and average monthly wages. Conversely, it has a favourable impact on these variables, although the positive effects are gradually diminishing. The aforementioned effects of consumer lending can be attributed to the nature of the cash flows generated by such lending. While this has a positive effect on consumption, subsequent negative flows generated by lending result in a reduction in the volume of further consumption. Furthermore, the periodic nature of economic development gives rise to additional risks for households in the context of this type of lending. A further decrease in income may create difficulties in repaying the loan. The issue may become more pronounced. Furthermore, inflation and its expectations can also precipitate shifts in the current reduction in consumption or its dynamics, thereby altering the behaviour of households. With regard to other indicators, including budget revenues and expenditures, GDP per

capita and indicators characterising the standard of living in general, the reactions are relatively insignificant.

With regard to the influence of state budgetary revenues and expenditures, it is evident that the impact of these on GDP per capita can be discerned by examining the reaction of the latter to the former's shocks. In the initial two quarters, the impact is observed to be negative; however, following this period, the impact is seen to become neutralized through the fading of fluctuations.

Taxation ultimately results in a reduction of income for both organizations and households, which in turn has a detrimental impact on the growth rate of GDP. This phenomenon can be attributed to two factors: firstly, the level of taxation exceeds the optimal tax burden, and secondly, the inefficiency of the state spending policy and its low level of inclusiveness.

The preponderance of current expenditures among public funds, while conducive to the growth of the population's income, fails to engender further impact on the increase in productivity, thereby nullifying its subsequent effects.

This is the reason why the impact of state budget expenditures on GDP per capita in the first three quarters was positive, after which the impact was reduced to zero again due to fading fluctuations. The influence of the state budget on other factors that contribute to the overall standard of living is comparatively limited. In particular, income policy generates a certain growth in the initial period, which can be explained by the initial negative impact of income policy on economic growth. However, in the future, this influence is positive, which we can further attribute to this shortcoming. It is possible that this can be attributed to unproductive and low inclusivity.
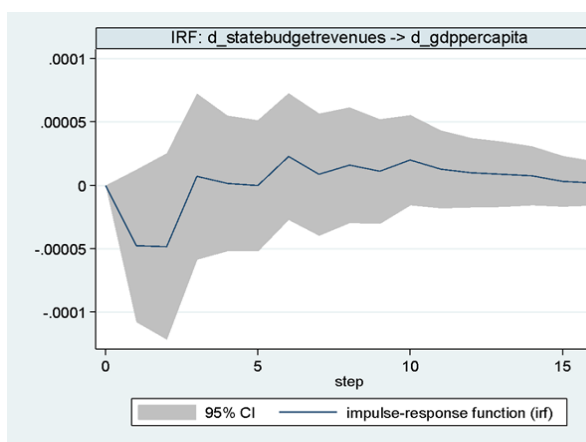
Graph 6. Responses of Per Capita GDP to One Standard Deviation Changes in Government Budget Revenues
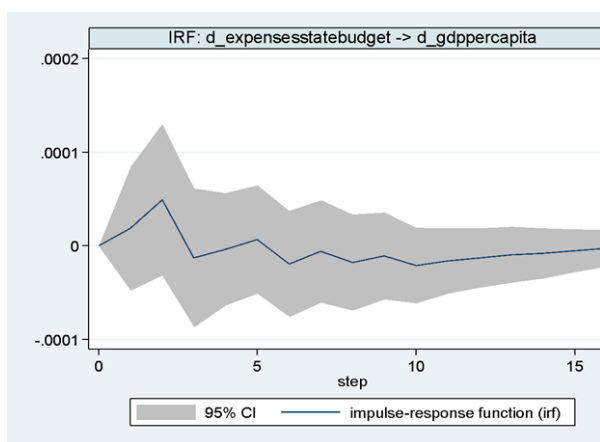
Graph 7. Responses of Per Capita GDP to One Standard Deviation Changes in Government Budget Expenditures
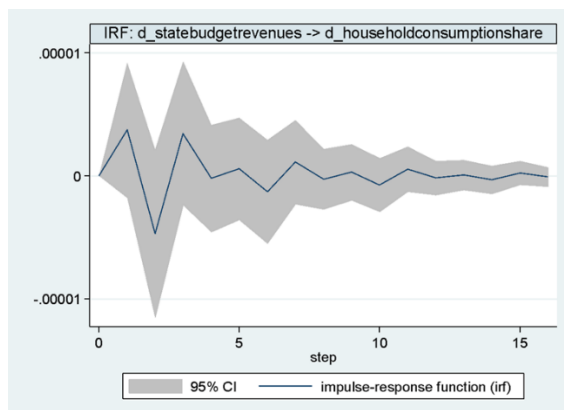
Graph 8. Responses of the Share of Household Consumption in Total Consumption to One Standard Deviation Changes in Government Budget Revenues
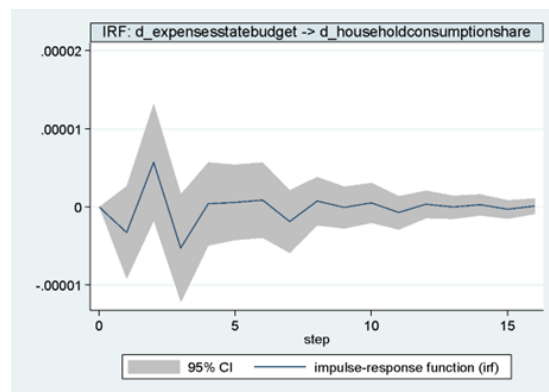
Graph 9. Responses of the Share of Household Consumption in Total Consumption to One Standard Deviation Changes in Government Budget Expenditures
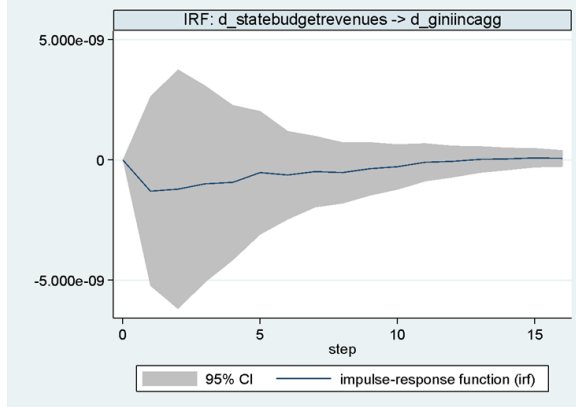
Graph 10. Responses of the Share of Household Consumption in Total Consumption to One Standard Deviation Changes in Government Budget Revenues
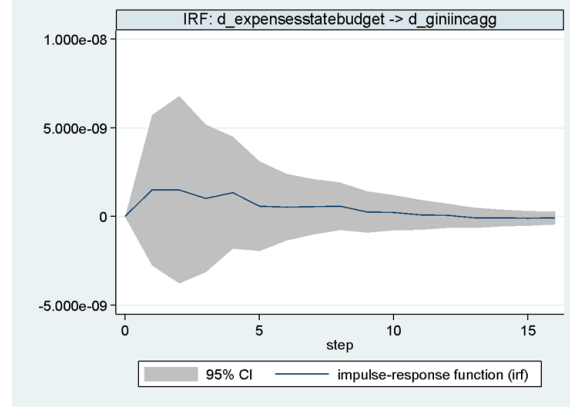
Graph 11. Responses of the Share of Household Consumption in Total Consumption to One Standard Deviation Changes in Government Budget Expenditures
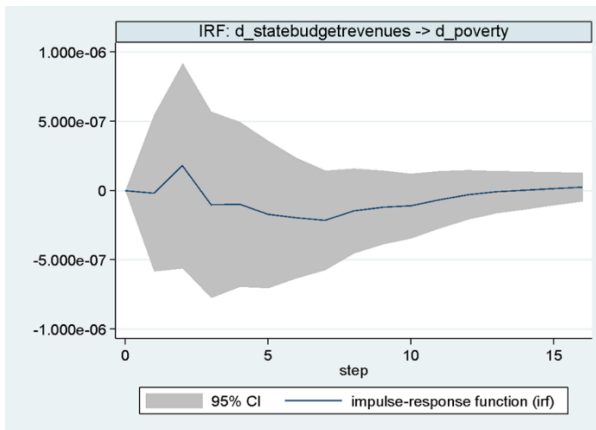
Graph 12. Responses of the Poverty Rate to One Standard Deviation Changes in Government Budget Revenues
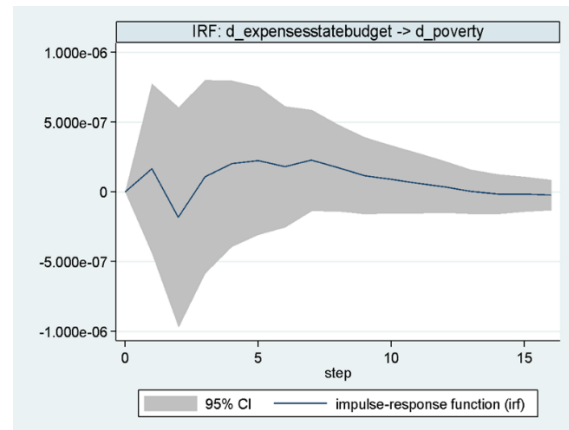
Graph 13. Responses of the Poverty Rate to One Standard Deviation Changes in Government Budget Expenditures
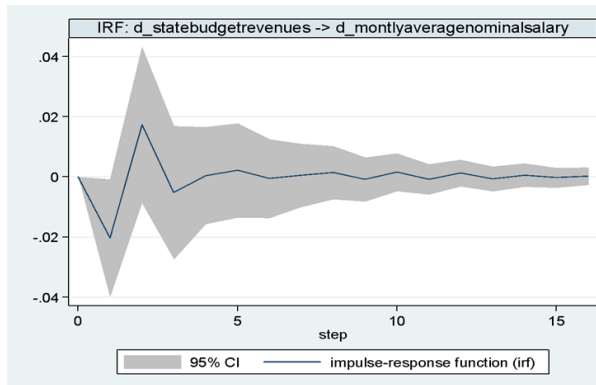
Graph 14. Responses of the Average Nominal Monthly Wage to One Standard Deviation Changes in Government Budget Revenues
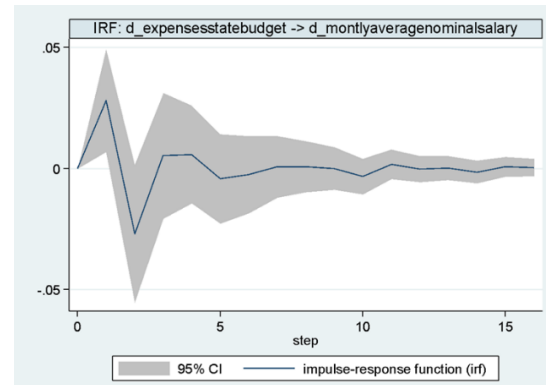
Graph 15. Responses of the Average Nominal Monthly Wage to One Standard Deviation Changes in Government Budget Expenditures

Furthermore, the growth patterns of indicators describing the standard of living were addressed, with a particular focus on elucidating the extent to which changes in the factor under consideration can be attributed to internal and external indicators included in the system. The Cholesky decomposition was employed to yield the following results.

The Tables 6-10 in appliactions illustrates the proportion of the change in GDP per capita that can be attributed to each indicator for the corresponding quarter.

For the sake of brevity, only cases of internal and external factors have been presented. To illustrate, 4.29% of the change in GDP per capita in the second quarter can be attributed to the unemployment rate, which is the highest among the factors considered in this lag. Therefore, the collective effect of internal and external factors on the standard of living in the second quarter can be seen to account for approximately 10% of the observed change in GDP per capita. The changes in the

volume of household consumption in the second quarter are to a greater extent than individual internal and external factors, due to changes in the balance of the financial account, government budget expenditures and the exchange rate of the US dollar to the dram. The Gin coefficient is most susceptible to influence from money transfers. The greatest impact on the poverty level is exerted by unemployment, consumer loans and government budget expenditures. Income is influenced by a number of factors, including the balance of the financial account, consumer loans, state budget revenues and expenditures.

The order of importance of the role of observed internal and external factors in changes in indicators characterising the standard of living, in accordance with the decrease in the overall effect over a four-year period: The share of consumer loans in GDP, the balance of the financial account in accordance with the balance of payments, The average monthly exchange rate of the US dollar, Expenditures of the state budget, Unemployment rate, Personal money transfers to Armenia, State budget revenues, Consumer price index compared to the same month last year.

In consideration of the influence of state budget revenues and expenditures on fluctuations in indicators that reflect the standard of living over the projected four-year period, it is notable that the former exerts a considerable impact on changes in the average monthly wage nomenclature, with an average contribution of 5.5%, and the share of household consumption in total consumption, with an average contribution of 2.2%. The role of budgets in GDP per capita and wage changes is relatively higher, with an average contribution of 1.6% and 1.8%, respectively.

Conclusions:

Summarizing the results of the analysis, we can note that

- The share of consumer loans in GDP has the most significant impact within the framework of the factors considered, while a relatively smaller impact is observed with respect to unemployment and inflation.

- A significant reduction in income resulting from unemployment has a significant impact on consumption volumes.

- Additionally, inflation and its associated expectations can influence the current reduction in consumption or its dynamics, thereby modifying household behaviour.

- The impact of state budget revenues on GDP per capita in the initial two quarters was negative; however, this effect was subsequently neutralised by the attenuation of fluctuations.

- The impact of government budget expenditures on GDP per capita during the initial three quarters was positive, after which the effect was reduced to zero due to the influence of fading fluctuations.

- The influence of state budget revenues on changes in indicators that characterise the standard of living is significant, particularly in the case of average monthly nominal wages (on average 5.5%) and the share of household consumption in total consumption (on average 2.2%).

- State budget expenditures exert a relatively greater influence on changes in GDP per capita and wages, with an average impact of 1.6% and 1.8%, respectively.

- A study of the growth structure of individual indicators reveals that 4.29% of the change in GDP per capita in the second quarter will be associated with the unemployment rate, which is the most significant factor among those considered in this lag. Furthermore, the lowest percentage was observed in the case of money transfers (0%).

- Based on the observations and forecasts, it can be posited that the collective effect of internal and external factors on living standards in the second quarter accounts for approximately 10% of the observed change in GDP per capita.

- The observed changes in the volume of consumption of the population in the second quarter are of a considerable magnitude in comparison with a number of selected internal and external factors, including changes in the balance of the financial account, government budget expenditures and the exchange rate of the US dollar against the dram. The most significant impact on the Gin coefficient is exerted by remittances, while unemployment, consumer loans and government budget expenditures have the greatest impact on poverty. Income is influenced by a number of factors, including the balance of the financial account, consumer loans, state budget revenues and budget expenditures.

- The sequence of importance of roles in changes in indicators characterising the standard of living, depending on the decrease in the overall effect over four years, is as follows: the share of consumer loans in GDP, the balance of the financial account in accordance with the balance of payments, the average monthly exchange rate of the US dollar, state budget expenditures, unemployment rate, personal money transfers to Armenia, state budget revenues and CPI.

Applications.
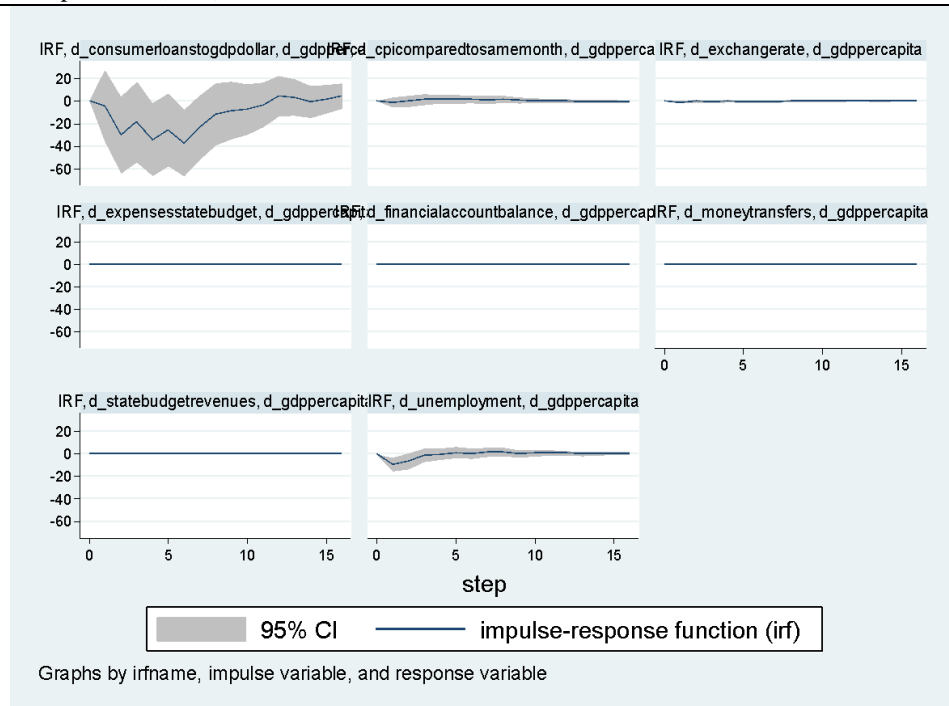
Figure 1 Reaction of GDP per capita to changes in indicators per unit of standard deviation
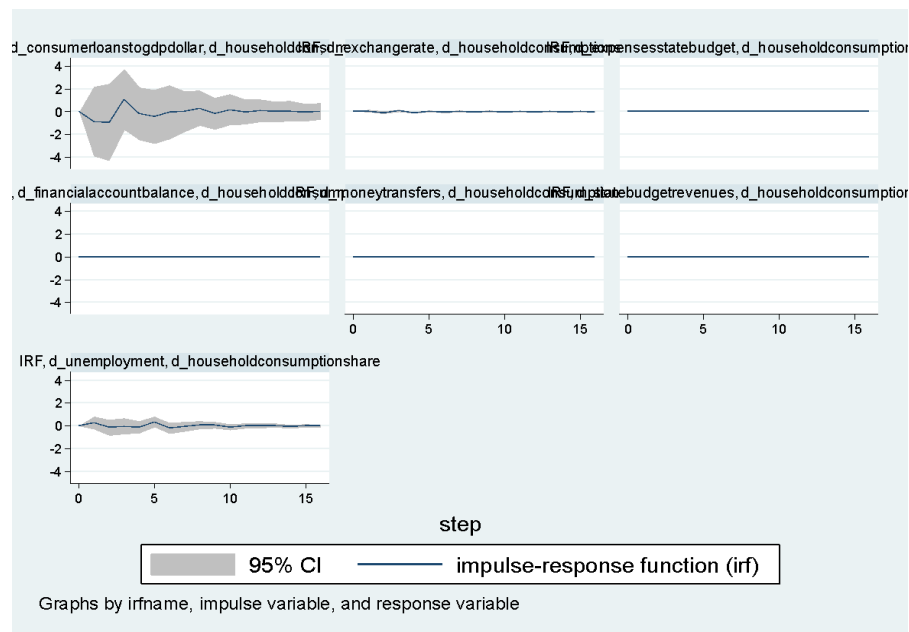
Figure 2. The share of household expenditure on final consumption in total consumer spending
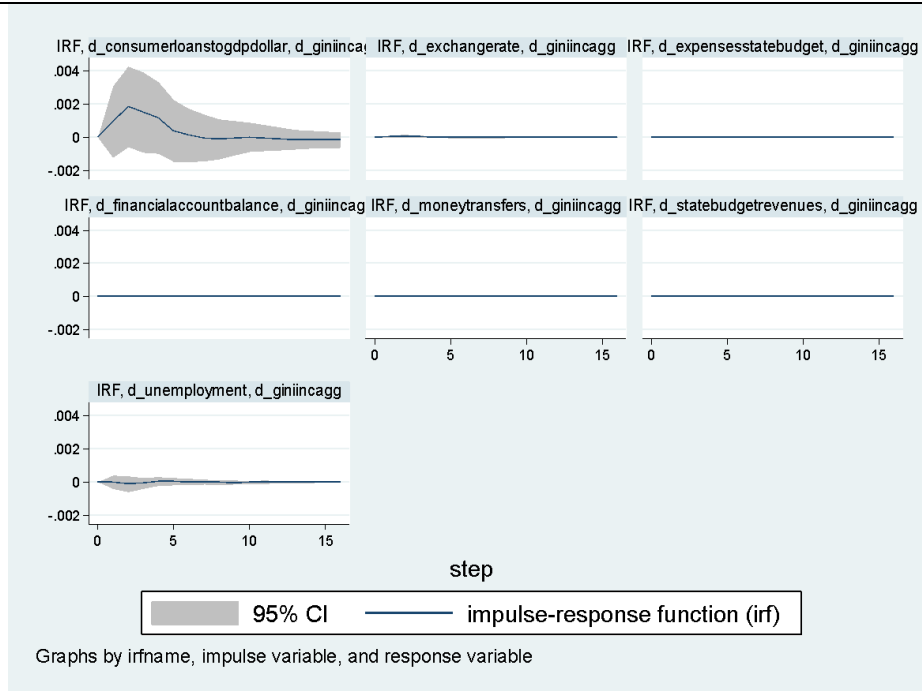
Figure 3. The reation of the Ginii coefficient to changes in indicators per unit of standard deviation
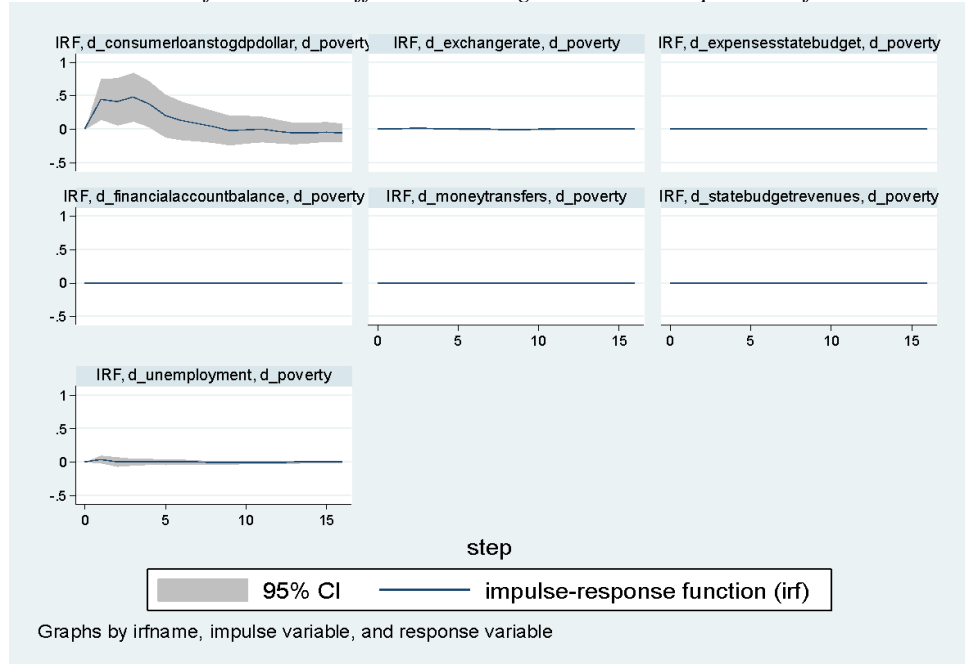
Figure 4. The reaction of the poverty level to changes in indicators per unit of standard deviation
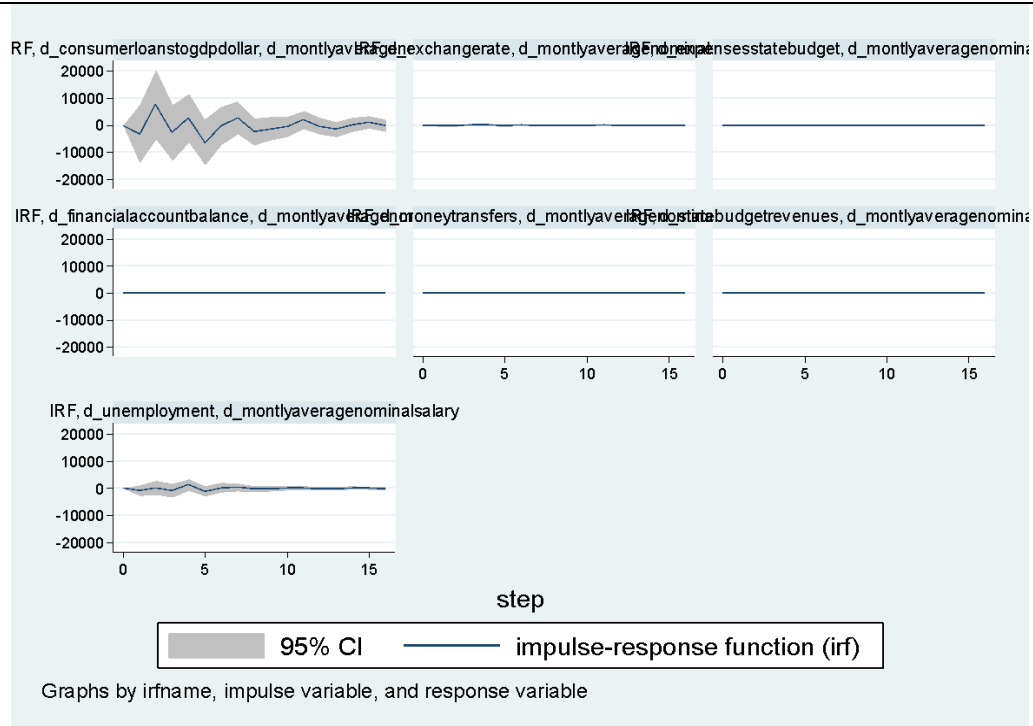
Figure 5. The reaction of the average monthly nominal salary to changes in indicators per unit of standard deviation

Table 6.

Shares of factors explaining changes in GDP per capita

Lag	State budget expenditures	State budget revenues	Share of Consumer Loans in GDP	Unemployment rate	Financial Account Balance	Personal Monetary Transfers to Armenia	Average Monthly USD Exchange Rate	CPI - Consumer Price Index	Total
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	1.49%	1.59%	0.04%	4.29%	0.98%	0.00%	1.63%	0.02%	10.02%
3	1.11%	1.66%	3.46%	5.48%	1.73%	0.03%	1.22%	0.07%	14.77%
4	1.47%	1.66%	3.79%	5.15%	1.66%	0.06%	1.32%	0.45%	15.56%
5	1.84%	1.64%	4.40%	4.70%	2.38%	0.06%	1.28%	0.71%	17.02%
6	1.73%	1.55%	4.62%	4.44%	2.25%	0.22%	1.21%	0.77%	16.79%
7	1.67%	1.65%	5.46%	4.29%	2.22%	0.60%	1.15%	0.82%	17.86%
8	1.79%	1.68%	5.94%	4.29%	2.34%	0.59%	1.17%	0.81%	18.60%
9	1.79%	1.69%	5.94%	4.24%	2.69%	0.58%	1.20%	0.82%	18.95%
10	1.77%	1.68%	6.05%	4.19%	2.76%	0.61%	1.18%	0.82%	19.07%
11	1.76%	1.69%	6.17%	4.17%	2.75%	0.71%	1.18%	0.81%	19.24%
12	1.81%	1.72%	6.24%	4.22%	2.77%	0.71%	1.17%	0.81%	19.44%
13	1.80%	1.72%	6.21%	4.21%	2.82%	0.71%	1.24%	0.80%	19.52%
14	1.81%	1.72%	6.19%	4.20%	2.82%	0.71%	1.25%	0.80%	19.50%
15	1.81%	1.72%	6.19%	4.20%	2.83%	0.72%	1.25%	0.81%	19.51%
16	1.81%	1.72%	6.18%	4.21%	2.83%	0.73%	1.25%	0.81%	19.54%
Average	1.59%	1.57%	4.80%	4.14%	2.24%	0.44%	1.17%	0.63%	16.59%

Table 7.

Shares of factors explaining the change in the share of household consumption in total consumption

Lag	State budget expenditures	State budget revenues	Share of Consumer Loans in GDP	Unemployment rate	Financial Account Balance	Personal Monetary Transfers to Armenia	Average Monthly USD Exchange Rate	CPI - Consumer Price Index	Total
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	1.62%	0.05%	0.28%	0.03%	4.00%	0.84%	1.45%	0.34%	8.60%
3	1.56%	0.10%	1.69%	0.76%	5.67%	2.62%	2.84%	0.31%	15.55%
4	1.56%	0.22%	1.81%	2.32%	5.48%	3.44%	4.02%	0.29%	19.13%
5	1.57%	0.22%	1.63%	2.40%	5.31%	3.15%	4.84%	0.36%	19.48%
6	2.47%	0.23%	1.49%	2.40%	5.25%	2.88%	4.90%	0.41%	20.04%
7	2.58%	0.23%	1.55%	2.43%	5.44%	2.90%	4.89%	0.41%	20.43%
8	2.64%	0.24%	1.53%	2.61%	5.44%	2.98%	4.85%	0.42%	20.72%
9	2.61%	0.24%	1.53%	2.87%	5.41%	2.96%	4.91%	0.42%	20.96%
10	2.64%	0.23%	1.50%	2.82%	5.47%	2.91%	4.99%	0.44%	21.01%
11	2.65%	0.24%	1.51%	2.84%	5.57%	2.91%	5.00%	0.44%	21.14%
12	2.64%	0.24%	1.50%	2.85%	5.58%	2.93%	4.99%	0.44%	21.17%
13	2.64%	0.24%	1.50%	2.89%	5.59%	2.94%	4.99%	0.44%	21.23%
14	2.64%	0.24%	1.50%	2.88%	5.60%	2.93%	5.00%	0.44%	21.23%
15	2.64%	0.24%	1.50%	2.89%	5.63%	2.93%	5.01%	0.44%	21.27%
16	2.63%	0.24%	1.50%	2.89%	5.63%	2.93%	5.00%	0.44%	21.27%
Average	2.19%	0.20%	1.38%	2.24%	5.07%	2.64%	4.23%	0.38%	18.33%

Table 8.

Contribution of Factors to Changes in the Gini Coefficient

Lag	State budget expenditures	State budget revenues	Share of Consumer Loans in GDP	Unemployment rate	Financial Account Balance	Personal Monetary Transfers to Armenia	Average Monthly USD Exchange Rate	CPI - Consumer Price Index	Total
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.24%	0.00%	0.35%	0.52%	0.28%	0.21%	1.60%
3	0.12%	0.04%	0.80%	0.54%	1.05%	1.21%	1.70%	0.20%	5.65%
4	0.12%	0.04%	1.22%	0.67%	1.21%	1.62%	2.09%	0.26%	7.23%
5	0.28%	0.04%	1.84%	0.65%	1.42%	1.79%	2.13%	0.30%	8.46%
6	0.32%	0.05%	2.11%	0.65%	1.51%	1.80%	2.14%	0.31%	8.90%
7	0.32%	0.06%	2.28%	0.66%	1.57%	1.80%	2.14%	0.34%	9.18%
8	0.36%	0.09%	2.38%	0.66%	1.57%	1.80%	2.16%	0.34%	9.36%
9	0.38%	0.12%	2.40%	0.66%	1.57%	1.79%	2.21%	0.34%	9.46%
10	0.38%	0.13%	2.39%	0.67%	1.57%	1.79%	2.22%	0.34%	9.50%
11	0.38%	0.14%	2.39%	0.67%	1.58%	1.79%	2.23%	0.34%	9.51%
12	0.38%	0.14%	2.39%	0.67%	1.57%	1.78%	2.23%	0.34%	9.51%
13	0.38%	0.14%	2.39%	0.67%	1.57%	1.78%	2.24%	0.34%	9.52%
14	0.38%	0.14%	2.39%	0.67%	1.57%	1.78%	2.24%	0.34%	9.52%
15	0.38%	0.14%	2.39%	0.67%	1.57%	1.78%	2.24%	0.35%	9.53%
16	0.38%	0.14%	2.40%	0.67%	1.58%	1.78%	2.24%	0.35%	9.53%
Average	0.29%	0.09%	1.88%	0.57%	1.33%	1.55%	1.90%	0.29%	7.90%

Table 9.

Contribution of Factors to Changes in the Poverty Rate

Lag	State budget expenditures	State budget revenues	Share of Consumer Loans in GDP	Unemployment rate	Financial Account Balance	Personal Monetary Transfers to Armenia	Average Monthly USD Exchange Rate	CPI - Consumer Price Index	Total
1	3.18%	0.41%	5.04%	1.87%	0.00%	0.00%	0.00%	0.00%	10.51%
2	1.84%	0.34%	3.31%	4.17%	0.65%	0.19%	0.62%	0.00%	11.12%
3	1.45%	0.52%	2.87%	3.15%	0.77%	0.44%	3.22%	0.09%	12.51%
4	1.32%	0.47%	3.66%	2.71%	1.60%	1.14%	4.09%	0.17%	15.17%
5	1.51%	0.43%	4.71%	2.47%	2.17%	1.27%	4.34%	0.22%	17.12%
6	1.50%	0.42%	5.23%	2.37%	2.58%	1.39%	4.22%	0.28%	18.00%
7	1.47%	0.44%	5.66%	2.32%	2.90%	1.52%	4.15%	0.31%	18.78%
8	1.47%	0.51%	6.03%	2.29%	2.98%	1.60%	4.10%	0.33%	19.31%
9	1.53%	0.57%	6.22%	2.30%	3.02%	1.58%	4.08%	0.33%	19.64%
10	1.52%	0.60%	6.20%	2.30%	3.11%	1.57%	4.11%	0.33%	19.75%
11	1.52%	0.62%	6.18%	2.29%	3.13%	1.57%	4.10%	0.33%	19.73%
12	1.51%	0.63%	6.18%	2.29%	3.13%	1.57%	4.09%	0.33%	19.73%
13	1.52%	0.63%	6.17%	2.30%	3.12%	1.57%	4.10%	0.33%	19.74%
14	1.51%	0.63%	6.17%	2.30%	3.12%	1.57%	4.10%	0.33%	19.75%
15	1.52%	0.63%	6.17%	2.29%	3.12%	1.57%	4.10%	0.34%	19.75%
16	1.52%	0.63%	6.17%	2.29%	3.13%	1.57%	4.10%	0.34%	19.75%
Average	1.62%	0.53%	5.37%	2.48%	2.41%	1.26%	3.59%	0.25%	17.52%

Table 10.
Contribution of Factors to Changes in the Average Nominal Monthly Wage

Lag	State budget expenditures	State budget revenues	Share of Consumer Loans in GDP	Unemployment rate	Financial Account Balance	Personal Monetary Transfers to Armenia	Average Monthly USD Exchange Rate	CPI - Consumer Price Index	Total
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.99%	1.24%	2.03%	0.00%	3.78%	0.47%	0.35%	0.01%	8.88%
3	2.31%	1.80%	3.31%	0.02%	3.58%	1.05%	0.38%	0.11%	12.56%
4	2.86%	1.68%	3.35%	0.02%	3.89%	1.72%	0.38%	0.14%	14.05%
5	6.18%	1.96%	3.44%	0.05%	3.54%	1.99%	0.76%	0.16%	18.09%
6	6.42%	2.08%	3.92%	0.21%	3.58%	1.93%	1.26%	0.18%	19.59%
7	6.79%	2.04%	3.87%	0.21%	3.58%	1.91%	1.27%	0.20%	19.87%
8	6.77%	2.01%	4.11%	0.36%	3.84%	1.90%	1.27%	0.20%	20.47%
9	6.88%	1.99%	4.09%	0.48%	3.92%	1.92%	1.27%	0.20%	20.74%
10	6.86%	1.98%	4.15%	0.47%	4.29%	1.92%	1.37%	0.20%	21.24%
11	6.98%	2.00%	4.15%	0.47%	4.28%	1.92%	1.39%	0.20%	21.40%
12	6.95%	1.99%	4.20%	0.51%	4.44%	1.95%	1.39%	0.20%	21.64%
13	7.01%	1.99%	4.19%	0.53%	4.42%	1.99%	1.39%	0.20%	21.72%
14	7.00%	1.98%	4.25%	0.53%	4.55%	1.99%	1.42%	0.20%	21.92%
15	7.03%	1.99%	4.25%	0.54%	4.55%	1.99%	1.42%	0.20%	21.97%
16	7.02%	1.98%	4.27%	0.55%	4.63%	2.01%	1.42%	0.20%	22.08%
Average	5.50%	1.80%	3.60%	0.31%	3.80%	1.67%	1.05%	0.16%	17.89%

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FINANCIAL LITERACY – THE KEY TO SPARK ENTREPRENEURIAL SPIRIT IN THE YOUNGER GENERATION

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ABSTRACT

The paper delves into the essential characteristics and features of financial literacy, focusing on a study conducted among the undergraduates from various engineering specialities at the Technical University of Varna. The research aimed to establish the level of financial literacy among the younger generation and provide recommendations for its enhancement.

Keywords: financial literacy, entrepreneurship, entrepreneurial activity, finance.

1. Financial literacy and entrepreneurship

Entrepreneurial activity is a complex set of processes and events undertaken by individuals with potential in a rapidly evolving and competitive business environment. The current globalized economy, with its multicultural dimensions, emphasizes the development of knowledge as a powerful catalyst for success [1,4,6,7]. Additionally, the integration processes within Europe are instrumental in shaping modern business ventures. Today's youth are confronted with a multitude of challenges related to their financial stability and prosperity. Balancing increasing personal responsibility with the diverse and complex array of financial products and services presents a serious dilemma for individuals when making financial decisions [2,3,8].

It is imperative to implement appropriate interventions aimed at enhancing the financial knowledge and skills of the younger generation/undergraduates in order for them to effectively manage limited financial resources, navigate economic uncertainty, and advocate for their rights [9,10,11]. Therefore, initiatives in the field of improving financial literacy should be viewed as an investment in human capital, fostering sustainable economic and social development. This, in turn, requires a shift in the process of training and a transformation of the traditional university model into a more entrepreneurial establishment of higher education. The primary objective of such a model should be to cultivate innovative thinking and entrepreneurial mindset among both students and lectures, while fostering collaboration with the business sector.

Financial literacy equips young individuals/undergraduates with the understanding of financial products and concepts, enabling them to develop the necessary skills to enhance their financial culture, i.e. to recognize financial risks and favourable opportunities for entrepreneurial growth, to empower them to make objective and informed decisions when selecting financial services.

More specifically, financial literacy encompasses a blend of financial knowledge, skills, motivation, and confidence in utilizing these capabilities when making sound financial decisions, with the ultimate outcome being the overall improvement in the well-being of individuals and society as a whole, ensuring fruitful participation of individuals in the economy (as stated in PISA) [8].

From a wider perspective, financial literacy plays a crucial role in driving the demand for financial products due to the recognized benefits they offer, producing, thereby, a powerful impact on the market growth. Similarly, consumers who are financially literate– those who are aware of their legal rights, understand their responsibilities, and being well-informed– through their informed choices and the exercise of their rights, contribute to the advancement of market competition [5,6,11].

The Organisation for Economic Co-operation and Development (OECD) identifies financial training (education) as a key tool in positively affecting the level of financial literacy [8]. Financial education can be defined as "*a process by which consumers increase their understanding of financial products and basic financial concepts, and through information, guidance, and objective advice, they tend to develop the skills and confidence needed to comprehend financial risks and opportunities, to make rational and informed decisions, to know where to seek assistance, and be capable of taking effective actions to improve their financial well-being*".

2. Assessment of the youth financial literacy and its impact on their entrepreneurial activity (a case study of the students from TU-Varna)

Investing in education and training to develop skills is essential for promoting growth and competitiveness. In today's knowledge-based economies, there is a demand for highly qualified individuals who can meet specific needs. According to Cedefop forecasts, the proportion of jobs in the EU requiring higher education is expected to increase from 29% in 2023 to 34% by 2028, while the number of low-skilled jobs during the same period is projected to decrease from 23% to 18% [8].

Universal skills such as practical thinking, initiative, problem-solving ability, and prompt decision-making in crisis situations are essential for preparing individuals for a wide range of professional fields, which are increasingly diverse and unpredictable today.

It is crucial to prioritize the development of entrepreneurial skills, as they not only enable individuals to start their own businesses but also improve their employability. Furthermore, to effectively navigate future professional responsibilities in a rapidly changing environment, students must also possess certain financial skills.

The current paper presents a study into the entrepreneurial attitudes and financial literacy of students conducted through a survey. The survey was designed to measure the following key indicators: what entrepreneurial attitudes exist among the students; what range of financial skills and knowledge they possess; and what aptitude for decision-making they have. The survey was conducted among students from various engineering specialties at TU-Varna, spanning from the 1st to the 4th -year including fully engineering specialties, such as Computer Systems and Technologies (CST), Software and Internet Technologies (SIT), Transport Engineering and Technologies (TET), Navigation (N), Mechanical Engineering and Technologies (MET), and

others), as well as hybrid specialties, namely Industrial Management (IM) and Technological Entrepreneurship and Innovations (TEI) , which incorporate financial courses. Altogether, a total of 70 randomly selected respondents participated in the study.

When asked: "Have you studied subjects related to entrepreneurship and finance?", the students from the engineering specialties reported that they had not taken such courses, but they had acquired knowledge in these areas due to their interest in opportunities for additional income. Conversely, all students in the IM and TEI specialties had received training in subjects like entrepreneurship and finance (Fig.1).
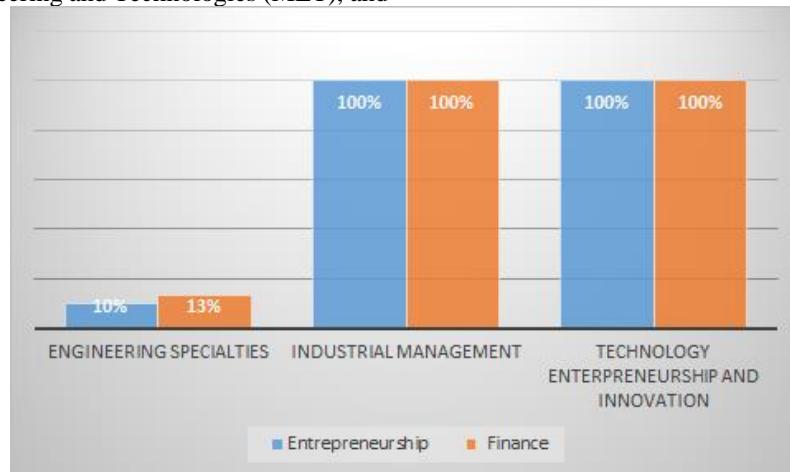
Fig.1 Subjects in the field of entrepreneurship and finance studied by the students at TU-Varna

The results of the study reveal that 65% of the students in engineering specialties lack confidence in their ability to start their own business. Only 35% of them have plans to launch a business. Notably, entrepreneurial initiative and intent to venture into business are particularly low among students in CST, SIT and N area of specialization. In contrast, 60% of the students in the IM specialty express a desire to start their own business, 30% feel uncertain about their capabilities, and 10% declared no intentions of pursuing business undertaking. Similar trends are observed among students in the TEI specialty, with 55% aspiring to start their own business, 30% feeling unsure about their success, and 15% - lacking interest in entrepreneurship (Fig.2).
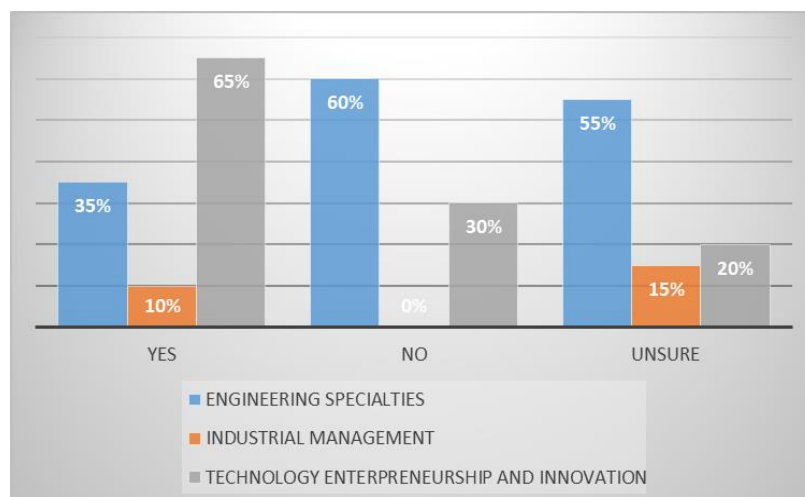
Fig.2 Have you considered the idea of starting your own business?

A significant percentage of the young individuals aspiring to launch their own business intend to finance their ventures via a bank loan (70%), while 20% plan to utilize personal funds, and 10% aim to secure funding through EU programs.

Interestingly, 60% of the students in the IM and TEI specialties maintain a personal /family budget with specified expense categories as opposed to the engineering students with only 20% of them having a personal budget at hand.

FUNDS FOR EMERGENCY EXPENSES

NO FUNDS FOR A PENSION FUND
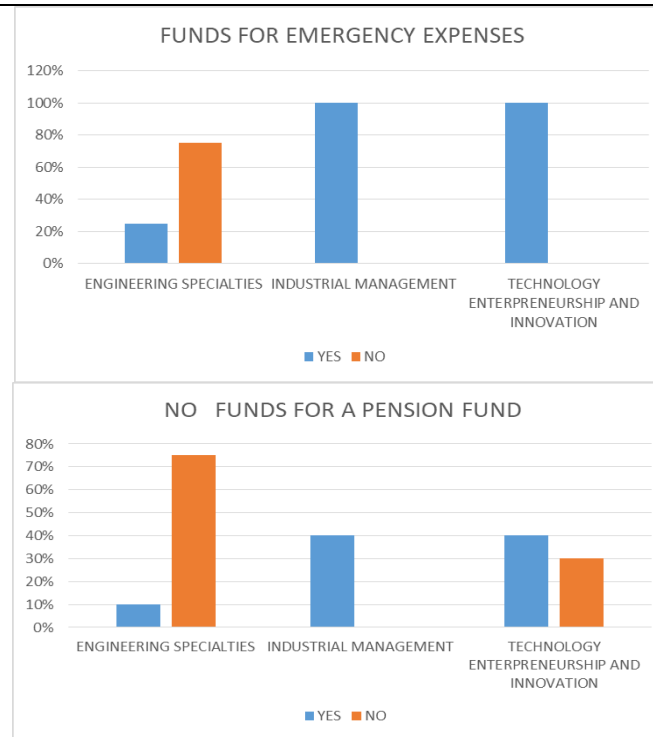
Fig. 3 Relative share of students allocating funds for emergency expenses and a pension fund

It is evident from Fig. 3 that a mere 25% of the fully engineering students allocate funds for emergency expenses, and only 10% contribute to a pension fund. 75% of them do not allocate money for unexpected costs or a retirement fund, citing the "lack of necessity" as the primary reason. Meanwhile, 100% of the students in IM and TEI specialties set aside financial resources for unexpected costs, with 40% of them contributing to a pension fund.

Approximately 70% of the students surveyed do not have investments in financial assets such as stocks, bonds, and others. The highest proportion of investments in financial assets comes from the students in the IM specialty at 28%, followed by the fully engineering specialties at 25%, and the TEI specialty – 15%.
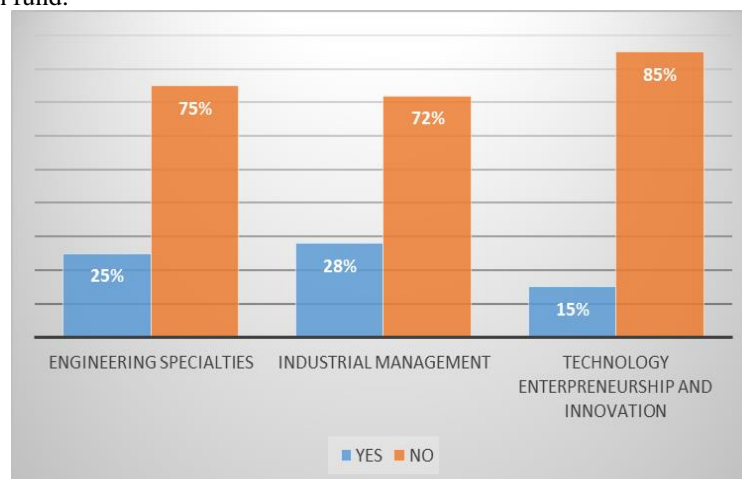
Fig.4 Relative share of investments in financial assets

80% of students utilize online banking as a payment method, with other financial technologies such as Revolut, Binance, Kiwi, and Wise also being commonly used.

Additionally, the students specializing in IM and TEI possess the skills needed to determine anticipated returns and profits from investments in financial assets, indicating their strong financial background.

3. Opportunities to enhance financial literacy among students

There exists a perfect opportunity to enhance financial literacy among students within the higher education system, considering, on one hand, their young age, and, on the other hand, the notable absence of sustainable education in personal finance. Addressing this gap, therefore, is imperative. In practice, young adults are increasingly entrusted with managing their personal finances and making significant financial decisions that can impact their future well-being, and it is, thus, vital for them to make informed decisions in this regard. The autonomy of

higher education institutions represents a major factor for increasing students' financial literacy by redesigning the curricula of specialties offered at various academic departments. In adherence to the regulatory requirements for curriculum structuring, there arise a possibility for partial or complete integration of financial literacy courses as elective or optional subjects within the curriculum, subject to approval from academic leadership and declared willingness on their part to prioritize financial literacy education. It is quite possible, on account of the expectations for enhanced practical training of the students and strengthened connections with employer organisations, for expert practitioners to be invited as guest lecturers to share valuable insights on specific topics related to financial literacy, regardless of the professional field in which the students are being trained. Another possibility includes coordinating research endeavours within and across higher education institutions with a particular emphasis on advancing financial literacy knowledge. The financial sector plays a pivotal role in this process, not only as a provider of financial services but also as a source of potential employment for students. It is advisable, in this regard, to organize an adequate process to facilitate knowledge transfer and exchange of ideas on current issues with students, which allows for flexibility in format and methods of manifestation: short internships; open days; digital educational resources; and podcasts. Adoption of informal learning methods is also a viable approach. New training channels can be established, to that effect, or existing ones can be further developed outside the formal education system. Within this framework, for example, in the department of Industrial Management guest lecturers have made significant contributions to the educational process by addressing specific topics related to financial literacy. Outstanding results are also achieved through the implementation of dual training methods, which, regrettably, have not yet been introduced in the Bulgarian higher education system, despite the existence of such a strategy.

4. Conclusion

Developing an entrepreneurial and financial mindset among the younger generation should commence during their university years, fostering a culture of openness to innovations and maintaining an entrepreneurial environment within the business sector. The drive to generate entrepreneurial ideas is closely linked to the expectation of success, which is rooted in identifying market needs, adapting to changes in market dynamics, and seizing opportunities to fill market niches.

The education of young adults/students must address the pressing demand of the Bulgarian economy for a new generation of skilled managers and entrepreneurs who are well-versed in contemporary practices and possess the practical skills needed to achieve sustainable growth and development. In view of this, universities and the government should prioritize the following initiatives:

– Implementing training programs based on real-life business scenarios– produced in collaboration with industry partners and organisations, and complemented by a series of interactive business simulations;

– Embracing a hands-on teaching approach – utilizing the latest concepts, practices, and business tools in the field of entrepreneurship, management, finance, and innovation, drawing inspiration from the interactive teaching and learning approach adopted in leading global educational institutions;

– Facilitating knowledge sharing and experience exchange among students to cultivate lasting professional relationships;

– Inviting guest lecturers from the business and financial sectors to provide valuable insights and share their expertise with students;

– Providing training, guidance and support to young individuals regarding opportunities for launching their own ventures;

– Providing consultancy services to the adolescents on about intellectual property issues;

– Assisting students in securing financial resources and funding to start their entrepreneurial endeavours;

– Offering support to startups founded by recent graduates to help them navigate the challenges of the business landscape;

– Equipping teams with the necessary skills to participate in EU programs focused on research and technology.

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THE ROLE OF SOCIAL CAPITAL IN MODERN BUSINESS INNOVATIVE ACTIVITIES

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ABSTRACT

Nowadays the role and importance of social capital is increasing significantly in business activity. Social capital manifests itself in mutual trust, shared norms, values, and networking. Initially, the theory of social capital developed in relation to society, but gradually developed and moved to the company level. At the national level, social capital leads to mutually beneficial interactions between countries and nations and helps solve global problems (global warming, the threat of nuclear war, famine, etc.); at the state level, it helps strengthen democratic institutions; at the enterprise level, it helps develop trust between colleagues; at the individual level, it strengthens a person's psychological health (removes feelings of loneliness, increases self-esteem and life satisfaction). The article highlights and substantiates the key role of social capital in the formation of economic entities regarding the development and implementation of innovations.

Keywords: social capital, innovative economy, business development.

Introduction

Social capital in business is about connections between people at work. It's the trust, knowledge, and cooperation that emerge from these relationships.

The intellectualization of the modern world draws attention to the problem of social capital as a resource necessary to improve the quality of life of an individual, the formation of a knowledge economy and innovative development of the country. The fact that social connections, interactionand trust, which form the basis of social capital, influencehe formation, development and accumulation of intellectual capital, which is of paramount importance and is included in the circle of the main interests of the world scientific community, is increasingly recognized.

Innovation creation is a complex process involving many different social and economic factors, as well as a wide range of individuals, institutions and firms engaged in the creation, development and dissemination of new knowledge and technologies. The era of lone inventors has passed. In modern conditions, no innovator acts alone. The innovative ability and receptivity of society are determined by the quality of the interrelations between economic agents. To effectively implement innovative activities, economic agents must have a reserve of social capital in the form of the necessary connections. Since the connections are not based on market interactions and not on a hierarchical principle, they form networks. The network organization is recognized as the most effective organizational structure for implementing innovative activities. The concept of social capital originated within the sociological scientific school and is associated with the names of P. Bourdieu and J. Coleman. J. Coleman defined social capital as the ability of subjects to benefit from participation in social networks and other social structures [5]. Currently, economists are showing significant interest in this subject of research. The influence of social capital on innovation was studied by H. Westlund, W. Chow, F. Sabatini, Sh. Gu, B.-A. Lundvall, L. Myasnikova, A. Zuev.

Social capital includes not hierarchical or commodity-money, but network relations of individuals. Unlike hierarchical relations, social capital presupposes voluntary interaction of equal subjects. Unlike market relations, as a result of this interaction, an exchange of values of an emotional, material or informational nature occurs on a non-commercial basis.

Hierarchical structures have limited learning capacity, and market structures do not facilitate the establishment of trust relationships. Thus, in a knowledge-based economy, the role and importance of social capital increases.

Like any type of capital, social capital has an incorporated state (in the form of reproducible dispositions and demonstrated abilities), an objectified (material) state, and an institutionalized (formalized) state.[4]. Social capital in its objectified state represents network (horizontal) connections. In its institutionalized state, it represents the reputation and image of economic agents.

The theory of industrial districts, clusters, the theory of national and regional innovation systems and the concept of the "triple helix" note the importance of social interactions of economic agents in the creation of innovations.

By developing and using social networks, the organization develops the ability to absorb knowledge, which allows it to quickly obtain new knowledge from universities and other research institutes. Innovative companies with high knowledge absorption ability are able to quickly develop innovative products.

Open Innovation and Social capital

Consideration of innovation processes that occur within the organization and their dependence on social capital would not be complete without taking into account inter-organizational interactions. The literature studying innovation has long focused on how individual innovators and teams organize their work to invent and introduce new ideas and products into the production process. However, starting with the pioneering works of S. Freeman and V. Lundvall, the term "national innovation system" came into scientific use, where the innovation is presented as a continuous process that encompasses stages starting from the birth of an innovative idea to the diffusion, absorption and use of innovative products (Freeman, 1987, Freeman, 1995, Lundvall, 1985, Lundvall, 1992). At the same time, emphasis should be placed on the importance of interactive learning for innovation, which takes place

both in the production process and during the sale of goods and after-sales service to consumers.

A little later, E. von Hippel demonstrated that innovations occur at any stage of economic activity and in various sectors of the economy. Accordingly, producers, suppliers, end users, and even competitors can serve as sources of innovation (Hippel, 1988). The importance of the interaction of various economic agents and organizations in the innovation process was emphasized in the works, in particular, (Brown and Eisenhardt, 1995), (Szulanski, 1996), (Baum, Calabrese, and Silverman, 2000) and others, which served as the theoretical basis for the birth of the concept of open innovation (Chesbrough, 2006), affirming the "interactionist" view of the innovation process.

The model of open innovation assumes that a certain organization uses knowledge from various sources to increase its innovative activity and in this way obtains additional value for customers (Maltsev, Sala, and Buketov, 2022). In other words, the firm does not seek to generate innovations completely independently, but tries to use internal and external ideas in an optimal way in order to be more effective in managing costs and risks, to accelerate the development of technologies.

The sources of knowledge, as a rule, are suppliers, research centers, universities, customers, competitors, companies with additional knowledge offers, which are united in a network of dense interaction which takes various organizational forms, including alliances, clusters, and joint projects. It is quite clear that interaction within such organizational structures requires integration and coordination, which, in turn, creates the need to create units with appropriate functions and, as a result, attract additional resources which can be significantly lower under conditions of relative commonality of socio-cultural values of the participants of interactions and their willingness to cooperate. This actualizes the importance of social capital to ensure coordination effect.

As practice shows, the previous interaction of representatives of various organizations, which were built in the field of close scientific contacts and exchange of professional experience, formed a circle of people with similar values and served as a basis for agreeing actions already within the newly created cooperation structures. Specialists who received education at the same universities, but worked in different companies, had more chances to build more effective cooperation in the field of innovation than representatives of other educational systems.

Transaction costs are important for the effectiveness of the open innovation model, including the costs of conducting negotiations and concluding agreements with participants in the innovation process, resolving interfirm conflicts (Slowinski and Sagal, 2010), monitoring information provided by partners (Maskell, 2000).

Social capital reduces these transaction costs by establishing relationships based on trust. When counterparties trust each other, the creation of alliances, clusters, etc. does not require lengthy negotiations, and agreements are mostly concluded in the form of implicit contracts. A high level of social capital makes the situation for partners more transparent and predictable,

which does not require additional costs for checking the authenticity of counterparties' statements. All this significantly saves the resources of the group, which can be directed to innovations.

This process is facilitated by the Internet and other means of communication, which simplify access to information, save time for searching for partners, and facilitate interaction that would be very expensive at a distance. This idea was developed by J. Baum, T. Calabrese, B. Silverman, demonstrating the effectiveness of Canadian biotech start-ups depending on the creation of alliances and their integration into a network that provided access to a variety of information. S. Ouechtati, K. K. Masmoudi, C. Slim established the relationship between social capital and open innovation, on the one hand, and the performance of small and medium-sized enterprises in Tunisia (Ouechtati, Masmoudi and Slim, 2022). In turn, S. Scott, M. Hughes and P Hughes found that informal connections between participants in the innovation process almost double the size of the network and provide access to resources.

Therefore, innovations are not created in a vacuum, but are the result of the interaction of many participants united in sustainable networks which contribute to innovation by reducing transaction costs, overcoming cultural and cognitive distance, and promoting collective learning (Pilipenko, 2013). Accordingly, cooperation in modern conditions increasingly take on the characteristics of a network, changing the market structure and nature of competition which, in the field of innovation, takes place mainly between network associations, while vertical integration is inferior to horizontal connections.

Implementing innovative activities in companies

Self-organization, one of the principles of innovative companies, involves the rejection of total control inherent in traditional hierarchical organizations. At the same time, delegation of decision-making to the lowest possible level of the organization occurs.

Self-organization becomes possible only on the basis of trust in employees and requires maximum use of capabilities at all levels of the organization. Companies 3M, HP, Motorola have decentralized decision-making processes, delegating these powers to the level of teams and divisions, and also encourage the creation of small businesses [9]. Changing organizational structures when implementing the principle of self-organization helps to increase the openness of the company and facilitate interaction with the outside world. Traditional hierarchical structures with clear boundaries between the organization and the external environment are being replaced in Western companies by more flexible structures - networks, virtual organizations and alliances with much more permeable boundaries.

Thus, social capital plays the role of the most important resource in the process of implementing innovative activities. Its formation in the regional innovation system presupposes cooperation of enterprises with universities and other organizations, and also requires the implementation of an appropriate innovation policy. The innovation policy of the organization

should be aimed at finding and encouraging social contacts within the framework of intellectual partnership with representatives of domestic and foreign enterprises, with universities and state research institutions. At the same time, it is necessary to change organizational structures, increase the degree of their openness for interaction with the external environment, decentralize decision-making processes, delegate powers to the team level, manage the ideology and corporate culture of the organization.

Conclusion

The main advantage of Social Capital for innovation is to be its comprehensiveness, as it addresses many elements that play an important role in innovations. It not only refers to investment in social networks or relationships, but also emphasizes the necessary cognitive quality of connections and collective actions to produce new knowledge and knowledge products. It focuses on the powerful creativity of the connections and their collaboration.

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ELEMENTS OF CREDIT POLICY AND STIMULATION OF CREDIT INVESTMENTS IN THE REAL ECONOMY

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ABSTRACT

The purpose of the study is the study of credit policy in the Republic of Azerbaijan for the possibility of increasing the effectiveness of credit investments in the real economy and the direction of its improvement. Methodology of research - such general theoretical methods as analysis and synthesis, deduction and induction, generalization of reference and scientific literature, theoretical modeling, grouping methods and comparisons were used during the research. Practical significance of research - analysis of export - import operations and the state of trade turnover in the country. The results of the research - the analysis carried out in the article showed that the market of goods and services for priority development requires the improvement of non-cash money circulation in the country. The originality and scientific novelty of the research consists in the development of recommendations for improving export positions in the Republic of Azerbaijan.

Keywords: trade, export, import, trade balance, monetary turnover, investment.

Introduction

Over one and a half thousand units of agricultural machinery and equipment were imported through "Agroleasing" and leased to farmers on preferential terms. According to the decision taken by the relevant state commission, in 2022, over one and a half thousand agricultural producers were allocated subsidies in the amount of 45 million manat.

During 2023, up to 165,000 meters of collector and drainage networks, more than 209,000 meters of irrigation canals were built and reconstructed on agricultural lands. Along with this, the construction of the Shamkir reservoir, the Upper Mil Canal, and the Takhtakorpyun reservoir was completed. Today, most of them are already successfully functioning. The Samur-Absheron Canal was reconstructed.

Cotton growing, sericulture, tobacco growing, and hazelnut growing also have great potential for export. The development of this sector will also have a positive impact on the urbanization process. It will provide employment to the population in the regions, rural areas, and improve the standard of living of people.

Over the past 5-6 years, the government has been implementing a number of measures aimed at developing tourism. The government is quite clearly aware that this requires the adoption of a set of measures to improve the activities of companies operating in this sector, which, in turn, requires a high level of services provided and professionalism of the workforce.

In order to develop tourism, it is necessary to stimulate tourism activities in the regions in this area, strengthen information and propaganda work corresponding to the priority development of tourist routes, which will contribute to successful development in the post-pandemic period. It is also necessary to take into account that in the post-pandemic period in 2020, the protection of socially sensitive groups of the population was strengthened (increase in pensions and social benefits, targeted social assistance, monthly food benefits for internally displaced persons, etc.), and the salaries of workers in healthcare, culture, sports, science and the agricultural sector increased by 10%. All this required diversification of the national economy, which was also shown in 2017, when significant reforms were carried out, the goals of which were the modernization and diversification of the national economy through the prevailing development of the non-oil sector, improvement of the market mechanism, state support for entrepreneurship and private business.

The strategic roadmap has ensured and will ensure the growth of competitiveness of domestic production. Responding to global challenges and as a result of attracting investments, developing a free business environment, entering markets and human capital, Azerbaijan has shown itself on the world pedestal as a country that has entered the group of high-income countries. For this purpose, four strategic goals were selected within the framework of the national economic prospects. As a result of the implementation of these goals and strategic roadmaps for 11 sectors, sustainable development has become a priority by ensuring a balance between the real and financial sectors. In this regard, it should be noted that the goal of ensuring fiscal sustainability has been achieved in Azerbaijan, and the monetary policy is based on the floating exchange rate regime. Putting fiscal and monetary policies in order ensured macroeconomic stability. The second goal in the national economic prospects was to increase the rationality of the activities of legal entities, controlling stakes and ensuring the dynamism of the economy through privatization. The third goal is related to the development of human capital. Finally, the fourth goal implied an even greater improvement of the business environment in the future.

The most clearly visible data can be found in the data of the State Committee of Azerbaijan for 2023 on exports and imports, which is an economic model suitable for Azerbaijan, i.e. an export-oriented model (Table 1).

Table 1.

Major export countries

Name of countries	Thousand US Dollars	Compared to total export volume, in %
Total	**33,898,554.9**	**100.0**
Including:		
Italy	1,520,8067.6	44.9
Turkey	5,359,328.1	15.8
Russia	1,196,411.3	3.5
Greece	1,363,448.3	4.0
Croatia	590,440.5	1.7
Georgia	759,444.5	2.2
China	78,739.1	0.2
India	1,234,731.0	3.6
Israel	1,401,607.3	4.1
Spain	785,367.8	2.3
Ukraine	118,645.8	0.4
Portugal	299,628.3	0.9
Germany	907,923.0	2.7
Czech Republic	6,84,215.5	2.0
Great Britain	447,910.5	1.3
Bulgaria	481,926.3	1.4
France	1,33,219.5	0.4
Romania	604,469.4	1.8
Vietnam	345,757.1	1.0
Other countries	**1,897,274.0**	**5.6**

Source: Statistical Indicators of the Republic of Azerbaijan-2023

Table 2.

Main import countries

Name of countries	Thousand US Dollars	Compared to total export volume, in %
Total	**17285344.7**	**100.0**
Including		
Russia	3162328.9	18.3
Turkey	2291271.4	13.3
China	3022810.5	17.5
USA	888168.9	5.1
Germany	916421.2	5.3
France	403052.0	2.3
Ukraine	235128.8	1.4
Italy	477904.0	2.8
Great Britain	342873.7	2.0
Iran	473087.3	2.7
Japan	435287.7	2.5
Korea	428091.1	2.5
India	200771.5	1.2
Spain	103138.4	0.6
Kazakhstan	215638.8	1.2
Other countries	**3689370.5**	**21.3**

Source: Statistical indicators of the Republic of Azerbaijan-2023

Additionally, Azerbaijan offers great opportunities for foreign investors, having made significant investments in the development and enhancement of infrastructure, increasing transit capabilities, and improving the business environment.

Diagram 1. Structure of credit investments by credit institutions, in % (01.01.2024)

Increasing the investment attractiveness of Azerbaijan for foreign investors involves simplifying business visas. It is necessary to continue reforming the customs system and encouraging the practice of foreign companies to attract labor resources. In addition, the transition to electronic document flow is currently being actively implemented. Thus, entrepreneurs will need only two documents to carry out export-import operations. As a result of reforms aimed at liberalizing export-import operations, since January 1, 2009, the "single window" principle has been applied when checking goods and vehicles passing through the border, and with the application of the new Customs Code, administrative procedures related to a number of export-import operations have been simplified once again. It should also be taken into account that along with improving conditions for foreign entities, it is necessary to protect the domestic market as much as possible, that is, by increasing customs duties, reduce imports of products and increase sales of local products with low cost.

Thus, a set of measures, ranging from supporting the production of products oriented towards export to directly simplifying the procedures for their sale, will become the foundation for the implementation of plans to diversify the economy of the republic.

We believe it is necessary to study the issues related to the theory of supply and demand when studying the causes of economic crises. The main ones, in our opinion, are the problems of correctly determining the level of taxation. Tax rates are directly related to the level of production and its absolute volume. Unreasonably high tax rates practically do not stimulate production growth due to the lack of the ability to pay them. In some cases, production is suspended, in others, the profile of work is changed to such an activity where tax rates are relatively low, and in the third, an opportunity is found to switch to illegal working conditions.

Tax rates can be increased until the achieved level becomes an obstacle to production and tax revenues to the treasury. The optimal level of tax rates should be determined by the government of each country depending on the current economic situation. As a rule, an unjustified increase in tax rates gives the opposite effect. Studying this dependence, the American economist Arthur B. Laffer was the first to construct a graphical model, where he theoretically substantiated the optimal point of tax rates. This curve has since gained sufficient popularity among economists involved in both taxation and economic development issues.

However, J. Keynes also pointed out that in order to get the economy out of such a situation, mandatory government intervention is necessary, mainly with the help of fiscal and monetary levers.

In his opinion, the government should actively interfere in the processes with the help of specially developed programs that provide not only for the aggregate volume of money supply and money demand, but also include such parameters as the minimum wage, price, and interest rate. International financial institutions have been guided by these provisions for a long period of time to stabilize the economies of developing countries. However, as already noted, in the early seventies, when other processes were taking place in the world economy that did not fall under Keynesian definitions, economists began to study in more detail the causes of sharp fluctuations in the economy. Thus, after many decades of dominance of Keynes's theories, alternative ideas have emerged that make it possible to more accurately determine the causes of fluctuations in the world economy. Unlike Keynes, the supporters of the new idea believed that the market itself is self-regulating, that is, they returned to the definitions of Adam Smith. In their opinion, strong government intervention in the economy ultimately does not provide an opportunity for its normal development.

There are two main ways to solve such issues. The first is the Keynesian method, and the second is the monetaristic approach.

The option proposed by Keynesians to prevent high inflation or hyperinflation mainly involves cutting government spending and revising tax policy. At the same time, it is also considered acceptable to control wages, prices, and the interest rate on bank loans. In addition, Keynesians note the special role of the volume of money supply. Unlike Keynesians, monetarists are more specific. To resolve this problem, they propose only to limit the volume of money supply. If we approach the analysis of the high inflation caused by the high level in more detail, we can see that both options propose to reduce the volume of money supply. The only difference is that in some sentences this is

done in a more its expanded form, and in others - more specifically.

Diagram 2. Amount of cash and non-cash money turnover for 2023.

As we can see from diagram 2, the amount of cash in circulation exceeds bank reserves. That is, the release of cash into circulation in national currency should be reduced to a minimum, so the share of the money supply in relation to GDP will sharply decrease and the economy will be demonetized, which will necessarily affect the level of production and effective demand.

Thus, by maximally reducing or eliminating individual budget expenditures, as well as practically suspending bank lending and tightening control over the release of cash into circulation, the intended goals will be achieved. All these measures will ultimately make it possible to sharply reduce the amount of cash in circulation, which will reduce the need for hard currency at all levels - thereby creating the possibility of regulating the level of inflation as a whole with a significant, as a rule, decline in production.

Table 3.

Major countries of trade turnover

Name of countries	Thousand US Dollars	Relative to trade turnover in %
Total	**51183899.6**	**100.0**
Including		
Italy	15685971.6	3.1
Turkey	7650599.5	1.5
Russia	4358740.2	8.5
Greece	1395789.9	2.7
Croatia	595225.6	1.2
Georgia	885826.1	1.7
China	3101549.6	6.1
India	333991.0	0.6
Israel	1443519.7	2.8
Iran	487394.7	0.9
Spain	888506.2	1.7
France	536271.5	1.0
Ukraine	353774.6	0.7
Portugal	313361.8	0.6
Germany	1824344.2	3.6
Czech Republic	767269.6	1.5
Great Britain	790784.2	1.5
Bulgaria	510930.7	1.0
Romania	670128.3	1.3
Vietnam	482093.3	0.9
USA	904180.3	1.8
Belarus	356589.4	0.7
Turkmenistan	773908.1	1.5
Other countries	**6073149.5**	**11.9**

Source: Statistical indicators of the Republic of Azerbaijan

It should be noted that an equally important object of macroeconomic research is the country's foreign economic activity. For example, the country's trade balance, which in turn indicates the state of the economy of each country. As we can see from the table, a positive balance indicates an excess of exports over imports, which creates a positive dynamic for the country's development. The reform of the financial sector began in 1992, when a two-tier banking system was introduced.

The procedure for allocating loans was determined in accordance with the annual credit plan, which was approved by parliament. The Central Bank did not control foreign exchange reserves, which were mainly allocated through the foreign exchange budget for state needs, including national security and defense. Differentiated requirements for the mandatory sale of foreign currency at rates below the market rate led to the formation of multiple exchange rates. Only in January 1994, the manat, the national currency of Azerbaijan, became the only legal tender in the country, which provided a certain autonomy to the monetary and credit regulation authorities. In the current economic situation, characterized by systemic changes and external shocks, the pursued financial policy did not meet the objectives of stabilizing the economy. Due to the decrease in the level of state revenues, the budget situation deteriorated sharply. This occurred, first of all, as a result of the reduction in production volume and the increase in the role of the informal sector in the economy.

However, the highest productivity growth in 2023 was observed in the information and communications sector - by 6.6%, to 1.724 billion manats. The share of the non-oil sector in the country's GDP was 62.6%. Non-oil exports grew by a record 10.5%, while total exports decreased by 33.7% compared to 2022. Official inflation in the country was observed at the level of 5.4%. During the year, the manat remained stable against the dollar, but devalued by twelve percent against the euro. As a result, according to the results of the year, GDP per capita amounted to 12114.5 manats. According to forecasts, GDP growth in 2024 will be 4.7%. In 2023 - 1.1%, in 2022 - 4.6%, in 2021 - 5.6%.

Table 4.

Main indicators of the state budget of the Republic of Azerbaijan

Years	Budget revenues, million manat	Share of GDP, in %	Budget expenditures, million manat	Share of GDP, in %	Budget deficit(-) Surplus(+) million manat	Share of GDP, in %
2012	17281,6	32,0	17105,6	31,7	176,0	0,3
2015	17153,2	31,6	17786,8	32,7	-633,6	-1,2
2017	16446,9	23,5	17588,4	25,1	-1141,5	-1,6
2018	22411,2	28,1	22718,9	28,5	-307,7	-0,4
2019	24199,6	29,6	24404,8	59,9	-205,2	-0,3
2020	24681,7	34,1	26416,3	36,5	-1734,6	-2,4
2021	26396,3	28,3	27422,4	29,4	-1026,1	-1,1
2022	30679,6	22,9	32064,6	23,9	-1385,0	-1,0
2023	35236,4	28,6	36458,0	29,6	-1221,6	-1,0

Source: Statistical indicators of the Republic of Azerbaijan-2023

As shown in Table 4, it is evident that expenditures grow in line with budget revenues, but despite the state budget deficit, it still does not exceed 3% of GDP. The budget system of Azerbaijan is the most important link in the republic's financial system. It includes the republican budget and local budgets. Local budgets are divided into city, village and town budgets. City budgets, in turn, consist of city budgets, city district budgets, village and town subordination budgets. The tasks performed with the help of the budget provide grounds for defining the essence of the budget. Without going into detail about the polemics about the essence, functions and principles of budget construction, we nevertheless believe it is necessary to define the initial theoretical positions on these concepts, which have been controversial to date. For the most effective management of the budget process, it is of fundamental importance how the term "budget" itself is defined. In most cases, this concept is limited to estimates related to annual allocations of funds by the relevant legislative body. Such a concept, however, can cover only a small share of all budget and tax operations. As has already been said above, the volume of long-term loans to the economy, which are the basis for its development, contributed to the smooth operation of financial and economic structures. For example, deliberate stimulation of issuing short-term trade loans led to the fact that most private enterprises began to closely engage in the export of various consumer (mainly food) goods. Naturally, here certain interests of enterprises engaged in the export of goods to the country were stimulated by maximizing profits compared to production.

CONCLUSION

The very emergence of a deficit is evidence of a shortage of budget revenues to cover existing government expenditures. It should be noted that the main thing is that the definition of all sources of income remains unbalanced, and what is no less important, what part of the expenses can be considered quite justified. The availability of alternative sources for covering the resulting deficit is also of no small importance. After all, in principle, the budget deficit can be covered by not one, but several sources, including such an inflationary source as a loan from the Central Bank. Determining the most acceptable option for covering the budget deficit can only take place if the government has

a financial and budgetary policy that is justified for the given stage of economic development.

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DEVELOPMENT OF REGIONAL TOURISM IN NAKCHIVAN AUTONOMOUS REPUBLIC AND FUTURE PERSPECTIVES

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ABSTRACT

In the article, the explanation of regional tourism is clearly explained, and it is justified that the aspect of safety is the main indicator in regional tourism. It is emphasized that tourism is a multifaceted and complex phenomenon, in which many fields of science, such as economics, business, politics, sociology, etc., are closely interested. In recent years, it is a rapidly developing and profitable field not only in our country, in the region, but even in the whole world. Tourism, as a strong factor of the economy, an effective social institution, and as an indicator of public welfare and culture in society, helps to raise the standard of living and spiritual enrichment of a person. It is the priority direction of the economy in the autonomous republic with high tourism potential. Also, the main directions of the mechanisms driving the development of tourism in the region were shown and the conditions of development were analyzed in detail. The problems of creating a regional brand have been investigated.

Keywords: tourism, regional tourism, development and stimulation of tourism, security, tourist activity.

Introduction. In recent years, one of the most dynamic, rapidly growing, and profitable sectors of the economy has been tourism. This industry is advancing at a high pace and, unlike other sectors, is less affected by economic crises. Tourism, which serves as the economic foundation for many countries, including developed nations, significantly contributes to the state budget. Nature endows some regions with underground and surface resources, and others with rich flora and fauna. However, in certain areas, a wealth of historical traditions, numerous cultural artifacts, diverse climate types, and natural settings have led to the formation of a vast tourism potential in these ancient lands. Beautiful nature, clean air, favorable geography, and boundless mountains and valleys have prompted Azerbaijan to designate the development of national tourism as a priority in the non-oil sector of its economy.

Initiatives undertaken to promote tourism, alongside state programs and improvements in the regulatory and legal framework, affirm this priority. At the national and regional levels, tourism plays a strategically significant role in social policy [1, p. 27-34].

Overall, the tourism sector connects with over 30 other industries, accounting for 8% of global exports and 31% of the world's service market, and employs more than 100 million people, representing one in every ten jobs worldwide. Today, tourism is one of the most profitable and dynamic sectors globally. Approximately 10% of global GDP, investments, job creation, and consumer expenditures are attributed to tourism. According to the latest edition of the International Tourism Barometer by UNWTO (World Tourism Organization), global tourist arrivals in 2023 reached 1.286 billion, almost matching pre-COVID-19 levels from 2019 [7].

Theoretical Aspects of Regional Tourism. Regional tourism fulfills the need for rest and revitalization, allowing individuals in continuous and monotonous work to return refreshed to their jobs, while also generating income and creating employment. To address the worsening income disparity between countries and regions due to globalization, tourism's income-generating and employment-creating characteristics can be leveraged. Through its geo-economic assets, socio-cultural values, and unique services rooted in non-exportable values, tourism brings foreign currency to regions. A key feature of tourism is its heavy reliance on natural, climatic, historical, folkloric, and cultural values, as these form the fundamental components of the industry. When natural beauty and cultural assets are marketed effectively and responsibly, they provide invaluable revenue streams that positively impact economic stability in countries and regions[2, p 15-19]. Tourism has gained increasing significance in the global economy as a major sector that directly or indirectly influences people's physical, social, and psychological needs. Although the primary reason for countries' interest in tourism is economic, another key reason is its contribution to improved social welfare. Tourism represents a general social quality and, due to this characteristic, is a multifaceted phenomenon involving economics, business, politics, sociology, and more. While various definitions of tourism exist, a common understanding is that tourism includes travel and temporary accommodation outside one's permanent residence to meet needs for vacation, rest, entertainment, culture, and similar activities[3, p. 15-19]. Regional tourism is not merely an economic event but also a sector that impacts society, thus possessing social, political, and ecological dimensions. Accordingly, when assessing tourism's effects, not only its material and economic outcomes, such as revenue generation and currency inflow, but also its social and cultural reflections should be considered.

Methodology. The economic effects of regional tourism on local development are explained as follows:

1. Employment generated by regional tourism reduces unemployment in rural areas.

2. Tourism increases the inadequate and unstable income of rural populations engaged in agriculture, improving their welfare levels.

3. The development of tourism in rural areas provides employment opportunities for women in various tourism establishments, promoting active participation in the workforce and reducing unemployment.

4. The advancement of regional tourism markets cultural assets, generating additional income for local people and contributing to reduced income inequality.

5. Efficient use of local resources in rural areas promotes economic diversification and strengthens local cooperation and development demands.

6. The growth of regional tourism brings additional income through family entrepreneurship for local communities.

7. Tourism investments in rural areas boost the income of sub-sectors and the construction sector.

8. The gap in development levels between urban and rural areas diminishes.

9. Infrastructure problems in the region are alleviated with the development of regional tourism [4, p. 349].

A distinctive feature of the regional tourism sector is that it belongs to the service sector, relying heavily on labor. No other sector of the economy is as directly connected to people as tourism. While personal activities generate tourism demand, human elements constitute the most crucial factors in responding to this demand. Tourism's labor-intensive nature suggests that the sector can significantly contribute to job creation in the region, facilitating employment for the nation's population and playing an essential role in alleviating unemployment [5, p. 87-96].

Development of Tourism in the Nakhchivan Autonomous Republic. Nakhchivan's favorable geographical position, diverse climatic zones, rich cultural heritage, natural therapeutic centers, over 200 mineral springs, unique cuisine, hospitality traditions, and modern advancements are the primary factors supporting tourism development in the autonomous republic. Specially protected natural areas, including Zangezur National Park, the Araz River, Ordubad, and Arpachay Nature Reserves, cover 28% of Nakhchivan's territory [6, p. 626-640]. During the autonomy years, comfortable asphalt roads, water lines, modern infrastructure, uninterrupted gas, electricity, communication services, and high-speed internet were established even in the most remote mountain villages.

Rural tourism has been developed in many settlements such as Bichanak, Kuku, Aghbulag, Nursu, Kechili, Khanagah, and Dirnis. Tourists visiting these areas can also enjoy a wide range of pure ecological products. Winter tourism has also grown in the autonomous republic, with the ghbulag Ski Center now operational. As one of the oldest settlements and a region rich in history, Nakhchivan attracts tourists with its cultural and historical heritage. Nakhchivan has great potential for religious tourism, with the Ashabi-Kahf pilgrimage site attracting Muslim visitors from both Azerbaijan and worldwide since independence. The tomb of Prophet Noah is also a notable religious tourism site [7].

Tourism Development Indicators in Nakhchivan. From 2006 to 2023, the number of hotels and hotel-type establishments in the country increased 1.5 times, reaching 657, and revenues from these facilities rose 2.37 times. During this period, the number of employees in Nakhchivan's hotels and similar establishments grew to 332, a 1.6-fold increase[9].

Tax Incentives for Tourism Development. Tax legislation has been amended, and various incentives have been introduced to support entrepreneurship, including those in the tourism sector. With changes to the Tax Code aimed at promoting regional tourism and reducing fixed tax costs, tax incentives for tourism enterprises, such as hotels and sanatoriums, have been established[8]. Effective January 1, 2024, property tax on real estate used in hotel, hotel, and sanatorium activities will be reduced by 75% for three years, excluding the cities of Baku, Sumgait, Khirdalan, and the Absheron district [10].

Conclusion. The study and expansion of tourism resources, providing essential services for tourist leisure, meeting visitor demands, expanding the range of excursions and other cultural activities, aligning with modern standards, studying and sustainably utilizing sanatorium-resort resources, expanding the construction of hotels and other tourism facilities, increasing tourism routes, and developing cultural, ecological, rural green, and recreational tourism underscore the high potential for regional tourism development in the Nakhchivan Autonomous Republic.

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MEDICAL SCIENCES

ПЕРВИННА ДІАГНОСТИКА ФЕНОМЕНУ РЕЙНО В ДІТЕЙ ПІДЛІТКОВОГО ВІКУ

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PRIMARY DIAGNOSIS OF RAYNAUD'S PHENOMENON IN ADOLESCENT CHILDREN

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АНОТАЦІЯ

Феномен Рейно — (ФР) це визначений клінічний синдром, поширеність якого становить 3–5% загальної популяції, із вищою частотою у холодних кліматичних зонах. Він характеризується повторюваними епізодами вазоспазму пальців, викликаного холодом, хімічними або емоційними тригерами. ФР класифікують як первинний, якщо він проявляється ізольовано, або вторинний, якщо він пов'язаний із основним захворюванням, головним чином із захворюванням сполучної тканини. В обох випадках вона проявляється своєрідними «потрійними» (блідістю, ціанозом і еритемою) або «подвійними» змінами кольору. Первинний ФР зазвичай є доброякісним станом, тоді як вторинний може розвиватися та ускладнюватися пальцевими виразками та гангреною, що може вимагати хірургічного лікування.

Хоча патогенез ФР залишається до кінця не з'ясованим, феномен Рейно зустрічається і в дитячому віці, особливо у підлітків, де його наявність може свідчити про ризик розвитку аутоімунних захворювань сполучної тканини.

Діагностика ФР включає ретельний збір анамнезу, фізикальний огляд, а також капіляроскопію нігтів, що дозволяє оцінити мікроциркуляторні зміни і допомагає відрізнити ФР від інших вазомоторних розладів (наприклад, акроціаноз, перніопатія, нейропатія дрібних волокон із вазомоторними симптомами та комплексний регіональний больовий синдром). У дітей необхідність діагностики визначається ретельною оцінкою, зокрема у разі виражених чи тривалих симптомів, оскільки первинна діагностика Рейно в дитячому віці може допомогти виявити потенційні ризики розвитку захворювань сполучної тканини. Незалежно від етіології, лікування включає зігрівання з уникненням тригерів і розгляд призначення вазодилататорів (наприклад, кальцієвих каналів, альфа-1 блокаторів). Вторинний ФР з виразкою пальців може потребувати

PDE5i, блокаторів рецепторів ендотеліну-1 та простаноїдів. При рефрактерних випадках можуть проводитись інтервенції, такі як пневматичні артеріальні насоси, введення ботулінічного токсину або хірургічна симпатектомія.

ABSTRACT

Raynaud's phenomenon is a well- defined clinical syndrome with a prevalence of 3-5% of the total population, with a higher frequency in cold climatic zones. It is characterized by recurrent episodes of cold-induced finger vasospasm, chemical or emotional triggers. FR is classified as primary if it manifests itself in isolation, or secondary if it is associated with an underlying disease, mainly connective tissue disease. In both cases, it manifests itself as a kind of "triple" (pallor, cyanosis and erythema) or "double" color changes. Primary RF is usually a benign condition, while secondary can develop and be complicated by finger ulcers and gangrene, which may require surgical treatment. Although the pathogenesis of FR remains not fully understood, Raynaud's phenomenon occurs in childhood, especially in adolescents, where its presence may indicate the risk of developing autoimmune connective tissue diseases.

Diagnosis of FR includes careful history collection, physical examination, as well as nail capillaroscopy, which allows to evaluate microcirculatory changes and helps to distinguish FR from other vasomotor disorders (for example, acrocyanosis, perniopathy, neuropathy of small fibers with vasomotor symptoms and complex regional pain syndrome). In children, the need for diagnosis is determined by a thorough assessment, in particular in the case of severe or prolonged symptoms, since the primary diagnosis of Raynaud's in childhood can help identify potential risks of developing connective tissue diseases. Regardless of etiology, treatment includes warming with avoidance of triggers and consideration of vasodilator prescribing (e.g., calcium channels, alpha-1 blockers). Secondary FR with finger ulcers may require PDE5i, endothelin-1 receptor blockers, and prostanoids. In refractory cases, interventions such as pneumatic arterial pumps, botulinum toxin administration, or surgical sympathectomy may be performed.

Ключові слова: Феномен Рейно, підлітковий вік, діагностика, опитування, статистика, чутливість та специфічність.

Keywords: Raynaud's phenomenon, adolescence, diagnostics, survey, statistics, sensitivity and specificity.

Постановка проблеми.

Вегетативна нервова система (ВНС) контролює фізіологічні функції в організмі, які не перебувають під прямим довільним контролем і зазвичай контролюється не свідомо. Мішенями вегетативної нервової системи є температура тіла, частота серцевих скорочень, дихання, випорожнення та травлення, сексуальне збудження, ендокринна функція, регуляція артеріального тиску та тонус судин.

Захворювання та проблеми з регуляцією вегетативної нервової системи називаються вегетативною дистонією, і вони можуть впливати на багато різних функцій ВНС, включаючи тонус судин та кров'яний тиск [1]. Вегетативно-судинно-трофічні порушення із судинноруховими розладами в дистальних відділах рук і ніг, рідше – на обличчі об'єднують у загальну патологію – ангіотрофоневрози. Найчастіше в групі ангіотрофоневрозів трапляється феномен (синдром) Рейно.

Моріс Рейно вперше охарактеризував це захворювання у своїй дисертації 1862 року, вважаючи, що симптоми його пацієнтів є наслідком дерегульованого звуження прекапілярних артеріол, викликаного гіперактивним неврологічним рефлексом [2]. Пізніше Т.Люїс (T. Lewis) визначив два варіанти для встановлення форми захворювання: первинний синдром Рейно (хвороба Рейно) та вторинний синдром Рейно [3]. На конференції (2011), яка була організована відділом судинної медицини Королівського медичного товариства, було рекомендовано використовувати термін «феномен Рейно» замість «синдром Рейно» і «хвороба Рейно» через відсутність консенсусу серед спеціалістів [4].

Феномен Рейно (ФР)– це патологія з порушеннями периферичної циркуляції крові внаслідок локальної артеріальної вазоконстрикції, розвитком трофічних порушень у результаті порушення кровопостачання відповідних органів та систем. Найчастіше при ньому уражаються судини пальців рук, ніг, підборіддя, губ, язика, вушних раковин, сосків, кінчика носа.

ФР є епізодичною реакцією на холод або емоційний стрес, що викликає зміни кольору та супутні симптоми, такі як оніміння, біль і поколювання в кінцівках. Феномен Рейно є поширеним захворюванням, і хоча воно зазвичай не загрожує життю, його симптоми можуть бути інвалідизуючими [5,7]. Первинний синдром ФР виникає внаслідок функціональних змін у кровоносних судинах і не призводить до незворотного ушкодження тканин, і пацієнти є серонегативними щодо ANA [6]. Вторинний синдром Рейно (наприклад, внаслідок системного склерозу та захворювань системної склеродермії) може призвести до втрати тканин, трофічних виразок і сухої гангрени кінцівок.

Незалежно від підтипу, характерною ознакою ФР є ішемія пальців у відповідь на холод, що викликає характерний «трифазний» колірний малюнок, (блідість, ціаноз, рубор), а також оніміння та набряк. Спочатку дистальні подушечки пальців стають блідими або біліють через звуження кровотоку; потім стають синіми, що є ознакою гіпоксії тканин; і, нарешті, червоний, так як тканина реперфузується [8]. Чітко відмежовані зміни кольору деякі вважають важливою діагностичною ознакою ФР, але без безпосереднього спостереження за нападом може бути важко оцінити цю ознаку [9,10].

ФР діагностується за єдиним кодом у міжнародній класифікації хвороб (МКХ-10 I73.0) у IX Класі «Хвороби системи кровообігу», блок «Хвороби артерій, артеріол та капілярів» [11].

Патофізіологія не цілком зрозуміла, і, мабуть, Феномен Рейно слід розглядати як мультифакторіальний стан. Вважається, що причиною надмірно вираженого вазоспазму є дисбаланс між вазодилататорами та вазоконстрикторами внаслідок порушення центральних та локальних механізмів регуляції судинного тонусу. Деяку роль відіграють фенотипічні зміни судинних ендотеліальних клітин, зміни реологічних параметрів у судинах, а також циркулюючих чинників, які погіршують кровотік [12,13]. Нещодавні дослідження свідчать, про наявність ймовірних генів, що збільшують ризик феномену Рейно [14]. Відомо, що при охолодженні підвищується продукція кисневих радикалів, які активують Rho-кіназу, що викликає транслокацію на клітинну мембрану α2с-адренорецепторів, відповідальних за вазоконстрикторні реакції.

Клініко-медико-соціальна проблема зумовлена значним поширенням захворювання. За даними ВООЗ, феномен Рейно зустрічається від 2,5 до 4% населення. Поширеність первинного ФР (без основного захворювання) вища в холодному кліматі і зустрічається досить часто в загальній популяції – 25-30%. У дітей шкільного віку його поширеність оцінюється в 15%.

У дітей важко оцінити поширеність ФР, оскільки багато сімей можуть сприймати зміни кольору як нормальну реакцію на вплив холоду. В одному педіатричному дослідженні (Велика Британія) використовувалася методологія опитування із зображеннями, і серед 720 школярів 18% дівчаток і 12% хлопчиків повідомили про зміну кольору пальців щонайменше раз на місяць або про відчуття «недостатньо чутливості чи поколювання» при впливі холоду на них [15]. Ще один багатопрофільний звіт виявив ФР у 2,2% дітей віком від 0 до 10 років і у 20% дітей у віці від 10 до 18 років [16], що вказує на необхідність ранньої діагностики у цій групі. Поширеність зростає з віком, особливо серед дівчат. Більшість дітей (близько 70 %) мають первинний Рейно, а вторинний Рейно асоційований з ювенільним системним червоним вовчаком, ювенільним системним склерозом, змішаним захворюванням сполучної тканини, а рідше з системним склерозом та синдромом Шегрена [17]. Ці захворювання потрібно виключити у кожної дитини з ФР. Незважаючи на широку поширеність ФР, стандартизовані діагностичні критерії досконало не встановлені.

Метою цього дослідження є аналіз та систематизація існуючих літературних даних, а також результатів власного опитування щодо поширеності феномену Рейно серед дітей підліткового віку, зокрема серед студентів молодших курсів ТНМУ. Дослідження спрямоване на виявлення основних факторів, що впливають на розвиток цього захворювання, а також на визначення принципів первинної діагностики феномену Рейно, що має важливе значення в клініці для своєчасного виявлення та подальшої тактики.

Виклад основного матеріалу:

У межах дослідження було проведено анкетування серед студентів першого та другого курсів Тернопільського національного медичного університету (ТНМУ), результати якого піддалися подальшому аналізу. Анкету складали 12 запитань, більшість яких базувалися на трикроковому алгоритмі діагностики феномена Рейно, затвердженому на Дев'ятому міжнародному конгресі з аутоімунних захворювань у 2014 році. У рамках дослідження також було здійснено формування первинної вибірки наукових робіт, що відповідають меті дослідження феномену Рейно, здійснено пошук у провідних наукових базах даних, таких як PubMed, Google Scholar, Medscape та Scopus. Пошук проводився з використанням відповідних дескрипторів: «Raynaud phenomenon», «diagnostic criteria for Raynaud's phenomenon», «treatment of Raynaud's phenomenon» та «prognostic factors of Raynaud's phenomenon». Було задіяно розширені функції пошукових систем для максимального охоплення релевантної інформації. До первинної вибірки включено роботи за останні 10 років, що висвітлюють патофізіологічні механізми, діагностичні підходи та терапевтичні стратегії для феномену Рейно.

Для діагностики феномену Рейно першочергово враховуються скарги пацієнта та клінічні симптоми. Діагноз вважається достовірним, якщо опитуваний відповів ствердно на питання першого і другого кроку та дав позитивну відповідь на три або більше питань з третього кроку трикрокового алгоритму діагностики феномену Рейно. Варто зазначити, що в опитувальник було додано одне питання щодо наявності чи відсутності у студентів підтвердженого захворювання сполучної тканини.

Після аналізу 109 анкет студентів, 5 анкет було відсіяно, оскільки у цих респондентів в анамнезі вже були діагностовані захворювання сполучної тканини. Після опрацювання анкет кроку 1 (рис. 1.) було виключено 67 анкет (61,5%) від усіх опитаних, оскільки така кількість учасників відповіли «ні» на питання «чи мають пальці біфазну зміну кольру (біле і синє забарвлення) при впливі на них холоду?». Аналізуючи наступний крок, слід враховувати, що чутливість пальців рук до холоду може проявлятися і у здорових людей. Холодна шкіра або незначне бліде забарвлення пальців вважаються нормальною відповіддю на дію холоду. Згідно з отриманими даними, майже 59% респондентів відчувають підвищену чутливість пальців до холоду, а 51% – помічають зміну кольору пальців рук.

Клінічно для феномену Рейно характерне початкове збліднення шкіри через спазм судин, яке зазвичай супроводжується ціанозом внаслідок дезоксигенації статичної венозної крові, а згодом почервонінням через реактивну гіперемію після відновлення кровотоку. Це формує класичну «трифазну зміну кольору».

Крок 1

Чи підвищена чутливість ваших пальців до холоду ?

ні 41.3%
так 58.7%
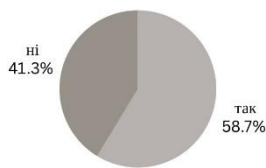
Чи змінюють пальці рук колір на холоді?

ні 48.6%
так 51.4%
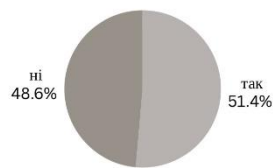
Крок 2

Чи мають пальці біле і синє забарвлення при дії холоду?
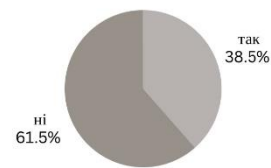
так 38.5%
ні 61.5%

Рис.1. Результати опитування Кроку 1 та Кроку 2.

Однак трифазна зміна кольору (ціаноз і рубор) не завжди присутня: вона виникає приблизно у третини пацієнтів з первинним феноменом Рейно та у двох третин пацієнтів із вторинним феноменом Рейно, пов'язаним із системною склеродермією. Тому важливо пам'ятати, що лише зблідення є високочутливою і високоспецифічною ознакою, яка може бути достатньою для діагностики феномену Рейно [18].

На етапі обробки кроку 3 (рис. 2.) оцінювались 37 анкет, що залишилися після проходження респондентами попередніх двох кроків алгоритму, виявлено 9 анкет, у яких було менше трьох позитивних відповідей. Отже, за результатами трикрокового алгоритму, феномен Рейно спостерігається у 28 з 109 опитаних осіб.
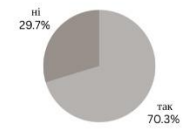
Крок 3

Зміна забарвлення пальців провокується, крім холоду, іншими чинниками (емоційний стрес та ін.)?

так 37.8%
ні 62.2%
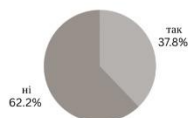
Зміни виникають на обох руках (не важливо, чи вони синхронні і симетричні)?

ні 24.3%
так 75.7%
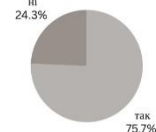
Зміни супроводжуються онімінням пальців, відчуттям поколювання, печіння?

ні 29.7%
так 70.3%

Ділянки шкіри із зміненим забарвленням чітко відмежовані від ділянок шкіри звичайного кольору?

так 28.9%
ні 71.1%
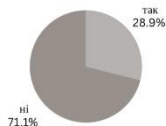
Чи є епізоди іншої локалізації (ніс, вуха, стопи, соски)?

так 44.2%
ні 55.8%
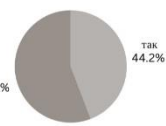
Чи спостерігалася трифазна зміна забарвлення (білий, синій, червоний) ?

ні 35.1%
так 64.9%
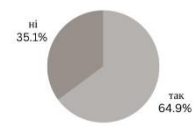
Рис. 2. Результати опитування Кроку 3.

Проаналізувавши результати вибірки студентів, було визначено чутливість і специфічність симптомів для оцінки їхньої значущості. Найбільш чутливими симптомами виявилися оніміння та парестезії (70%) та наявність пароксизмів на обох руках (76%). Найбільш специфічними симптомами були чітке відмежування змін на шкірі (93%), поява епізодів під впливом факторів, відмінних від холоду (96%), та трифазна зміна забарвлення пальців (91%).

Проте, ці дані є не точними, і діагноз вимагає остаточного підтвердження за допомогою лабораторно-інструментальних методів діагностики У 2016 році були опубліковані рекомендації щодо подальшого обстеження дітей з РП. The Pediatric Rheumatology Society Group (PRES) Juvenile Scleroderma Group запропонувала проводити скринінг всіх дітей з феноменом Рейно за допомогою тестування ANA та капіляроскопічного обстеження

[19]. Інтерпретація капіляроскопічних зображень повинна проводитися відповідно до визначень міжнародного консенсусу від EULAR SG MC RD. Капіляроскопічне обстеження має діагностичне значення при оцінці ФР [20]. Серед сучасних малоінвазивних діагностичних методів інфрачервона термографія є найбільш доступним і досить інформативним діагностичним методом радіаційної діагностики, який дозволяє вивчати патогенетичні механізми розвитку периферичних судинних розладів, зокрема при феномені Рейно.

Висновки

Феномен Рейно (ФР) – це порушення периферичної циркуляції, що виникає через локальну артеріальну вазоконстрикцію і часто проявляється як реакція на холод або емоційний стрес. Характерними симптомами є зміни забарвлення шкіри, оніміння, біль і поколювання в кінцівках. При впливі

холоду спостерігається «трифазна» або «двофазна» зміна кольору (блідість, ціаноз, рубор) на пальцях.

За даними розглянутих досліджень, феномен Рейно виявляється у 20% підлітків віком від 10 до 18 років, що підкреслює важливість ранньої діагностики у цій віковій групі. У нашому дослідженні, проведеному серед 109 студентів ТНМУ, ФР було підтверджено у 25,7% опитаних. Специфічними симптомами для первинної діагностики ФР є чітке відмежування змін на шкірі, поява епізодів під впливом чинників, відмінних від холоду, а також трифазна зміна кольору пальців. Однак, незважаючи на виражені клінічні ознаки, діагноз феномену Рейно потребує додаткового обстеження для підтвердження, зокрема за допомогою лабораторних та інструментальних методів, таких як тестування на антитіла (ANA) та капіляроскопія. Тому важливість ранньої діагностики та подальшого моніторингу стану пацієнтів з ФР, особливо серед підлітків, не можна недооцінювати.

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COST-EFFECTIVENESS OF SEASONAL INFLUENZA VACCINATION PROPHYLAXIS

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ABSTRACT

Influenza remains one of the world's greatest public health challenges. Each year, there are about 1 billion cases worldwide, of which 3 to 5 million are severe, resulting in 290,000 to 650,000 flu-related deaths. All of this results in great costs for those affected as well as for the health system and society as a whole. This article presents an analysis of influenza morbidity and costs associated with treatment. The article also contains data on the coverage for seasonal influenza immunization. Based on an analysis of the data presented, we concluded that seasonal influenza vaccination is the only effective and inexpensive means of preventing new influenza epidemics and reducing treatment costs for the health systems and the population.

Keywords: vaccine prophylaxis, influenza, morbidity, cost, effectiveness, epidemic.

INTRODUCTION

Influenza persists as one of the world's greatest challenges to public health. Each year, there are about 1 billion cases worldwide, of which 3 to 5 million are severe, resulting in 290,000 to 650,000 flu-related deaths. The most effective way to prevent the disease, recommended by the WHO, is annual influenza vaccination. Vaccination is particularly important for people at higher risk of severe complications from influenza and for health professionals (WHO launches new global influenza strategy, https://www.zdrave.net/ /n8930 accessed 06.11.2024).

The goal of this paper is to present the cost-effectiveness of vaccination prophylaxis in influenza season.

To achieve this goal, we have set ourselves the following tasks:

1. An analysis of the morbidity and hospitalization rates of non-immunized and immunized persons based on the available literature.

2. An analysis of seasonal influenza vaccine coverage in Europe and Bulgaria.

To achieve this goal, we have used a documentary method, analyzing regulatory documents, WHO reports and available literature sources related to vaccination and seasonal influenza spread.

ANALYSIS

Influenza epidemics cause economic losses, both direct (hospitalisation, outpatient care, doctor visits) and indirect (temporary disability, strain on health and insurance services), and suffering for patients (A. Galev, 2020).

A WHO report states that the global influenza strategy for the 2019-2030 period provides for the prevention of seasonal influenza, as well as the control of the virus' spread from animals to humans and the preparation for the next influenza pandemic. The world has experienced several deadly influenza pandemics, the worst being the Spanish Flu, which killed tens of millions in 1918. Other pandemics have followed since - in 1957, 1968 and 2009, when the H1N1 virus caused 18 500 deaths in 241 countries (https://novini.bg/zdrave/bolesti/528393).

According to the Centers for Disease Control and Prevention, in the USA during the 2019/2020 season, seasonal influenza vaccination prevented 7.5 million influenza cases, 3.7 million influenza-related physician consultations, 105,000 influenza-related hospitalizations, and 6,300 deaths resulting from influenza.

In another study conducted in 2018, again among adults hospitalized due to influenza, the results showed that vaccinated patients were 59% less likely to be admitted to an intensive care unit compared to unvaccinated patients. Vaccinated patients treated in an intensive care unit stay 4 days less than unvaccinated patients (https://www.sciencedirect.com/science/article/pii/S0264410X18309976?via%3Dihub).

The long-standing influenza tracking system in Bulgaria shows that annual influenza epidemics are a serious health problem faced by our country. On average, around 1 400 000 to 1 600 000 cases of acute respiratory illness (ARIs) and influenza occur in regional cities alone each year, and they account for 10 to 30% of all temporary disability cases. These data demonstrate that annual influenza epidemics are the cause of serious economic loss stemming from both home and hospital treatment costs and unrealised social product due to the massive impact on individuals of working age.

Influenza cases are mainly clustered within 3 - 4 weeks. During these weeks, the national average morbidity rate reaches over 300 per 10 000 people, which means that at least 250 000 - 300 000 people were ill during the epidemic upsurge.

In the majority of cases, costs arising from a disease are calculated by adding together all direct, indirect and non-material costs. Direct costs arise from the use of medical and non-medical resources. Indirect costs are caused by productivity loss and absenteeism, while non-material costs are associated with reduced job performance and reduced quality of life. Direct costs are influenced by chronic comorbidities and other risk factors (e.g. age), which can lead to an increase in hospitalizations and longer treatment periods.

Seasonal influenza immunization coverage of patients at risk of serious complications, healthcare workers and healthy individuals in Europe is extremely varied (A. Galev, 2020). The UK and the Netherlands have well-established guidelines that are updated on a regular basis. They are also the countries with the best vaccination coverage (only these two European countries are close to the target of 75% coverage among the elderly). A European Commission report identified the need to improve seasonal influenza vaccination coverage and prevention policies in other European countries. According to this report, all Member States should take further action to maximise the benefits of seasonal influenza vaccination across Europe. The data from Bulgaria show that influenza vaccination coverage has been exceptionally low - below or slightly above 3% of the population over the past few years.

In accordance with Ordinance No. 15 of 2005 on immunization in the Republic of Bulgaria, immunization against influenza in the country is recommended and is carried out at the expense of the patients. Immunization against seasonal influenza is recommended annually for all persons 65 years of age and older, and for adults and children over 6 months of age who have chronic conditions.

As stated in the National Programme for Improving the Vaccination of Seasonal Influenza and Pneumococcal Infections in Persons Aged 65 Years and Older 2023-2026 in our country, influenza vaccines have the potential to prevent severe courses and mortality from influenza. Vaccinated patients are 26% less likely to be admitted to an intensive care unit and 31% less likely to die from influenza compared to those who are not vaccinated, according to a 2021 study of adults hospitalized for influenza (https://www.sciencedirect.com/science/article/pii/S0264410X21005624?dgcid=author).

In Bulgaria, immunization coverage with seasonal influenza vaccines is low, with an average coverage of only 2.4 per 100 people (2.17-2.61%) for the 2013-2017 period (based on vaccine sales).

With the introduction of the National Seasonal Influenza Vaccine Improvement Program, 2019-2022, the following influenza immunization coverage in persons aged 65 years and above, who are the target group

of the program, has been achieved: 2019 - 7.8%, 2020 - 11.4% and 2021 - 13.24%.

As of 14.10.2024, 86 460 persons aged 65 and over have been vaccinated against influenza free of charge, under the National Programme for Improving the Vaccination of Seasonal Influenza and Pneumococcal Infections. 348 000 vaccine doses have been distributed under the National Programme for Improving the Vaccination of Seasonal Influenza and Pneumococcal Infections in Persons Aged 65 Years (https://plusmen.bg/bg/facts/news/50).

CONCLUSION

Influenza constitutes a significant socio-economic burden on society in terms of medical treatment (increased number of consultations, hospitalizations, clinical complications, use of medicines) and work absenteeism. There are different estimates of the overall economic impact of an influenza epidemic. So, or example, the total impact of an influenza epidemic (total estimated direct and indirect costs) in industrialised countries could be as high as €56.7 million per one million people. Seasonal influenza vaccines are the only effective and inexpensive measure for preventing new influenza epidemics and reducing the treatment costs to both the health systems and the population.

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СОПОСТАВЛЕНИЕ ГЕМАТОЛОГИЧЕСКОГО И АУТОИММУННОГО СТАТУСА ПАЦИЕНТОВ С БОЛЕЗНЬЮ ГРЕЙВСА И АУТОИММУННЫМ ТИРЕОИДИТОМ ПРИ ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ

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COMPARISON OF HEMATOLOGIC AND AUTOIMMUNE STATUS OF PATIENTS WITH GRAVES DISEASE AND AUTOIMMUNE THYROIDITIS DURING SURGICAL TREATMENT

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АННОТАЦИЯ

Обследовано 28 (65,1%) пациентов с БГ с анемией (средний возраст 43,6±2,5 лет) и 36 лиц с АИТ с анемией (средний возраст 44,1±1,7 лет). Выполнение тотальной тиреоидэктомии у пациентов с БГ и АИТ с анемией приводит к прекращению аутоиммунного процесса и улучшению гематологических показателей на фоне эутиреоза, достигнутого в течение года после операции за счет заместительной терапии левотироксином. Сохранение ткани ЩЖ при выполнении субтотальной тиреоидэктомии у обеих групп лиц способствует, по - видимому, дальнейшему усугублению аутоиммунных нарушений и ухудшению гематологических показателей, несмотря на эутиреоидный гормональный фон пациентов спустя год после операции.

ABSTRACT

A total of 28 (65.1%) patients with Graves' disease (GD) and anemia (average age 43.6 ± 2.5 years) and 36 individuals with autoimmune thyroiditis (AIT) and anemia (average age 44.1 ± 1.7 years) were examined. Performing total thyroidectomy in patients with GD and AIT with anemia leads to the cessation of the autoimmune process and improvement in hematologic parameters against the background of euthyroidism, achieved within a year after the surgery through replacement therapy with levothyroxine. Preservation of thyroid tissue in both

groups of patients during subtotal thyroidectomy seems to contribute to further exacerbation of autoimmune disorders and deterioration of hematologic parameters, despite the euthyroid hormonal profile of patients a year after surgery.

Известно, что некоторые заболевания щитовидной железы (ЩЖ) могут влиять на гемопоэз [7]. Это касается прежде всего аутоиммунных заболеваний, сопровождающихся дисфункцией ЩЖ, – болезнь Грейвса и аутоиммунный тиреоидит [13, 14, 17,19]. Хотя анемия и дисфункция ЩЖ наблюдаются одновременно, причинно-следственная связь между нарушениями остается неоднозначной. Если гормоны ЩЖ стимулируют эритропоэз, то в свою очередь, железодефицитная анемия отрицательно влияет на статус тиреоидных гормонов[20, 16, 21]. Механизмы развития анемии при гипотиреозе (АИТ) и гипертиреозе (БГ) до сегодняшнего дня до конца не изучены, причем в литературе в большей степени освещены причины развития и формы анемии при гипотиреозе, чем при гипертиреозе [6, 8, 11, 16, 17, 21]. Немногочисленные исследования, посвященные выявлению связи анемии и заболеваний ЩЖ сообщают о противоречивых результатах относительно частоты анемии при гипотиреозе и гипертиреозе[8, 14, 15, 18, 21, 22]. Железодефицитная анемия может быть первым симптомом, приводящем к диагностике гипотиреоза и аутоиммунной тиреопатологии [1, 10, 11,13]. Пациенты с тиреоидными антителами подвержены более высокому риску развития дефицита железа и анемии, считают Ş. Koç et al, опираясь на полученные результаты [13]. Проведя большие когортные исследования, некоторые авторы установили, что даже на фоне эутиреоза имеется достоверная положительная связь между уровнем свободных тиреоидных гормонов, гемоглобином и уровнем эритроцитов [1, 5, 22]. Взаимоотягощающее течение анемии и аутоиммунных заболеваний ЩЖ отрицательно сказывается на качестве жизни пациентов и является клинической проблемой [8, 9, 12].

Целью исследования было сопоставление гематологических и иммунологических параметров пациентов с БГ и АИТ при выполнении различных объемов оперативного вмешательства.

Материал и методы

Обследовано 28 (65,1%) пациентов с БГ с анемией (средний возраст 43,6±2,5 лет) и 36 лиц с АИТ с анемией (средний возраст 44,1±1,7 лет). Среди пациентов с БГ анемия легкой степени отмечалась у 25 (89,3%), средней степени тяжести - у 3 (10,7%) лиц. При оценке гемограмм лиц с АИТ анемия легкой степени была выявлена у 34 (94,4%), средней степени тяжести - у 2 (5,6%) больных. По объему выполненной тиреоидэктомии пациенты обеих групп были разделены на две подгруппы группы: перенесшие тотальную тиреоидэктомию и субтотальную тиреоидэктомию (в эту группу вошли больные, которым были выполнены операции объемом меньше, чем тотальная тиреоидэктомия – пре-

дельно тотальная тиреоидэктомия, гемитиреоидэктомия с субтотальной резекцией противоположной доли, субтотальная резекция ЩЖ).

В клиническом анализе крови определяли гемоглобин, эритроцитарные индексы MCV(средний объем эритроцита), МСН(среднее содержание HGB в эритроците), МСНС(средняя концентрация HGB в эритроцитарной массе). Кроме того, определяли уровень сывороточного железа (Feсыв) и ферритина (Фр) (набор фирмы Roche). Диагноз анемии устанавливали при уровне гемоглобина 120г/л и менее у женщин и 130г/л и менее у мужчин (ВОЗ, 2001). Фенотипирование лимфоцитов крови проводили с помощью люминесцентного микроскопа по маркерам CD3+(общая популяция Т- лимфоцитов), CD4+(Т- хелперы), CD8+(Т- цитотоксические супрессоры), CD19+(В-лимфоциты)(панель ООО-«Сорбент», Москва). Результаты учитывали в %. Содержание ЦИК в сыворотке крови проводили по методу Ю.А.Гриневича, А.Н.Алферова, 1981, в модификации[2]. Для определения эритрофагоцитоза в плазме крови применяли известный метод исследования периферической крови метод Цинкхама – Конли в модификации Е.Н.Новоселовой[3]. Определяли уровень гормонов :TSH и Т4 свободный (набор фирмы Roche) и антител к рецептору ТТГ (TSHRAb) и тиреоиднойпероксидазе (ТРОАb) (набор фирмы Roche).Математический анализ полученных результатов проводили с использованием пакета программ Excel, 2017. Были использованы структурные характеристики вариационного ряда (средняя, ошибка средней), а для оценки различий между выборками применяли непараметрический критерий Вилкоксона-Манна-Уитни [4].

Результаты и их обсуждение

В таблице №1 приведена сравнительная гемограмма пациентов с БГ и АИТ до и после выполнения субтотальной тиреоидэктомии. В обеих группах больных отмечаются однонаправленные изменения как до, так и после операции. В дооперационном периоде более выраженные изменения отмечаются в группе больных АИТ: по уровню MCV, МСН, Fe сыв., Фр отмечаются статистически значимые изменения, а по уровню ЦП и НСТ недостоверные в сравнении с соответствующими показателями группы лиц с БГ. Спустя 6 месяцев после операции в обеих группах наблюдается усугубление анемии, по показателям: HGB, RBC, ЦП, МСН и Fe сыв. они статистически достоверно отличаются между собой. Еще более выраженное нарушение всех гематологических показателей в обеих группах пациентов в сравнении с контролем наблюдается через год после субтотальной тиреоидэктомии, при этом по показателям: HGB, RBC и НСТ они достоверно отличаются между собой.

Таблица № 1

Сравнительная гемограмма лиц с БГ и АИТ, подвергшихся субтотальной тиреоидэктомии(M±m)

Показатель	БГ субтотальная тиреоидэктомия (n=10)			АИТ субтотальная тиреоидэктомия (n=12)			Практ. здоровые (n=15)
	До опер	6 мес	1 год	До опер	6 мес	1 год	
HGB, г/л	102,5±3,6*	98,1±3,6*	94,1±1,6*	107,3±2,3*	106,1±2,0*^	104,7±2,4*^	133,2±1,8
RBC x 10^{12}/л	4,3±0,1	3,9±0,2*	3,6± 0,1*	4,5±0,1	4,2±0,1^	3,9±0,08*^	4,3± 0,07
HCT, %	33,6±1,1*	32,3±1,9*	28,1±1,1*	32,1±0,7*	31,9±0,7*	31,0±0,7*^	39,8±0,5
ЦП	079±0,02*	0,83±0,01*	0,78±0,02*	0,75±0,02*	0,77±0,02*^	0,8 ±0,02*	0,92±0,006
MCV, фл	78,2±2,4*	80,5±2,4*	76,1±2,7*	72,4±2,3*^	76,3±2,1*	78,7±1,9*	91,9 ±0,6
MCH, пг	26,5±0,8*	27,1±0,8*	25,8± 0,8*	24,3±0,8*^	25,7±0,7*^	26,7± 0,7*	30,8±0,2
MCHC, г/дл	33,7±0,09*	33,4±0,09	33,1±0,3*	33,4±0,09	33,7±0,1	33,7 ±0,08	33,4±0,04
Fecыв., ммол/л	14,7±0,7*	13,6±0,6*	11,3± 0.4*	12,5±0,6*^	11,8 ±0,6*^	10,9± 0.4*	18,4 ±1,3
Фр,нг/мл	23,9±2,8*	19,3±4,2*	15,1±2,3*	18,6± 2,2*^	15,4± 4,0*	13,3± 3,4*	35,9 ±2,0

* - статистическая достоверность различий относительно данных у практически здоровых

^ - статистическая достоверность различий данных групп с БГ и АИТ между собой

Иммунные нарушения, выражающиеся в иммунодефиците клеточного звена иммунитета и активации гуморального звена отмечаются в обеих группах больных, при этом лишь уровень CD4+ хелперов достоверно ниже у больных АИТ (p<0,05)(таблица №2). Спустя 6 месяцев после операции показатели клеточного иммунитета и уровень ЦИК у лиц с АИТ статистически значимо ниже соответствующих показателей группы больных с БГ. Спустя год эта тенденция сохраняется: изменения уровней CD3+, CD4+, субпопуляционного индекса и ЦИК более выражены у больных АИТ (p<0,05). Уровень TRAb при БГ снизился, но недостоверно; уровень TPOAb при АИТ практически не изменился. При этом больные, находясь на заместительной терапии были в эутиреоидном состоянии. Таким образом, при выполнении субтотальной тиреоидэктомии в обеих группах наблюдаются однотипные изменения, до и после операции, лишь по некоторым показателям более выраженные у пациентов с АИТ (таблица №2).

Таблица №2

Иммунограмма лиц с БГ и АИТ, подвергшихся субтотальной тиреоидэктомии (M±m)

Показатель	БГ субтотальная тиреоидэктомия (n=10)			АИТ субтотальная тиреоидэктомия (n=12)			Практ. здоровые (n=15)
	До опер	6 мес	1 год	До опер	6 мес	1 год	
CD3+, %	50,8±1,6*	56,0± 1,5*	56,9± 1,5*	48,9 ±1,7*	48,3± 1,7*^	49,0±1,7*^	66,5 ±1,4
CD4+, %	30,3±0,8*	31,3±1,1*	31,2±0,7*	27,8±0,4*^	27,2±0,6*^	26,9±0,6*^	37,9±0,9
CD8+,%	19,3±0,7*	18,7±0,5*	17,7±0,7*	18,0±0,4*	17,5±0,3*^	17,0±0,4*	28,3±0,8
CD4+/CD8+	1,58±0,05*	1,67±0,05*	1,78±0,06*	1,54±0,02*	1,55±0,02*^	1,58±0,03*^	1,4±0,04
CD19+,%	18,7±0,8*	19,6±0,8*	20,8±0,6*	19,7±1,0*	20,4±0,8*	20,8±0,7*	11,3±0,6
ЦИК, усл.ед.	97,0±3,3*	105,0±3,2*	113,0±2,8*	85,8±3,3*	88,8±2,4*^	90,8±1,7*^	64,3±1,5
ЭФ, %	2,1±0,4*	2,6±0,3*	2,9±0,5*	2,5±0,2*	2,7±0,2*	2,8±0,2*	0,8±0,08
TRAb, (IU/l)	9,5±1,5*		7,7±1,6*^				<1,75 – negative >1,75 – pozitiv
TPOAb, IU/ml				163,6 ±41,5*		164,1±40,3*	<30
TSH	0,1±0,03*	-	2,18±0,4	3,7±0,7^	-	3,7±0,3^	0,32-5,2
T4 free	13,3±3,5*	-	1,4±0,09	1,4±0,1^	-	1,1±0,08	0,7-1,8

* - статистическая достоверность различий относительно данных у практически здоровых

^ - статистическая достоверность различий данных групп с БГ и АИТ между собой

Проведение сравнительной оценки гематологических и иммунологических параметров пациентов с БГ и АИТ с анемией, перенесших тотальную тиреоидэктомию выявила следующее. В дооперационном периоде в обеих группах больных наблюдаются гематологические нарушения, характерные для анемии, причем однонаправленные и статистически недостоверно отличающиеся между собой, кроме RBC, по которому группы отличаются между собой значимо (p<0,05). Спустя 6 месяцев после тотальной тиреоидэктомии наблюдается тенденция к улучшению гематологических параметров обеих

групп, причем лишь по уровню ЦП, МСНС и Фр они отличаются между собой статистически недостоверно. Спустя год после операции гематологические параметры значительно улучшились у пациентов обеих групп и практически не отличаются от контрольных. Лишь показатель уровня гематокрита у лиц с АИТ еще достоверно отличается от соответствующего показателя контроля и пациентов с БГ (p<0,05) (таблица №3).

Таблица № 3

Сравнительная гемограмма пациентов с БГ и АИТ, подвергшихся тотальной тиреоидэктомии (M±m)

Показа Тель	БГ тотальная тиреоидэктомия (n=18)			АИТ тотальная тиреоидэктомия (n=24)			Практ. здоровые (n=15)
	До опер	6 мес	1 год	До опер	6 мес	1 год	
HGB, г/л	109,8±8,3*	117,4±1,4*	132,3±2,3	105,7±2,7*	124,7±2,4*^	128,1±1,5	133,2±1,8
RBC x 10^{12}/л	4,5±0,1	4,0±0,05	4,8± 0,09*	4,2±0,1^	4,6±0,1*^	4,7± 0,06*	4,3± 0,07
НСТ, %	32,7±0,4*	34,9±0,5*	39,7±0,7	31,8±0,7*	37,1±0,7*^	37,9± 0,4^	39,8±0,5
ЦП	0,77±0,02*	0,87±0,01*	0,82±0,01	0,79±0,01*	0,8±0,01*	0,81 ±0,01	0,92±0,006
MCV, фл	74,6±2,3*	87,1±1,3*	82,7±1,5*	76,2±1,4*	80,5±1,7*^	80,9± 1,2*	91,9 ±0,6
MCH, пг	25,1±0,8*	29,3±0,4	27,6± 0,6*	25,4±0,5*	27,1±0,5*^	27,2±0,4*	30,8±0,2
MCHC, г/дл	33,5±0,06	33,6±0,07	33,3±0,3	33,1±0,2	33,5±0,04	33,7 ±0,09	33,4±0,04
Feсыв., ммол/л	14,7±0,3*	16,1±0,4	17,4± 1,1	12,2±0,5*	14,3 ±0,6*^	15,2± 0,7	18,4 ±1,3
Фр,нг/мл	26,4±2,4*	33,9±1,0	34,3±0,6	23,3± 2,1*	30,4± 2,1	35,7± 0,3	35,9 ±2,0

* - статистическая достоверность различий относительно данных у практически здоровых
^ - статистическая достоверность различий данных групп с БГ и АИТ между собой

Сопоставление иммунологических параметров до выполнения тотальной тиреоидэктомии вывило, что в обеих группах отмечаются выраженные в сравнении с контролем изменения и только по показателю ЭФ нарушения более выраженны у больных АИТ (p<0,05) (таблица №4). Спустя 6 месяцев после операции иммунологические показатели обеих групп улучшились, но в большей степени лиц с БГ. По значениям пяти показателей: CD8+, CD4+/CD8+, CD19+, ЦИК, ЭФ эта группа достоверно отличается от значений показателей лиц с АИТ. Год после операции – время становления гормонов гипофиза и щитовидной железы, разрешения аутоиммунных процессов в сохраненной ткани ЩЖ. Через год после оперативного вмешательства иммунологические параметры обеих групп приблизились к контрольным, лишь в группе больных АИТ еще сохраняются значимые изменения в сравнении с соответствующими показателями лиц с БГ по трем аутоиммунным параметрам: CD8+, ЦИК, ЭФ (таблица №4). Однако, значительное улучшение всех иммунологических параметров после тотальной тиреоидэктомии делает эту разницу не столь существенной.

Таблица№ 4

Иммунограмма лиц с БГ и АИТ, подвергшихся тотальной тиреоидэктомии (M±m)

Показа Тель	БГ тотальная тиреоидэктомия (n=18)			АИТ тотальная тиреоидэктомия(n=24)			Практ. здоровые (n=15)
	До опер	6 мес	1 год	До опер	6 мес	1 год	
CD3+, %	48,7 ±1,4*	53,3± 1,2*	62,7± 0,7	47,0 ±0,9*	53,9± 0,7*	61,3±0,7*	66,5 ±1,4
CD4+, %	30,2±0,8*	32,4±0,7*	35,4±0,5	29,5±0,6*	31,6±0,5*	33,8±0,4*	37,9±0,9
CD8+,%	17,9±0,5*	25,3±0,5	27,1±0,5	17,6±0,4*	20,5±0,4*^	24,8±0,3*^	28,3±0,8
CD4+/ CD8+	1,68±0,03*	1,3±0,02*	1,3±0,02*	1,68±0,02*	1,53±0,01*^	1,36±0,01	1,4±0,04
CD19+,%	19,4±0,5*	13,9±0,5*	12,9±0,4	20,4±0,4*	17,3±0,4*^	13,1±0,3	11,3±0,6
ЦИК, усл.ед.	98,8±2,0*	69,1±1,3	63,6±0,9	98,9±2,6*	77,9±1,3*^	67,3±1,2^	64,3±1,5
ЭФ, %	2,1±0,3*	1,2±0,1*	0,78±0,06	3,1±0,3*^	1,8±0,2*^	1,1±0,03^	0,8±0,08
TRAb, (IU/l)	11,7±1,4		2,1±0,1^				<1,75 – negative
TPOAb, IU/ml				281,7 ±42,8*		19,2±2,7*^	>1,75 – pozitiv
TSH	0,11±0,02*	-	2,4±0,3	4,0±0,5	-	3,3±0,2^	0,32-5,2
T4 free	14,3±3,4*	-	1,5±0,06	1,2±0,08	-	1,3±0,07	0,7-1,8

* - статистическая достоверность различий относительно данных у практически здоровых
^ - статистическая достоверность различий данных групп с БГ и АИТ между собой

Выводы

1. В дооперационном периоде как у лиц с БГ, так и у пациентов с АИТ с анемией наблюдаются выраженные и однонаправленные гематологические нарушения (снижение HGB, HCT, ЦП, MCV, MCH, Fe сыв и Фр), характерные анемии и глубокие и однонаправленные аутоиммунные нарушения, выражающиеся в клеточном иммунодефиците (снижение уровня CD3+, CD4+, CD8+) и повышении активности гуморального иммунитета (повышение уровня CD19+, CD4+/CD8+, ЦИК, ЭФ, TRAb и TPOAb).

2. Выполнение тотальной тиреоидэктомии у пациентов с БГ и АИТ с анемией приводит к прекращению аутоиммунного процесса и улучшению гематологических показателей на фоне эутиреоза, достигнутого в течение года после операции за счет заместительной терапии левотироксином.

3. Сохранение ткани ЩЖ при выполнении субтотальной тиреоидэктомии у обеих групп больных способствует, по - видимому, дальнейшему усугублению аутоиммунных нарушений и ухудшению гематологических показателей, несмотря на эутиреоидный гормональный фон пациентов спустя год после операции.

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RISK MANAGEMENT IN HOSPITAL MEDICAL INSTITUTIONS

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ABSTRACT

Risk management is an extremely important point in the strategic analysis and planning of the hospital's activities.

Hospital organizations are exposed to a much wider range of adverse impacts than all other economic entities - companies, organizations, etc., because the content of the concept of risk in hospitals includes not only financial components, but also certain parameters of health.

Once the decision has been made that a certain risk needs to be managed, it can be done in several possible ways: elimination, minimization, transfer and acceptance.

Keywords: risk management, hospitals, strategic analysis, adverse impacts.

Introduction:

Risk management is an ancient idea. Ever since the time of the Old Testament, of ancient Rome, and of ancient China, there has been a desire among people both to predict future dangers and natural catastrophes, and to adapt to them.

It is accepted that the professor of insurance from Temple University (USA) Wayne Snider in 1955 first proposed the concept of "risk management". A year later, Russell Gallagher in Volume 34 of the Harvard Business Review first described the profession of risk manager.

In 1996, the Global Association of Risk Professionals (GARP) was also established, which is a nongovernmental independent association of risk management practitioners and professionals. A risk manager is a specialist who has the knowledge and skills with the capabilities of a diverse set of tools to make or propose decisions on risk management in a particular organization.

Leading risk management organizations are the Risk and Insurance Management Society, Inc. (RIMS), founded in 1950, and the International Federation of Risk and Insurance Management (IFRIMA), formed in 1984. Apart from them, there are currently dozens of organizations that form a strong infrastructure of risk management. [2,3]

Risk management is an extremely important point of the strategic analysis and planning of the hospital's activity, including under conditions other than the understanding of "comfortable". [1]

The purpose of the article is to present significant aspects related to risk management in hospital medical institutions.

Exposure:

Risk management is a part of the activity of the management of an organization, which in a general sense is aimed at its effective protection (most often economic) from unwanted deliberate or accidental events, bringing certain primarily material damage to this organization. As a management activity, risk management requires the integrated efforts of the entire organization and includes decision-making and the realization (implementation) of the decisions made as a sequence of management impacts. This also defines the task of risk management as the process of selecting and implementing solutions that minimize a wide range of accidental or malicious events.

Each company, after adopting the general management strategy, also adopts a strategy for risks in general and for each specific risk in particular. In order to ensure the risk strategy, it is necessary to form a program for integrated risk management of the company. [2]

Risk management is a mechanism for managing risk exposure that allows us to recognize the events that may lead to adverse or harmful consequences in the future, the extent of their negative effect and how they can be controlled.

G. Komitov (2018) states the following working definition of risk management in hospital medical institutions:

"The identification, analysis, and control of risks that may threaten patient service, assets, or the image of the hospital organization."

Risk factors inevitably accompany the operation of the hospital in the modern conditions of a market economy and a strong competitive environment. *"The risk for the medical institution is a system of certain (risk) factors that simultaneously or successively in different periods of time exert their direct or indirect negative impact on the hospital's activity."* [1]

Hospital organizations are exposed to a much wider range of adverse impacts than all other economic entities - companies, organizations, etc., because within the content of the concept of risk in hospitals, not only financial components are included, but also certain parameters of health. While, for example, a commercial organization is exposed to the risk of low revenue, in the hospital treatment facility, the risk management problems are also related to the outcome of the hospital treatment - recovered, improved, unchanged or died. Ensuring better health also depends on the means that are provided for it, but the other more important condition is the implementation of an adequate and expedient

diagnostic-treatment process related to the professionalism of the hospital team, ensuring better health.

The most essential part of the control functions of managers at all management levels of the medical facility is their efforts to minimize substandard health services. According to the medical standards operating in our country, the hospital has extremely complex risk management and a complex toolkit for ensuring and managing the quality of the services it provides. The main reasons for this are: [4]

- the variety and serious nature of the diseases treated in the hospital;
- the complexity of the medical assistance provided;
- the intensity of the health services provided;
- absence, from a pragmatic point of view, of a difference in the significance of control over the quality of conditions (means), activities (processes) and results.

Structure of the management program for risk in the medical institution:

S. Spiridonov notes that support at all levels of the hospital's management structure is critical to the success of the risk management program. The importance of such support is also dictated by the fact that it is an integral part of the hospital's business plan and its strategic plans for development and activity. Providing the risk program with the necessary resources is evidence of support from the hospital's senior management. At the same time, it would be proper to plan and direct the control of the implementation of this program by a group appointed by the director of the hospital, which includes representatives of the Medical Council, the Council of Health Care, the Treatment Control Commission and the Commission for the fight against nosocomial infections. This means that said program will have greater clinical effectiveness if risk management and quality assurance activities are integrated.

Hospital management should appoint a person to be responsible for risk management. It is necessary for this person to carry out the orders of the above-listed persons of the task force and report to them. Their duties should include activities on:

- detection and analysis of risks;
- creation and implementation of a resource-provided program approved by the hospital's management;
- reviewing all available and upcoming contracts with organizations for service of equipment, technical devices and installation facilities and controlling their implementation;
- supervision of all procedures related to the technical, fire, radiation and epidemiological safety of patients and staff;
- conducting staff training to improve their skills on the organizational aspects of risk management;
- personal participation in the elimination of losses personally incurred in unforeseen risk situations.

Table 1 shows the relationship between risk management and quality assurance activities:

It is important to note that complete overlap of risk management with quality assurance is not desirable due to the fact that the administrative orientation of the risk program and the clinical orientation of the quality assurance program require a number of activities and functions to address separately with different in nature control tools and management decisions.

Table 1.

Relationships between risk management and quality assurance activities

No	Risk management	Quality assurance
1	Protection of the material, technical and financial assets of the hospital	Related to the philosophy of the hospital
2	Protection of human and intangible values and resources	Improving the qualifications of all professionals
3	Preventing harm to patients, visitors, staff and property	Improving the quality of diagnostic, treatment and rehabilitation activities and care for the sick
4	Reducing total losses by targeting individual discrepancies and individuals	Comparing the quality of the provided health services with medical standards and measurable accreditation criteria
5	Loss prevention through: - accident prevention; - continuous ongoing observations on the quality of patient care (protocols and technical sheets for good general and specific nursing care); - control over compliance with the Charter of Patients' Rights	Prevention of future losses or - impairments of patients through continuous observations in problem areas (e.g. accreditation indicators marked as "mandatory")
6	Addressing any incident that occurs by applying the risk management steps: - risk identification; - risk analysis; - risk assessment; - processing of risk	Search for facts in the provision of health services that do not correspond to medical standards. Apply the following quality assurance steps: - identification of the problem; - determining the size of the problem; - implementation of corrective action; - continuation of relevant care and activities; - analysis of the obtained results

Source: Adapted from S. Spiridonov, 2012

Principles of hospital risk management:

The main steps of risk management consist of defining, evaluating, reducing, eliminating or transforming the risk.

Risk identification (recognition) can be done in many ways, but the most common of them is the collection and combination of data about different problems - a procedure that makes it possible to identify the risk area and make it the focus of action. There is a requirement that risk management efforts are not only rapid but at the same time focused on eliminating, reducing or restructuring risk.

The risk assessment should be carried out by reviewing and categorizing the information on the problems that are burdened with signs of risk (electrical network and outlets that include high pressure devices, septic operating rooms, etc.).

The elimination or reduction of risk can be achieved in the following ways:

- bringing the construction of the hospital building into compliance with safety standards;

- greater frequency in conducting internal audits on the implementation of medical standards for the quality of conditions (means), processes (activities) and results;

- improving relationships between patients and hospital staff;

- hiring external specialists to carry out specialized control of material areas and points, the exploitation of which may lead to the emergence of a risky situation.

The periodic evaluation of the efforts made by the staff to eliminate, reduce or transform the risk is also a prerequisite for a better implementation of the measures within the scope of risk management. [4]

CONCLUSION:

Risk management is carried out within the management of the hospital, as well as any other organization, and is an integral part of it.

The responsibility for implementing risk management within the organization rests with senior executive management.

Once the decision has been made that a certain risk must be managed, it can be done in several possible ways: elimination (liquidation), minimization (through certain steps to reduce its adverse effects to an acceptable level), transfer, i.e. exporting the identified risk to an external organization and acceptance – when there is nothing to be done in response to the impact of the risk factors.

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ЛЕЧЕНИЕ ПЕРЕЛОМОВ И ЗАБОЛЕВАНИЙ ПРОКСИМАЛЬНОГО ОТДЕЛА БЕДРА У ДЕТЕЙ С ПРИМЕНЕНИЕМ МОНОЛАТЕРАЛЬНОГО АППАРАТА ВНЕШНЕЙ ФИКСАЦИИ

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TREATMENT OF FRACTURES AND DISEASES OF THE PROXIMAL FEMOR IN CHILDREN USING A MONOLATERAL EXTERNAL FIXATION DEVICE

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АННОТАЦИЯ

Авторами разработана и успешно применена компоновка монолатерального аппарата внешней фиксации разработанная для лечения переломов и заболеваний проксимального отдела бедренной кости у детей. Особенностью лечения данного вида переломов, с применением аппаратов внешней фиксации, является то, что при наличии короткого проксимального фрагмента кости возникают трудности создания стабильного остеосинтеза, который достигается пространственным расположением фиксирующих элементов (внутрикостные стержни). Разработанная конструкция выносных кронштейнов позволяет достичь жесткой фиксации проксимального фрагмента кости на опоре аппарата, тем самым создать стабильный остеосинтез при выполнении как ортопедических, так и травматологических вмешательств на бедренном сегменте у детей.

ABSTRACT

The authors have developed and successfully applied a monolateral external fixation device designed for the treatment of fractures and diseases of the proximal femur in children. A feature of the treatment of this type of fractures, using external fixation devices, is that in the presence of a short proximal bone fragment, it is difficult to create stable osteosynthesis, which is achieved by the spatial arrangement of fixing elements (intraosseous rods).

The developed design of the outrigger brackets makes it possible to achieve rigid fixation of the proximal bone fragment on the support of the device, thereby creating stable osteosynthesis when performing both orthopedic and traumatological interventions on the femoral segment in children.

Ключевые слова: vонолатеральный аппарат, проксимальный диафиз бедра, компоновка, чрескостный остеосинтез.

Keywords: monolateral apparatus, proximal diaphysis of the hip, layout, transosseous osteosynthesis.

При лечении диафизарных переломов бедренной кости у детей и подростков в настоящее время широко используются монолатеральные аппараты внешней фиксации. К их достоинствам следует отнести малый вес и габариты, быстроту наложения, с возможностью послеоперационной докоррекции положения отломков, удобство для больного в послеоперационном периоде [1, с. 58]. Однако при лечении переломов проксимального диафиза бедренной кости (чрез-, подвертельные переломы), или при коррекции шеечно диафизарного угла (ШДУ) при варусной, или вальгусной деформации шейки бедренной кости приходится сталкиваться с определенными трудностями при фиксации проксимального отдела бедренной кости (ПОБК). Это объясняется как архитектоникой ПОБК, так и тем, что мы имеем дело с коротким проксимальным фрагментом, а для его стабильной фиксации необходим «пространственный разброс элементов фиксации» (цит. по Г.А. Илизарову). Ортопедами это достигается установкой на проксимальной опоре аппарата двух внутрикостных стержней. При этом возможны два варианта фиксации ПОБК. Первый – проведение одного стержня строго во фронтальной плоскости вблизи линии перелома (подвертельный перелом), другого внутрикостного стержня - вдоль оси шейки бедренной кости (рис.1).
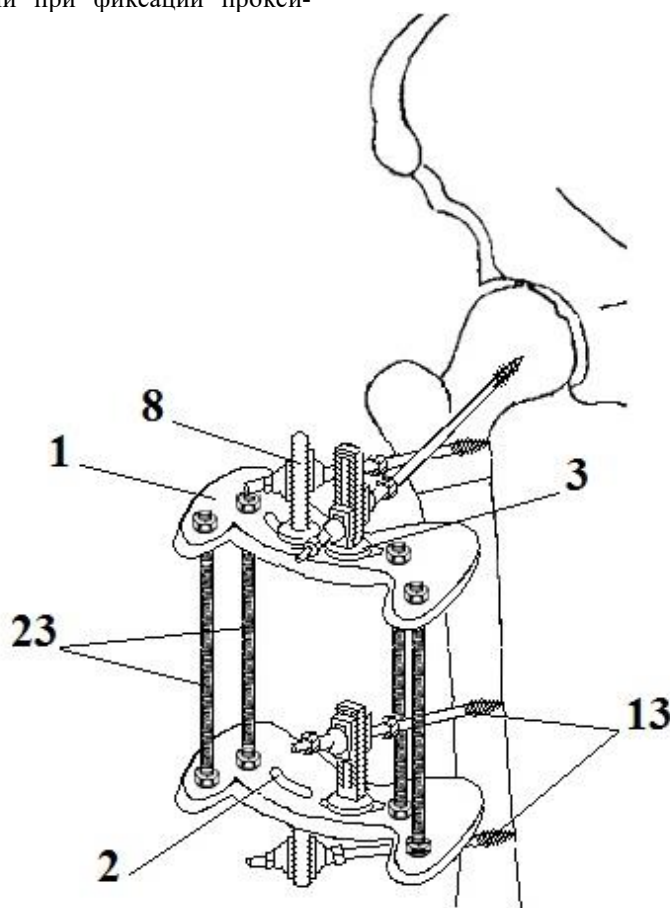

Рис. 1. Способ проведения стержней в проксимальном отделе бедренной кости фрагментом

Второй вариант фиксации ПОБК - это проведение внутрикостных стержней вдоль оси шейки бедренной кости, под углом 25-30°относительно друг друга во фронтальной плоскости (рис. 2).
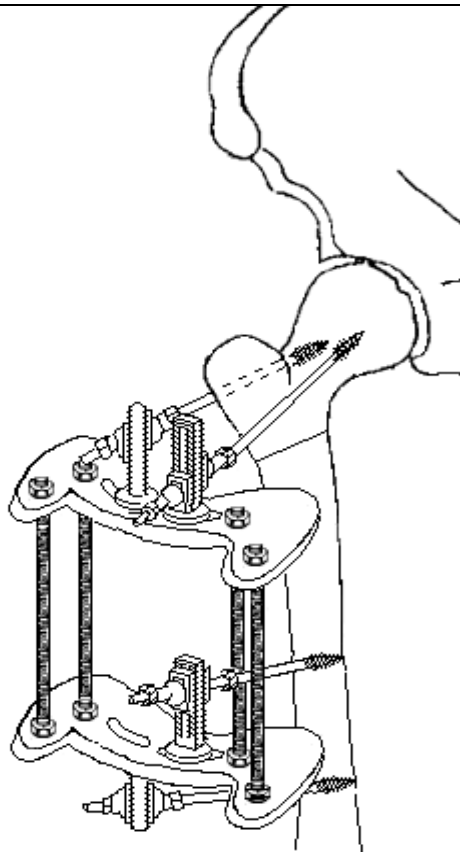
Рис. 2. Второй вариант проведения стержней в проксимальном отделе бедренной кости

Использование внутрикостных стержней, проведенных таким образом, показало свою эффективность в плане создания жесткости фиксации, и послеоперационной управляемости проксимальным фрагментом кости [1, с. 58]. Для этого применяют два штатных выносных кронштейна аппарата Илизарова, соединенных между собой под углом 90° [2, с. 216; 3, с. 72]. Однако установка внутрикостного стержня на предлагаемой конструкции из собранных выносных кронштейнов нестабильна, так как имеется вероятность поворота выносного кронштейна относительно опоры, а также их поворота относительно друг к другу. Это наблюдается при коррекции деформации ПОБК (например, при коррекции ШДУ), что объясняется постоянными, растущими компрессирующими усилиями мышц вертельной группы при производимой коррекции. Такой самопроизвольный поворот приводит к потере дистракционного режима и преждевременному сращению фрагментов в зоне остеотомии. Также поворот кронштейнов, установленных на проксимальной опоре, наблюдается и при лечении переломов проксимального отдела бедренной кости, что происходит обычно при репозиции фрагментов. Таким образом, применение известных штатных устройств не позволяет (адекватно возникающим при репозиции, или при дистракции, нагрузкам) проводить фиксацию внутрикостного стержня к опорам аппарата внешней фиксации, соответственно пространственному расположению шейки бедренной кости (с учетом угла антеторсии и шеечно-диафизарного угла).

Клинический пример.

Б-ная О-ва, 11 лет, и.б. № 1767, поступила в отделение детской ортопедии 14.05.2010 с диагнозом: Закрытый подвертельный перелом левой бедренной кости со смещением (рис. 3).

Рис. 3. Б-ная О-ва, 11 лет, и.б. № 1767, рентгеновский снимок проксимального отдела бедренной кости до операции

Под комбинированной анестезией больной произведен ЧКОС левого бедра в операционной приемного отделения в день поступления. Больная уложена на ортопедический стол, произведена дистракция на столе с последующим рентгеноконтролем. В проксимальный фрагмент введены два внутрикостных стержня: один строго во фронтальной плоскости вблизи линии перелома, другой - вдоль оси шейки бедренной кости. Последние смонтированы за счет двух выносных выносных стержне-фиксаторах расположенных на проксимальной опоре.

На дистальной опоре внутрикостные стержни вводятся в костный фрагмент перпендикулярно оси отломка с ротационным закосом относительно друг друга (рис. 4, 5).
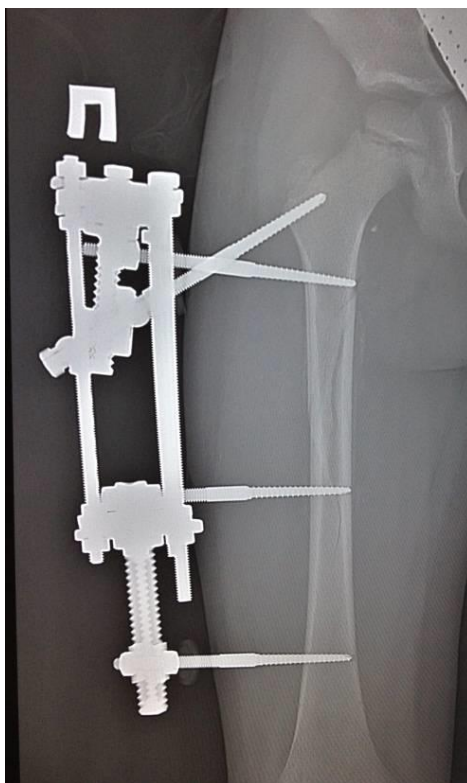

Рис. 4. Рентгеновский снимок проксимального отдела бедренной кости после наложения аппарата, прямая проекция
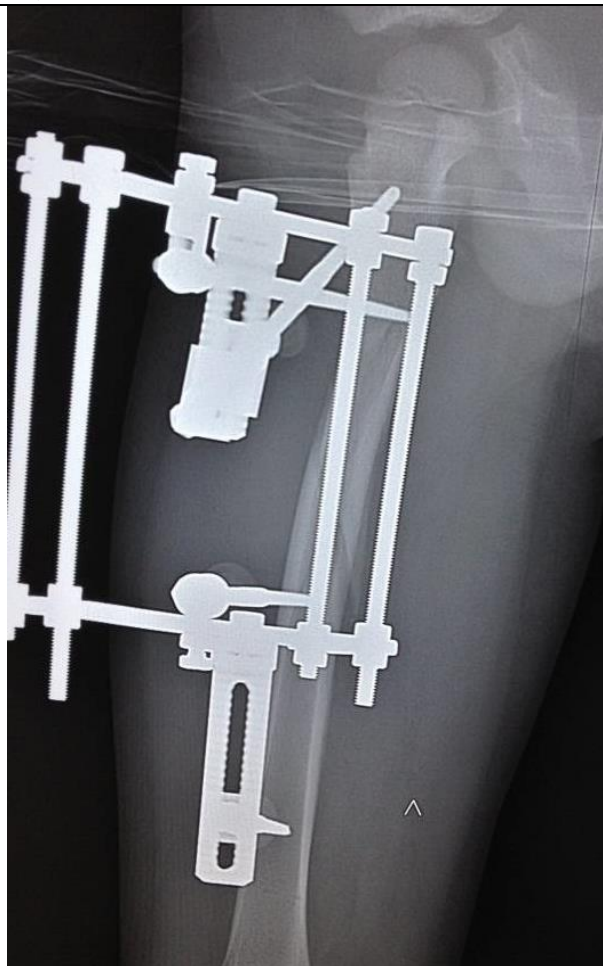
Рис. 5. Рентгеновский снимок проксимального отдела бедренной кости после наложения аппарата, боковая проекция

При этом положение опоры также расположено перпендикулярно оси дистального фрагмента. Относительно отрепонированных на ортопедическом столе костных фрагментов опоры должны располагаться на одинаковом отдалении от последних, это достигается временной установкой резьбовой штанги и коррекции положения опор за счет передвижения их за счет специальных гаек, имеющих сферическую головку. После того, как визуально положение резьбовой штанги становится параллельным оси поврежденного сегмента производится установка второй резьбовой штанги. Делается рентгенконтроль. За счет перемещения специальных гаек по внутрикостным стержням, а при необходимости и поворота кронштейна вокруг своей оси по радиальным зубцам, которые контактируют с зубцами ответной формы, расположенными на нижней поверхности пьедестала производится окончательная репозиция фрагментов.

С применением данного устройства прооперировано 32 пациента с переломами верхней трети бедренной кости и 7 больных с варусной деформацией шейки бедренной кости.

Безусловным преимуществом применяемой конструкции является удобство монтажа внутрикостных резьбовых стержней на проксимальной опоре аппарата, что не только существенно сокращает время операции, но и за счет достигаемого

«пространственного разброса чрескостных элементов», достигается стабильная фиксация проксимального отдела бедренной кости.

Основным биомеханическим нарушением при варусной деформации шейки бедренной кости является уменьшение шеечно-диафизарного угла, что служит причиной относительного укорочения конечности, недостаточности ягодичных мышц и неправильной установки головки во впадине. Деформация шеечно-диафизарной области проксимального отдела бедра и связанная с этим децентрация головки бедренной кости в вертлужной впадине являются причиной развития деформирующего. Кроме уменьшения ШДУ при варусной деформации после перенесенного остеомиелита возникает торсионная патология в виде отклонения головки кзади от фронтальной плоскости. После исправления варусной деформации бедра наличие избыточного угла ретроверсии или ретрофлексии приводит к недостаточности отводящих мышц бедра. Кроме этого, при оперативной коррекции углов проксимального отдела при coxavarae необходимо учитывать силу компрессии, возникающей в тазобедренном суставе. Это объясняется тем, что при формировании coxavarae наступает ретракция почти всех групп тазобедренных мышц вследствие сближения их точек прикрепления. Поэтому вмешательство по коррекции углов ПОБК дополняется подкожной тенотомией приводящих мышц бедра и рассечением

массиатова тракта. Если разница величин ШДУ, со-ответствующего возрастной норме, и ШДУ при coxavarae больше 30^0, то декомпрессивная операция на мягких тканях дополняется разгрузкой сустава аппаратом внешней фиксации с наложением тазовой опоры. Это особенно необходимо, если в остеомиелитический процесс вовлекалась (кроме ПОБК) вертлужная впадина, с осложнением в виде её скошенности при ацетабулярном индексе более 25^0 ввиду возникновения вывиха бедра при коррекции ШДУ.

Применяемый в настоящее время накостный остеосинтез при лечении coxavaraeявляется в большинстве своем травматичным и достаточно сложным, требующим значительного отслоения надкостницы, широкого разреза мягких тканей, повторных операций для удаления металлофиксаторов, длительной гипсовой иммобилизации.

В НИЦТ «ВТО» для лечения указанных больных применяется чрескостный остеосинтез как аппаратами Илизарова, так и аппаратами стержневой фиксации (рис. 6 а, б, в).
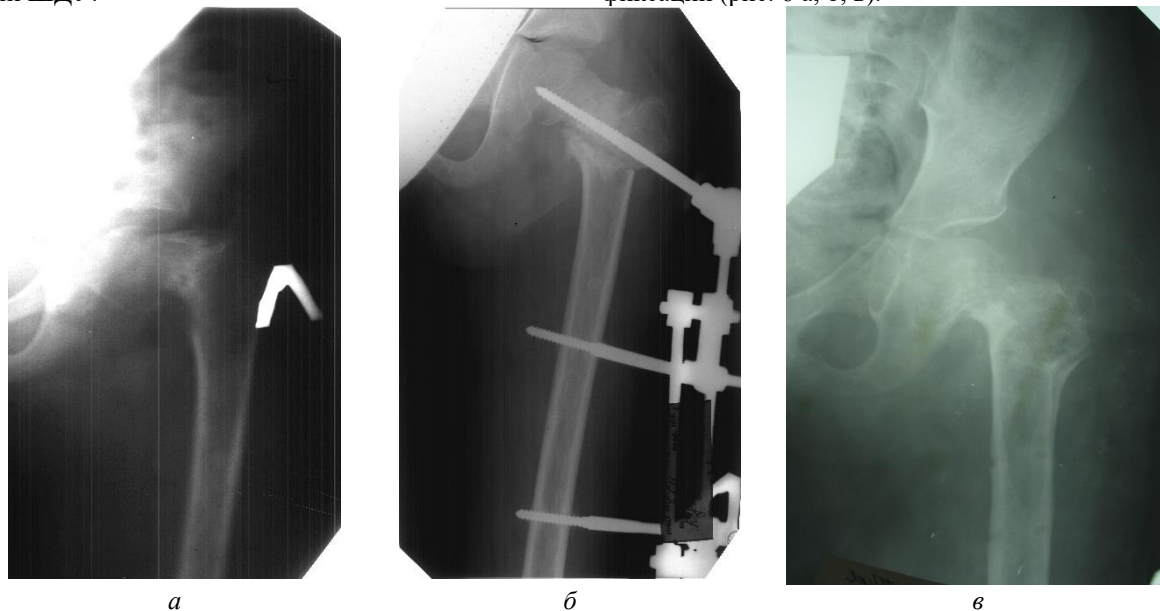

а   *б*   *в*

Рис. 6. Рентгенограмма больной А-ва (и/б. №5687), 5 лет, с диагнозом: постостеомиелитическая варус-ная деформация шейки правой бедренной кости: а – до лечения, б – в процессе лечения, в - через 2 года.

Клинический пример: Б-ная А-ва, и/б №5687, 5 лет, поступила на лечение в отделение детской ортопедии НИЦТ «ВТО» с диагнозом: постостеомиелитическая варусная деформация шейки бедренной кости. Операция производилась следующим образом: в положении больной на боку в область большого вертела ввинчивались два внутрикостных стержня под углом 45^0 друг к другу и фиксировались на выносной пластине. Плоскость расположения фиксаторов должна образовать угол с горизонтальной плоскостью, равный углу коррекции с небольшой гиперкоррекцией. На нижнюю и среднюю треть бедра на внутрикостных стержнях или парах перекрещивающихся спиц монтировали опоры, выполненные в виде секторов (¼ кольца) или кольцевых опор аппарата Илизарова. Между собой их соединили резьбовыми штангами. Планку и опоры

(сектора или кольца аппарата Илизарова) фиксировали двумя стержнями с шарнирным устройством. После наложения тазовой дуги для разгрузки сустава последняя соединяется с аппаратом на бедре. После этого по наружной поверхности верхней трети бедра произвели разрез кожи, мягких тканей, по Кохеру, выполнили полное косое рассечение массиатова тракта и обнажение бедренной кости. Затем произвели межвертельную остеотомию с иссечением костного клина, равного углу коррекции ШДУ. Угол ретроторсии и ШДУ корригировали одномоментно, используя внутрикостные стержни, установленные в шейке бедренной кости. Рану ушили наглухо, до дренажей. Операцию закончили подкожной тенотомией приводящих мышц бедра (рис. 7).

Рис. 7. Наложенная тазовая опора при лечении coxavarae

При необходимости докоррекцию ШДУ в послеоперационном периоде до нормальных возрастных величин производят постепенно, путем формирования клиновидного костного регенерата за счет узла коррекции аппарата.

После коррекции деформации проксимального отдела бедра при сопутствующем укорочении бедренной кости производят удлинение бедренной кости путем перемещения гаек резьбовых штанг аппарата. Скорость удлинения составляет 0,25 мм 4 раза в день. После коррекции элементов деформации проксимального отдела бедренной кости и необходимого удлинения конечности аппарат стабилизируют до созревания костного регенерата, а тазовую дугу демонтируют.

После созревания регенерата аппарат на 9-й неделе был демонтирован. Больному проведен курс реабилитационной терапии.

Через 2 года после операции углы АТ и ШДУ составляли 20^0 и 125^0 соответственно, контуры эпифиза головки бедренной кости были ровные, определялось его восстановление, прослеживалась ростковая зона. По данному способу прооперировано 6 детей. У всех больных получены положительные анатомо-функциональные результаты.

Резюме

Оперативное лечение больных с указанным видом заболевания проксимального отдела бедренной кости направлено на коррекцию углов АТ и ШДУ, при оперативной коррекции углов проксимального отдела при coxavarae необходимо учитывать силу компрессии, возникающей в тазобедренном суставе.

При коррекции ШДУ до 30^0 показана декомпрессивная операция на мягких тканях с разгрузкой сустава аппаратом внешней фиксации и одномоментной коррекцией углов ПОБК, при разнице величин ШДУ, соответствующего возрастной норме, и ШДУ при coxavarae больше 30^0 показана декомпрессивная операция на мягких тканях с разгрузкой сустава аппаратом внешней фиксации, наложением тазовой опоры и постепенным формированием углов ПОБК.

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ЛЕЧЕНИЕ ПОЛИФОКАЛЬНЫХ НЕСТАБИЛЬНЫХ ПОВРЕЖДЕНИЙ ТАЗОВОГО КОЛЬЦА С ОТКРЫТЫМИ ДВУСТОРОННИМИ ПЕРЕЛОМАМИ В ПРЕДЕЛАХ ПЕРЕДНЕГО ПОЛУКОЛЬЦА ТИПА «БАБОЧКИ», С РАСХОЖДЕНИЕМ СИМФИЗА

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TREATMENT OF POLYFOCAL UNSTABLE DAMAGES OF THE PELVIC RING WITH OPEN BILATERAL FRACTURES WITHIN THE ANTERIOR SEMI-RING OF THE "BUTTERFLY" TYPE, WITH SYMPHYSIC DISCHARGE

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АННОТАЦИЯ

К серьезным повреждениям опорно-двигательного аппарата относятся травмы таза с нарушением целостности его кольца. Данные повреждения составляют 3-7 % от общего количества всех повреждений скелета. Для лечения нестабильных повреждений тазового кольца используются различные варианты его репозиции и стабилизации.

Цель разработки заключается в создании возможности малотравматичной полноценной внеочаговой репозиции и стабилизации полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза.

Технология обеспечивает анатомически правильную внеочаговую репозицию и стабилизацию смещенных полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза и заключается в монтаже аппарата на чрескостных стержнях, установленных в крылья подвздошных костей, также в обе лонные кости у оснований лобковых бугорков встречно вводят спицы через симфиз в лонную или седалищную кость контрлатеральной стороны через неповрежденные мягкие ткани. Более того, технология позволяет осуществить трехплоскостную репозицию сформированного единого костного блока переднего полукольца тракцией и разворотом спицами и костными щипцами. Этим достигается сокращение сроков лечения больных и уменьшение количества инфекционных осложнений.

Формирование опоры на подвздошных костях обеспечивает стабилизацию нестабильных повреждений тазового кольца. Встречно введенные спицы в обе лонные кости у оснований лобковых бугорков через

симфиз в лонную или седалищную кость контрлатеральной стороны позволяют надежно удерживать достигнутое анатомически правильное взаимоотношение лонных костей в восстановленном симфизе.

Разработанная технология обеспечивает возможность произвести малотравматично полноценную внеочаговую репозицию и стабилизацию полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза с ранней активизацией и реабилитацией пациента, что позволяет сократить сроки и улучшить результаты лечения.

ABSTRACT

Serious injuries to the musculoskeletal system include pelvic injuries with a violation of the integrity of its ring. These injuries account for 3-7% of the total number of all skeletal injuries. Various repositioning and stabilization options are used to treat unstable pelvic ring injuries. The purpose of the development is to create the possibility of a low-traumatic full-fledged out-of-focal reposition and stabilization of polypocal unstable pelvic ring injuries with open bilateral fractures within the anterior semicircle of the "butterfly" type and a divergence of the symphysis. The technology provides anatomically correct out-of-focal reposition and stabilization of displaced polypocal unstable pelvic ring injuries with open bilateral fractures within the anterior semicircle of the "butterfly" type and the divergence of the symphysis and consists in mounting the device on transosseous rods installed in the wings of the iliac bones, also spokes are counter-inserted into both pubic bones at the bases of the pubic tubercles through the symphysis into the pubic or the sciatic bone of the contralateral side through intact soft tissues. Moreover, the technology allows for a three-plane reposition of the formed single bone block of the anterior semicircle by traction and reversal with spokes and bone forceps. This reduces the duration of treatment of patients and reduces the number of infectious complications. The formation of support on the iliac bones ensures the stabilization of unstable pelvic ring injuries. Counter-inserted spokes into both pubic bones at the bases of the pubic tubercles through the symphysis into the pubic or sciatic bone of the contralateral side make it possible to reliably maintain the achieved anatomically correct relationship of the pubic bones in the restored symphysis. The developed technology makes it possible to perform a low-traumatic full-fledged out-of-focal reposition and stabilization of polypocal unstable pelvic ring injuries with open bilateral fractures within the anterior semicircle of the "butterfly" type and the divergence of the symphysis with early activation and rehabilitation of the patient, which reduces the time and improves treatment results.

Ключевые слова: тазовое кольцо, симфиз, аппаратов внешней фиксации, нестабильные повреждения, репозиция, смещение.

Keywords: pelvic ring, symphysis, external fixation devices, unstable injuries, reposition, displacement.

Введение

Переломы и повреждения таза с нарушением целостности его кольцаявляются результатом высокоэнергетических травм и зачастую приводят к инвалидности и смертности населения трудоспособного возраста [1, с. 442; 2, с. 2405]. К наиболее серьезным повреждениям опорно-двигательного аппарата относят переломы костей таза с нарушением целостности тазового кольца. Данные повреждения составляют 3-7 % от общего количества всех повреждений скелета [3, с. 253; 4, с. 260].

Широкое распространение в мировой хирургической практике за рубежом получила тактика «damage control orthopedics» («контроля повреждений»). Она подразумевает оказание экстренной оперативной помощи для остановки внутренней кровопотери, противошоковую терапию и, по стабилизации состояния пациента, оказания показанного хирургического вмешательства [5, с. 145].

Хирургическое лечение переломов таза представляет собой широко обсуждаемую проблему. Увеличение из года в год пострадавших с травмой таза с утяжелением возникающих повреждений требует комплексной оценки повреждений таза и их соответствующего лечения. Стабилизация тазового кольца изучается постоянно многими коллективами авторов. Несмотря на это, сложившая ситуация требует разработки новых технологий репозиции и стабилизации повреждений тазового кольца, что позволит улучшить результаты лечения [6, с. 12; 7, с. 39].

В ведущих травматологических центрах используются различные технологии репозиции и стабилизации повреждений тазового кольца [8, с. 38; 9, с. 17].

Хирургические доступы для оперативного лечения в настоящее время являются часто расширенными и травматичными. Сложность лечения нестабильных повреждений таза обусловлена трудностями репозиции имеющихся смещений, обеспечением длительной и надежной фиксации [10, с. 266].

Аппаратный метод лечения обеспечивает щадящий характер оперативного вмешательства и стабильность анатомично восстановленного таза. Этим достигается благоприятное течение травматической болезни [11, с. 46; 12, с. 32].

Применяются различные методики с использованием аппаратов чрескостной фиксации при репозиции и стабилизации поврежденных элементов таза и дополнительной фиксацией лонных костей аллотрансплантатом [13, с. 56]. Способ имеет ограниченное применение, поскольку он показан лишь при изолированных повреждениях симфиза.

Другая технология [14, с. 48] синтеза симфиза состоит в использовании аппаратов с установкой чрескостных стержней в крылья подвздошных костей, на которых монтируется опора. В аппарате производится репозиция костных фрагментов, сочленений таза с надежной стабилизацией. После полноценной репозиции лонное сочленение стабилизируется накостной пластиной. Приведенный способ связан со скелетированием лонных костей в

зоне или вблизи с открытым повреждением с последующим погружным металлоостеосинтезом, что зачастую сопровождается инфицированием.

Открытые переломы костей таза встречаются довольно редко в мирное время. Известен способ лечения полифокальных нестабильных повреждений тазового кольца с окрытыми переломами в пределах переднего полукольца с расхождением симфиза [15, с. 64]. Он также подразумевает монтаж аппарата на чрескостных стержнях, установленных в крылья подвздошных костей с дополнительной внеочаговой фиксацией лонных костей. Этот дополнительной узел внеочаговой фиксации лонных костей с помощью резьбовых стержней громоздкий и не всегда позволяет в полной мере производить трехплоскостную репозицию.

Цель исследования состоит в создании возможности полноценной внеочаговой репозиции и стабилизации полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза, ранней активизации и реабилитации, сокращении сроков лечения пациентов.

Материалы и методы исследования

Сложности оказания неотложной хирургической помощи пострадавшим с полифокальными нестабильными повреждениями тазового кольца с открытыми переломами в пределах переднего полукольцасвязаны с близостью раны промежности с поврежденным передним полукольцом таза.

Технология, разработанная с учетом близости промежности и переднего полукольца таза, позволяет произвести малотравматично анатомически правильную внеочаговую репозицию и стабилизацию смещенных полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза. Это снижает возможность возникновения инфекционных осложнений, обеспечивает условия для ранней активизации и реабилитации, сокращения сроков лечения пациентов.

Предлагаемая технология лечения полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольцатипа «бабочка» с расхождением симфиза основывается на преимуществах чрескостного внеочагового остеосинтеза и заключается в монтаже аппарата на чрескостных стержнях, установленных в крылья подвздошных костей. Формирование опоры на подвздошных костях, состоящей из двух полуколец обеспечивает возможность анатомичной репозиции и стабилизацию нестабильных переломов тазового кольца.

До соединения полукольцевых опор, смонтированных на стержнях, установленных в крылья подвздошных костей, распорками под визуальным и мануальным контролем производят анатомически правильную репозицию симфиза через мини доступ до 4 сантиметров вне раны промежности. В обе лонные кости у оснований лобковых бугорков встречно вводят спицы через симфиз в лонную или седалищную кость контрлатеральной стороны через неповрежденные мягкие ткани, что позволяет надежно удерживать достигнутое анатомически правильное взаимоотношение лонных костей в восстановленном симфизе.

После рентгеновского контроляпроизводят трехплоскостную репозицию остаточного смещения образовавшегося единого костного блока тракцией и разворотом спицами и костными щипцами. Переднее полукольцо таза сводится, расхождение которого неизбежно при латеральной нестабильности. Аппарат стабилизируют резьбовыми распорками, закрепляя их концы в упомянутых полукольцевых опорах, устанавливая дистальную распорку над симфизом, а проксимальную – краниально относительно полукольцевых опор. Создавая напряжение в спицах их свободные концыбез предварительного изгиба крепят к ближайшей распорке. Устанавливают дренажи, рану ушивают. После сведения переднего полукольца натяжение тканей промежности снимается, что создает благоприятные условия для обработки раны. Накладываются наводящие швы.

Результаты исследования и их обсуждение

До 2022 года пациентам с данным видом повреждений оказывалась традиционная помощь в следующей последовательности: первичная хирургическая обработка раны, после чего монтировалось скелетное вытяжение за мыщелки бедра со стороны таза, где имелась тенденция к смещению.

После заживления раны оказывалась хирургическая помощь на фоне несвежих переломов костей таза в виде комбинированного остеосинтеза: наложение аппарата стержневой остеофиксации и накостный остеосинтез лонной или лонных костей и симфиза на средних сроках 1 месяц. Соответственно сроки активизации откладывались. Сроки пребывания в стационаре составляли 4-5 недель.

В виду больших дооперационных сроков и формирования регенератов не всегда удавалось достичь полную репозицию, сроки аппаратной стабилизации таза возрастали, что приводило к увеличению сроков реабилитации и ограничению статодинамической функции тазового пояса.

Предлагаемую технологию поясняют приведенные иллюстрации: на рис.1, где 1- полукольцевые опоры, к которым фиксированы внутрикостные стержни, 2. Полукольцевые опоры 1 соединены резьбовыми распорками: дистальной - 3 и проксимальной - 4, к которым крепятся спицы 5; на рис.2- рентгено - компьютерная томография, 3 D реконструкция костей таза до оперативного лечения; на рис.3- обзорная рентгенография костей таза после операции.
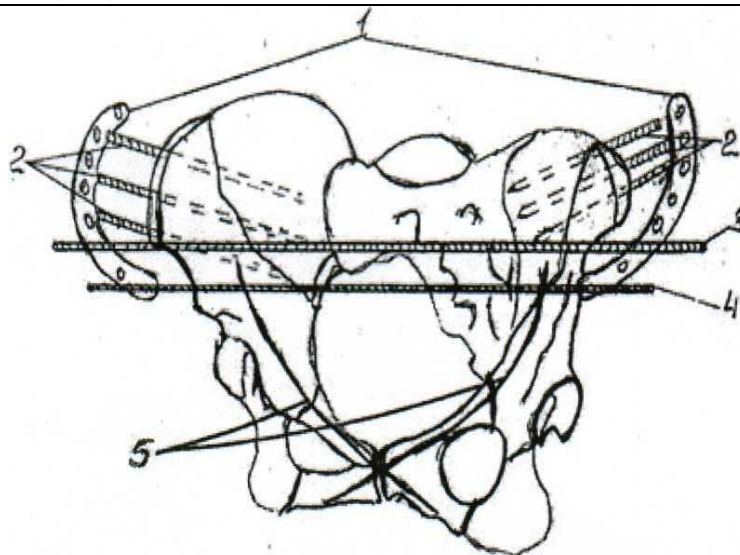
Рис. 1. Схема предлагаемого способа.

Осуществление технологии: пациент укладывается на операционном столе на спину. Подготовка операционного поля. На чрескостных стержнях, установленных в крылья подвздошных костей монтируются опоры 2. Под визуальным и мануальным контролем производят анатомически правильную репозицию симфиза и смещенных переломов лонных и седалищных костей. В обе лонные кости у оснований лобковых бугорков встречно вводят спицы через симфиз в лонную или седалищную кость контрлатеральной стороны через неповрежденные мягкие ткани. Производят рентгеновский контроль и трехплоскостную репозицию остаточного смещения образовавшегося единого костного блока тракцией и разворотом спицами и костными щипцами. Производят стабилизацию аппарата резьбовыми распорками, закрепляя их концы в упомянутых полукольцевых опорах, устанавливая дистальную распорку над симфизом, а проксимальную – краниально относительно полукольцевых опор. Создавая напряжение в спицах их свободные концы без предварительного изгиба спиц крепят к ближайшей распорке. Это способствует достаточной стабилизации образовавшегося единого костного блока после его репозиции.

Устанавливают дренажи, рану ушивают.

Производят обработку раны промежности и, или, лобковой зоны. Накладываются наводящие швы.

В травматологическом отделении ГАУЗ ДРКБ МЗ РТ и ГАУЗ РКБ МЗ РТ с 2022 по 2024 гг. нами оказана помощь с применением разработанной технологии 4 пострадавшим с полифокальными нестабильными повреждениями тазового кольца с открытыми переломами в пределах переднего полукольца с положительным результатом, что составило 8% от числа пострадавших с полифокальными нестабильными повреждениями тазового кольца, которым оказана хирургическая помощь в виде комбинированного остеосинтеза, включающего накостный остеосинтез переднего полукольца.

Активизация пациентов обеих групп произведена на 2 сутки после оперативного вмешательства. Средняя длительность пребывания в стационаре 1 неделя. Демонтаж аппарата производился на 8 - 10 неделе. Статодинамическая функция тазового пояса у всех пострадавших восстановлена.

Таким образом, сроки стационарного лечения пациентов традиционным способом составили 4-5 недель, тогда как разработанная технология лечения данной категории пациентов позволяет сокращать сроки пребывания в стационаре в 4 раза. Качество жизни при лечении традиционным методом страдает в отличие от современных методов лечения.

Клинический пример.

Пострадавшая А., 15 лет. ДТП. Госпитализирована в отделение травматологии ГАУЗ ДРКБ МЗ РТ 24.06.23. В приемном отделении начата противошоковая терапия, РКТ – обследование (рис.2). Д-з: «Травматический шок II ст. Закрытый перелом боковой массы крестца справа. Закрытое повреждение левого крестцово-подвздошного сочленения с латеральным смещением Закрытый перелом обеих лонных и седалищных костей, разрыв симфиза со смещением. Рваная рана внутренней поверхности левого бедра и паховой области слева».

На рентгено-компьютерной томографии (РКТ) таза (рис.2): перелом обеих лонных и седалищных костей, перелом боковой массы крестца справа, повреждение левого крестцово-подвздошного сочленения с латеральным смещением, повреждение лонного сочленения с расхождением 3см.

На второй день оказана хирургическая помощь (26.06.23). Пациент уложен на операционный стол на спину. Подготовка операционного поля. На чрескостных стержнях, установленных в крылья подвздошных костей смонтированы опоры 2. Произведена первичная хирургическая обработка раны внутренней поверхности левого бедра и паховой области слева. Рана ушита, установлены дренажи.

Рис.2. Рентгено-компьютерной томографии от 24.06.23 – обследование при госпитализации.

Сформирован линейным надлобковым разрезом доступ к лонному сочленению протяженностью до 4 сантиметров. Под визуальным и мануальным контролем осуществлена анатомически правильная репозиция симфиза и смещенных переломов лонных и седалищных костей. В обе лонные кости у оснований лобковых бугорков встречно введены спицы через симфиз в лонную или седалищную кость контрлатеральной стороны через неповрежденные мягкие ткани. Произведен рентгеновский контроль и трехплоскостная репозиция остаточного смещения образовавшегося единого костного блока тракцией и разворотом спицами и костными щипцами. Произведена стабилизация аппарата резьбовыми распорками,

закрепление их концов в упомянутых полукольцевых опорах.

Дистальная распоркаустановлена над симфизом, а проксимальная – краниально относительно полукольцевых опор. Создавая напряжение в спицах, их свободные концы без предварительного изгиба закреплены на ближайшей распорке. Установлен трубчатый дренаж, рана ушита. Рентгеновский снимок (рис. 3). Стояние костных отломков удовлетворительное. Произведена обработка раны внутренней поверхности левого бедра и паховой области слева. Рана ушита, установлены дренажи. На вторые сутки пациентка активизирована.
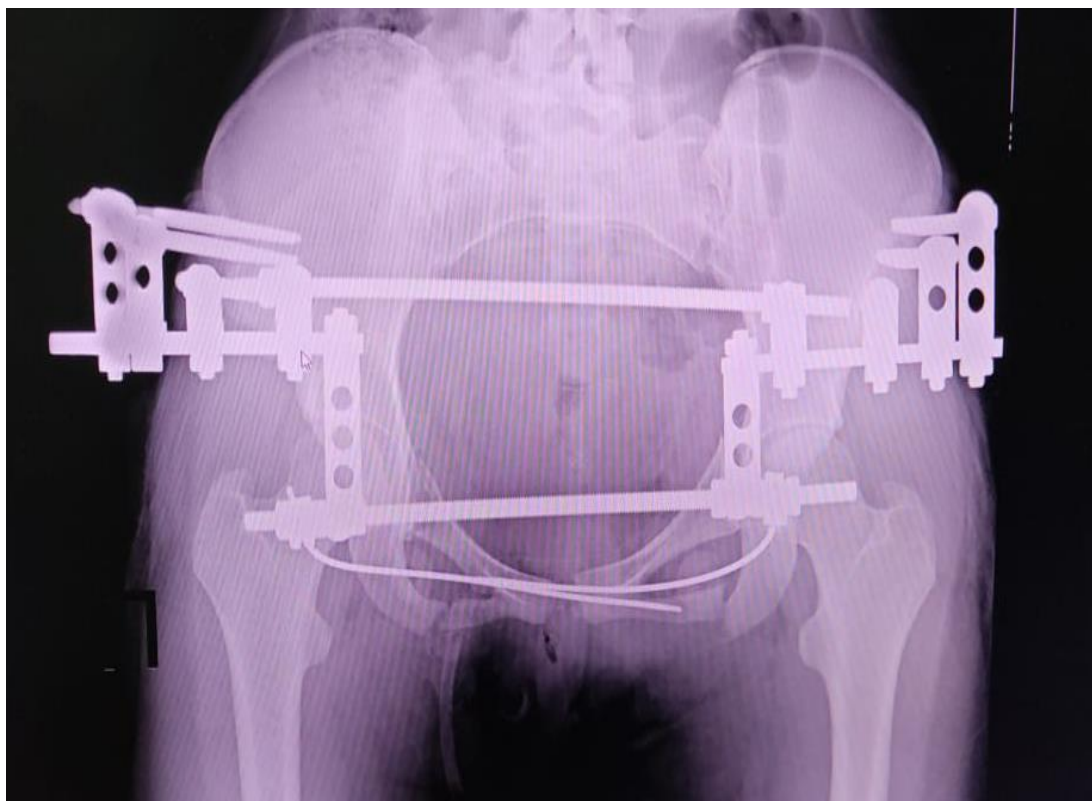

Рис.3. Рентгеновский снимок после оперативного лечения от 26.06.23

Ходьба с помощью костылей. Демонтаж аппарата через 10 недель (10.09.23). Произведено рентгено-компьютерная томография таза (рис. 4).
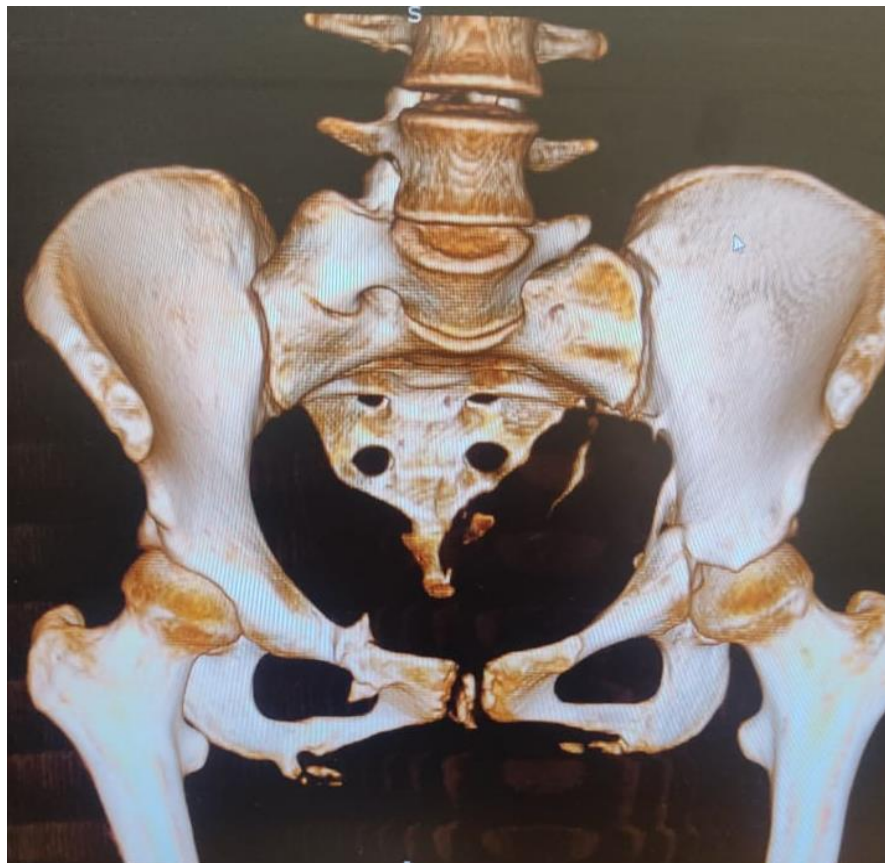

Рис.4. Рентгено-компьютерной томографии (РКТ) таза после демонтажа аппарата от 10.09.23.

На РКТ таза: сросшиеся переломы лонных, седалищных костей и боковой массы крестца справа.

В течение 10 дней проводился курс реабилитационных мероприятий: ЛФК, массаж. Статодинамическая функция тазового кольца полностью восстановлена.

Заключение

Разработанная технология обеспечила возможность произвести малотравматично на ранних сроках полноценную внеочаговую репозицию и стабилизацию полифокальных нестабильных повреждений тазового кольца с открытыми двусторонними переломами в пределах переднего полукольца типа «бабочка» и расхождением симфиза, позволила избежать инфекционных или гнойных послеоперационных осложнений, сократить сроки пребывания в стационаре, обеспечило повышение качества жизни пациентов за счет исключения метода скелетного вытяжения, раннюю активизацию и реабилитацию, что позволило в сжатые сроки восстановить статодинамическую функцию тазового пояса.

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PEDAGOGICAL SCIENCES

THE TECHNOLOGY OF MASTERING THE CONCEPT OF "LENGTH" IN I CLASSES OF SECONDARY SCHOOLS

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ABSTRACT

Among the problems of didactics, the need to "achieve the perfection of the methodical system of teaching this or that subject, to make it adequate to the convocations of the industrial revolutions" has always been relevant, and even today, the formation of an educational space that transforms the characteristics of the IV industrial revolution is an important and urgent problem. It also makes researches about the model of "methodical system" aimed at solving the mentioned problem relevant. Which in these research processes are necessary elements to determine the nomenclature and classification of teaching tools, the scientific-theoretical and technological features of their application according to the logic of the modern teaching process of various subjects. The elementary course of mathematics is also an integrative course in its content, which follows from the objectives of teaching mathematics in elementary grades. Thus, in addition to arithmetic material (basic material), elements of algebra, geometry, physics, astronomy and natural science are also included in the mathematics course of grades I-IV, and concepts, definitions, rules and properties related to these elements are mainly taught to students at an intuitive level. It is obvious that the fields of science that we mentioned are directly related to quantities. The subject of mathematics is closely related to quantities and their measurement. Despite what has been said, we claim the relevance of conducting research on the topic "Technology of application of the "problem task type" to the management of the process of teaching Mathematics in secondary schools".

Keywords: methodical system, measurement, measurement skills, quantities, length, method of teaching length, conventional measurement units, method of teaching centimeter.

The actuality of the subject. Measuring skills and measuring tools are widely used in everyday life. Measurement provides a link between different areas of mathematics. For example, when measuring, there is a very close connection between number concepts and spatial concepts. From this point of view, the "Measurement" section in the 1st grade includes a wide application of numbers and addition-subtraction operations on numbers. In the first class, the measurement of quantities such as length, mass, capacity and time and various related problems are given.

Solving these problems serves to reinforce the skills taught throughout the year, as well as to improve skills related to elementary algebra (finding the unknown, how long, how short, heavy-light, scale model, etc.). The formation of students' measurement skills is mainly carried out in 5 stages:

1. Determination of the quantity to be measured.

2. Comparison and ranking (comparison of objects to be measured with others).

3. Measurement with non-standard (conventional) units.

4. Measurement with standard units.

5. Application.

The importance of teaching quantities in primary grades is as follows:

➢ the knowledge and habits gained by students are directly related to life;

➢ by learning the basic quantities, they prepare for the next stages of education;

➢ familiarity with quantities develops students' spatial imagination;

➢ by learning to measure quantities, they gain practical knowledge and skills necessary for life;

➢ by measuring the quantities, students' ideas about numbers and arithmetic operations are broadened and deepened.

Every teacher should pay attention to some points when teaching quantities in the first grade: before measuring different quantities, it is important to get acquainted with certain characteristics of these quantities; for example, a child should know that the length of a pencil does not change when it is taken out of the bag and placed on the table, or when you take apples from the basket, the mass of the basket decreases. How much liquid a container holds is measured by its capacity, and different containers can have the same capacity. Also, in the city where you live, the clock shows the same time everywhere - at home and at school: if the clock at home shows 1 o'clock, then it is 1 o'clock at school. For this purpose, in order to better understand the characteristics of quantities, students should be given tasks of different nature.

Literacy competence, which is one of the competencies defined for a person of the 21st century, requires the formation of the ability to understand and interpret information, facts, emotions, and ideas presented in written and oral form, as well as to express them orally and in writing. : "Length", "long-short", "same length", "weight", "heavy-light", The correct expression of concepts such as "capacity", "wide-narrow", "time", "before-after", as well as their standard measurement units taught in the 1st grade (centimeter, kilogram, liter and hour) should be in focus.

Before starting the teaching of this subject, students should have mastered the skills of number representation and addition-subtraction up to 20 in the number axis.

It should not be overlooked that the connection between different subjects is ensured under the "Measurements" content line, since integration in the lesson helps students to gain a wider and deeper understanding by combining the knowledge of different subjects, and makes the learning process of students more interesting and effective. Thus, measurement and evaluation are used in various subjects, including physical education, visual arts, technology, music, and life sciences.

Children's first intuitive ideas about length (distance) begin to form in the preschool period. Ideas about the geometric dimensions of an object, i.e. its length, width, height, wide, narrow, thick, thin, tall, short, etc., are formed and developed starting from the preschool period. In the first grade, this process is further deepened. It should be noted that the color, shape, and material from which the objects are made gradually fade into the background and are isolated from the observation and comparison. Items are compared by length.

Now let's get acquainted with the method of teaching length. In the first grade, students should acquire the following learning outcomes:

• Estimates which of two or more given objects is longer or shorter without using measurements (4.1.2).

• Given objects are "tall", "short", "tall", "short", "about the same length", etc. according to their length. compares with words (4.1.2).

• Selects a convenient conventional unit of measurement (clamp, cuboid, inch, foot, step, etc.) to measure the length of an object (4.2.1).

• Compares the length of objects using conventional units of measurement (4.1.2).

• Estimates which of the given objects are long-short, heavy-light, wide-narrow (1.3.5).

• Explains that a ruler is used to measure length and draw lines (4.2.2).

• Measure the length of a given piece with a ruler (4.2.2).

• Draws a line of given length using a ruler (4.2.3).

• Describes addition and subtraction problems in mathematical expressions (2.1.3).

• Apply addition and subtraction skills in a circle of 20 to find length in simple problems (4.2.1).

Research shows that the principle of visuality is assessed by new dimensions of pedagogical thinking. The principle of objectivity does not simply deny the function and role of visuality in the learning process, but interprets them in the course of the formation of new theoretical thinking. Violation of the principle of visuality in training can negatively affect the effectiveness of the teaching process. The principle of visuality requires that the learned information be presented in a concrete, clear and visualized way. That is why various aids should be used in the learning process: a ruler, colored tape and strips, colored pencils, various objects for measuring.

4 hours have been allocated for teaching the subject. In the lesson, students get acquainted with the concept of "length", they get the ability to compare the lengths of objects. During the comparison, the expressions "longer", "shorter", "same" are used. When teaching the subject, the teacher should pay attention to some elements: In order to master the measurement skills, first of all, the skills of comparing quantities should be formed. For this purpose, "What is the length?", "Which is longer?", "Which is shorter?", "Which objects are the same length?" questions are clarified. It is very important to expect such consistency when examining questions. Clamps, cubes and other various measuring tools should be prepared before the lesson in order to use different conventional measurement units.

The teacher can start the lesson by comparing the lengths of different objects in the classroom. For example, pen and book, desk and board, etc. Comparisons can also be made between students, for example: girls with long and short hair, tall and short boys can be compared. In the lesson, pairs are assigned to distribute colored strips of different lengths prepared in advance and compare their lengths.

As we know, the student's cognitive activity is closely related to his asking a question and searching for the correct answer to that question. Conscious activity, regulation of one's own activity, evaluation and reference to the obtained results are related to this issue. One of the main conditions for the development of the student's logical thinking is that he formulates questions and answers them logically. So, at the research-discussion stage, it is necessary to direct the task in such a way that the student is involved in cognitive activity.

- Grandmother Aynur and Elkhana knitted a scarf. Whose scarf is longer? How to determine this?

A relevant image is displayed. In the research task, scarves can be compared according to the number of stripes. I would also like to mention that this task can be done with the whole class with the help of various objects (small ribbons, strips cut from colored paper, pencils, etc.).

In the further continuation of the educational process, students' performance of the following practical task has a positive effect on their preparation, which the generalization of the obtained materials leads us to this conclusion: 2-3 pencils of different lengths are placed on the table. A student is brought in front of the board and his eyes are covered with a handkerchief. The student arranges several pencils by hand on the table according to their length. The pupil's eyes are opened and the correctness of the sequence is checked.

The procedure for comparing objects by their length and measuring their length is explained. It is noted that the unit of measurement is used to measure.

A teacher must plan a lesson that correctly identifies the content, activities used to learn, or appropriate expectations for students at different levels to be successful so that differentiation can occur. Research shows that differentiated instruction is effective for gifted students as well as students with disabilities.

When students are given more choices about how they can learn the material, they feel more responsible for their own learning. Since the teachers organize the learning process according to the learning needs of the students, it is observed that there are less order-discipline problems in the classrooms, instead, it seems that the students are more engaged in learning. Thus, in

teaching the subject, the teacher should take into account the above, both in the guide stage and in the tasks for independent work.

At the next stage of the lesson, the students can be given the following task. The task can be performed with the whole class. The teacher should act as a facilitator and guide the students.
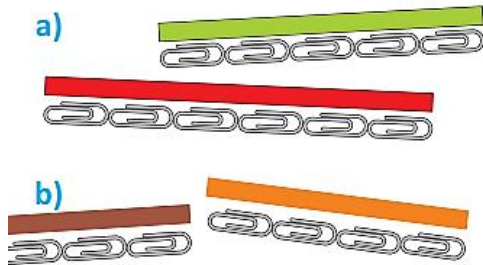
The task can be performed visually (approximate) first. As confirmation of the comparison, the numbers showing their lengths are compared. The main goal in these tasks is to form estimation skills. It is necessary to pay attention to the sequence of tasks. 1. The lengths are first determined roughly, and then sorted from longest to shortest. 2. In this task, students first estimate the length and then check it.

Conventional units of measurement should be explained as learning material. However, there are points that the teacher should pay attention to when teaching these concepts. So what are they? Let's take a look: As we know, using conventional measurement units in measurement is one of the important skills needed in everyday life. For example, we often measure the width of the door in inches to determine whether any item will pass, or determine the location of the refrigerator based on our height. Using conventional units of measurement is a preliminary step to using standard units of measurement. In this regard, attention should be paid to the expectation of consistency.

An important task of the training process is to support the student during training and improve his training results.

The training model of subjects is based on the model "Learn → reinforce → apply".

Learn - mastery of knowledge and skills with visual aids enriched with illustrative materials.

Consolidate – improving new acquired knowledge and skills through exercises, studies, writing and other ways.

Apply – applying learned knowledge and skills to increasingly complex problem solving and modeling. Each subject is taught on the basis of a five-step learning cycle. Problem solving is of exceptional importance in the teaching of mathematics, as we and other theorists and practitioners have repeatedly emphasized. In general, the term "mathematical problem" refers to those issues that arise both within mathematics and outside it, which are expressed in "mathematical language" and are solved by mathematical methods and tools. These issues have different contents and may be related to other fields of science, life, and daily practical activities.

It is a pity that in textbooks containing problems and examples, we rarely find issues that have content related to life events and other fields of science that are outside the content. However, such problems not only reveal the connection of mathematics with life and other sciences, but also require converting it into mathematical language, which itself helps to develop a certain creative ability. The topic begins with problem solving and ends with problem solving.

In general, it is important to distinguish between the concepts of "problem solving" and "teaching problem solving." In this regard, it is recommended to approach the 4-phase cognitive process (understanding - planning - solving - checking) as a three-stage student activity in the educational process. teaching problem solving is realized in three stages: involvement, brainstorming and discussion.

During the teaching of length, it is planned to give such a problem at the application stage (the problem is intended to form students' estimation skills using conventional measurement units):

Problem: The picture shows a tape and a clamp. Students have to find approximately how many clamps the tape has.

It is very important to follow the sequence to solve the problem. First, the students themselves estimate the length of the tape. Then they review the answer options and mark the option closest to their own (for example, Pomegranate). At the last stage, they check their answers with a tool equal to the length of the clamp (for example, the width of a finger or the tip of a pencil, etc.).

Mathematical games are one of the most effective methods in teaching mathematics, which help to develop the student's interest in learning and to master the subject. It's fun for kids and a way to make learning more efficient for the teacher. Especially in mathematics classes, the role of mathematical games is very important in preventing the mental fatigue of students, so that the lesson is not boring.

Guided by what we have said, during the teaching of the topic, "Who will find it right?" the game can be played:

Rules of the game:

1. An object that can be measured in the room and a suitable measurement unit (clamp, cube, square, foot) are selected.

2. Players estimate and record the length of the object.

3. The length of the item is measured with the selected measurement unit.

4. The player who guesses the closest to the correct answer gets 1 point.

The game can be played in class or after school.

Such a task can be given to work at home, which students can be given such a task: choose 4-5 objects at home. Then the sheet is filled in the order indicated. Students bring it to the next class.

To ensure interdisciplinary integration, it is necessary to focus on the fact that measurement skills are widely used in physical education, technology, fine arts. "Long-short", "tall-short" etc. words should be used.

In the 3rd hour of teaching the subject, students get acquainted with centimeters as a standard unit of length. Takes measurements using a ruler, draws a piece of a given length, compares the length of pieces with measurements, solves various length problems to improve addition-subtraction skills.

When introducing the first standard unit of measurement, the centimeter, in first grade, the teacher should consider some issues: Correct use of measuring tools is one of the important measurement skills. The simplest measuring tool students encounter is a ruler. In this regard, students are first introduced to centimeters. Standard units of measurement are units used in a certain system of units (centimeter, kilogram, liter, hour). Conventional units are any units that are convenient for the user depending on certain conditions (for example: inches, steps for measuring length; cubes for measuring weight; cups, cups for measuring volume).

As the first stage of the lesson, the teacher can measure the edge of the table and write the result on the board in order to direct the students' attention to the lesson and to make them more active. Then one of the students measures the length of the table with his inch and the result of the measurement is again written on the board. The teacher asks why the two numbers are different. Students' answers are listened to.

It is appropriate to ask such an issue at the research discussion stage:

- Lala measured the edge in inches to decorate the photo album. He asked his younger brother to cut a ribbon 3 inches long. Lala saw that the tape was short. What do you think is the reason for the tape being short?

A discussion is organized around the question in the task. Different questions explain the meaning of standard units of measurement. It is explained that a ruler is a tool for measuring the length of objects. Students are taught the basic skills of using a ruler.

Drawing a piece of fabric to a given length in first grade is one of the skills that students struggle with the most. It is more appropriate to form it in several stages: 1) first, the ability to draw a straight line should be formed. For this, fun tasks can be given, such as drawing colored lines using different pencils; 2) and then they are instructed to mark two points at a certain distance. This can also be given in a fun way; for example: "First, make a dot with a blue pencil. Measure 3 centimeters and make a point with a red pencil"; 3) at the last stage, these two points are connected. Each stage is repeated several times.

Each of the action steps can be repeated several times separately to draw a given length of fabric to provide differential training. You may be asked to draw a piece that consists of several parts; for example, "Take a red cloth 2 cm long and a blue cloth 4 cm long from its end. What is the total length of these pieces?"

Students are instructed to cut different lengths of colored strips at home. The cut strips are glued to a sheet of checkered notebook. The length in centimeters is written below.

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THE IMPACT OF DIGITAL EDUCATIONAL PLATFORMS ON THE DEVELOPMENT OF CREATIVE THINKING IN HIGH SCHOOL STUDENTS

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ABSTRACT

This article examines the impact of digital educational platforms (DEP) on the development of creative thinking (CrT) in high school students. It analyzes the role of digital technologies in the educational process and their potential to stimulate students' creative engagement. Theoretical approaches to CrT development, such as constructivism, problem-based learning, and gamified learning, are explored, demonstrating their integration within the digital environment. Special attention is given to modern models of digital technology implementation, including SAMR (Substitution, Augmentation, Modification, Redefinition) and TPACK (Technology, Pedagogy, and Content Knowledge), which enable more effective integration of platforms into the learning process. The article provides examples of DEP usage in the USA and Kyrgyzstan, showcasing a positive influence on student engagement and creativity.

Keywords: digital educational platforms (DEP), creative thinking (CrT), high school students, interactive learning, problem-based learning, gamification, flexible learning.

Introduction

The education system is greatly influenced by the digitalization of society, changing traditional teaching approaches and opening up new possibilities for student growth. An important part of these changes is the use of digital education platforms (DEP), which are increasingly being introduced into the learning process in high schools. They provide a variety of resources for engaging and personalized learning, which is essential in today's rapidly changing world focused on digital technology and information. Creative thinking (CrT) is essential in high school education as it allows students to adapt to a constantly evolving world and develop innovative ideas that foster social and technological advancement.

This study is important because educational systems need to be updated to the digital age, as older teaching methods are no longer effective in preparing students for modern challenges. The objective of this research to analyze how DEP affect the growth of CrT in high school students.

Main part. CrT, its role in the educational process

The ability to generate new and original ideas, non-standard solutions and apply knowledge in new contexts is called CrT. It includes essential components such as divergent thinking (the ability to identify diverse solutions), convergent thinking (the ability to choose optimal solutions), flexibility, and openness to new ideas. This skill is considered crucial in education, especially in high school, where students prepare for professional activities and higher education. Developing this skill supports not only academic success but also personal growth, adaptability, and effective interaction with the world around them.

Modern approaches to developing CrT in an educational setting include various methods aimed at actively engaging students and creating opportunities for self-directed learning. **Constructivism**, for instance, assumes that knowledge is created by students through active engagement with their surroundings. Constructivist methods, such as project-based activities, group work, and research assignments, promote CrT by encouraging student autonomy and engagement. **Problem-based learning** focuses on solving real-world issues that require analysis, research, and the generation of original solutions. This approach fosters critical and CrT, as students encounter problems requiring new ideas and flexible thinking. **Gamified learning**, in turn, incorporates game elements into the learning process, stimulating creativity and enhancing student motivation. Game-based approaches provide a safe space for experimentation and unconventional thinking, which is essential for developing creative skills.

Thus, CrT is a crucial component of the educational process, helping high school students prepare for future professional and academic pursuits. Modern pedagogical approaches create optimal conditions for the development of this skill, allowing students to actively explore and interact with their environment.

Digital educational platforms in the context of modern education

An integral part of today's educational system is DEP. They not only enhance education accessibility but also enable the use of innovative teaching methods aimed at developing critical and CrT skills. These technologies serve as tools and systems utilized to organize the learning process, provide educational resources, and facilitate interaction between students and teachers (table 1).

Table 1.

Types and features of DEP [1, 2]

Type of DEP	Examples of platforms	Features
Online courses and massive open online courses (MOOC)	Coursera, edX, Khan Academy	They provide a wide range of courses with the opportunity to study at your own pace, support the personalization of learning and self-organization.
Learning management systems	Moodle, Google Classroom	It helps to organize educational process management, interaction, knowledge assessment, as well as create a flexible learning environment using digital resources.
Virtual classrooms and interactive learning programs	Zoom, Microsoft Teams, Labster	They allow you to conduct real-time classes, simulations and experiments; promote active learning and CT.
Gamified and project-based educational platforms	Scratch, the educational edition of Minecraft	They develop creativity and project thinking through programming, modeling and project development.
Specialized platforms for specific disciplines	Khan Academy (mathematics), Duolingo (languages)	They provide specialized resources and courses for in-depth study of specific disciplines.

According to the author, DEP encompass a wide range of opportunities and areas. They allow the learning process to be tailored to individual student needs, making education more flexible and accessible. Through such platforms, students can study both general and specialized subjects, utilizing interactive and gamified approaches that stimulate creativity and develop project-thinking skills. Overall, these platforms transform traditional teaching methods, making them more dynamic and focused on personal development.

The integration of DEP into the educational process requires applying pedagogical models and approaches to maximize their potential. Figure 1 shows the most well-known and widely used models – SAMR (Substitution, Augmentation, Modification, Redefinition) and TPACK (Technology, Pedagogy, and Content Knowledge).
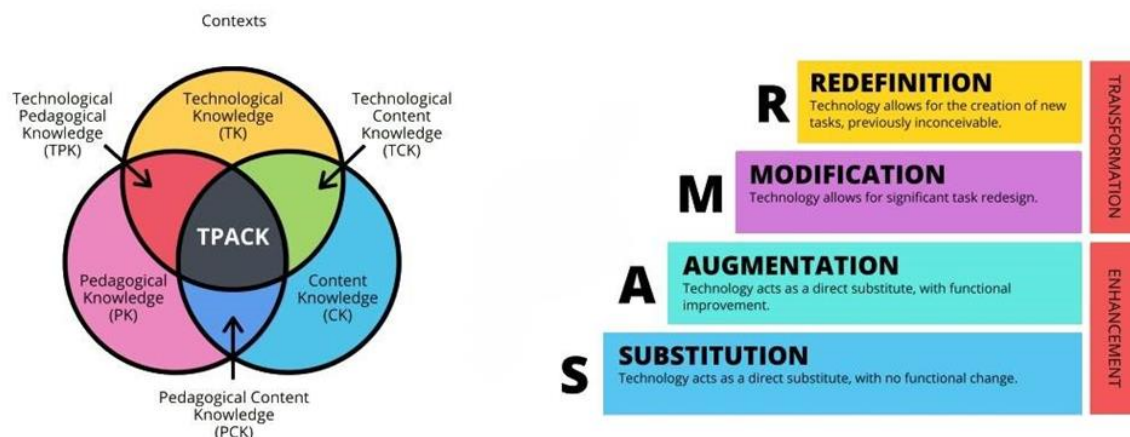

Figure 1. Models of technology integration in education

The **SAMR model**, developed by Ruben Puentedura, describes different levels of technology integration in education, starting from the basic replacement of traditional tools and progressing to a full transformation of the educational process. This model suggests a phased approach to technology implementation, where its use gradually becomes more complex and in-depth. At the first stage, technology is used for simple substitution of traditional methods, such as transitioning from paper textbooks to electronic ones. The next level, augmentation, improves the functionality of educational materials, for instance, by adding interactive elements [3]. At the levels of modification and redefinition, technology begins to radically change the educational process, creating new forms of learning activities, such as virtual labs or cross-cultural projects, that would be impossible without digital tools. Thus, SAMR emphasizes that technology should not simply reproduce traditional approaches but also offer new forms of interaction and learning that promote CrT development.

The **TPACK model** emphasizes a comprehensive approach to technology use by integrating it with pedagogical expertise and subject content. This model assumes that effective technology integration requires a combination of three core knowledge areas: pedagogical, content, and technological knowledge. Pedagogical knowledge includes understanding effective teaching methods and strategies, while content knowledge involves a deep mastery of the subject. Technological knowledge pertains to the use of digital tools to achieve learning objectives. TPACK helps to understand how best to combine these elements so that DEP not only

complement but also enhance the learning process, enabling students to better comprehend material and develop creative skills.

Thus, both models highlight the importance of a thoughtful approach to integrating digital technologies into education. They help structure and systematize technology use in a way that promotes active learning, stimulating students' creativity and critical thinking.

The impact of DEP on CrT development

Using DEP stimulates CrT as they create an **interactive and flexible learning** environment in which students can learn at their own pace, adapting the process to their individual needs. Platforms provide access to a wide **range of multimedia resources**, such as videos, simulations, interactive tasks, and gamified elements, allowing students to engage more actively and deeply with learning material. For example, interactive simulations and labs enable students to conduct experiments independently and explore different scenarios, fostering critical thinking and problem-solving skills. Virtual environments generally have fewer resource constraints than traditional classrooms, giving students more opportunities for creative experiments and project development. Simulators and interactive labs allow students to conduct virtual experiments in conditions that may be inaccessible in a real classroom, thereby enhancing their research skills and ability to find unconventional solutions.

One example of DEP use is **Minecraft Education Edition**, employed in educational institutions in the USA to develop creative abilities and project-thinking skills. Within educational projects, students can create virtual architectural structures, simulate historical events, or design eco-friendly cities. Such tasks require students to adopt a creative approach, analyze information, and apply knowledge in practice, which fosters the development of their creative abilities and critical thinking [4].

Another example is the **Duolingo** platform, used for learning foreign languages in high school. It supports students through gamified tasks, interactive quizzes, and assignments that require using the language in practical situations. This approach helps students develop creativity and communication skills, utilizing the language to solve problems and perform practical tasks [5].

In Kyrgyzstan, the **Online Mektep** platform has been widely used to ensure access to school education during the pandemic. This platform provides students with remote learning opportunities through interactive lessons, videos, assignments, and quizzes. Incorporating this platform into the educational process enables students to study at a convenient pace, promoting self-organization and independent problem-solving skills, essential components of CrT [6].

These practical examples of DEP usage vividly demonstrate their potential to develop CrT through interactive methodologies and project-based learning. It is also worth noting that studies conducted in the USA and Kyrgyzstan confirm this effect, showing how digital tools are successfully integrated into the educational process.

For instance, in the USA, a study was conducted using the **Scratch** platform to teach programming and digital creativity. More than 200 high school students participated in this study over an academic year, creating their own projects: interactive games, animations, and multimedia stories. The results indicated that students actively using Scratch showed significant improvement in divergent thinking skills and the ability to find unconventional solutions [7]. The platform encouraged students to develop unique projects, requiring them to generate new ideas, design algorithms, and take a creative approach to programming. Researchers noted that students working with Scratch became more confident in their abilities and eagerly shared ideas with classmates, which further enhanced their engagement and developed CrT.

In Kyrgyzstan, the **Taalim-Forum Foundation** conducted a study under the KIX project to implement DEP to improve education quality and develop CrT in high school students. The research, conducted in schools in Bishkek, involved using online platforms and interactive tools to engage students in the educational process. During the experiment, students worked with virtual labs and simulators, allowing them to solve scientific problems and develop project-thinking skills. The results showed that students actively using digital tools demonstrated improved CrT skills and increased motivation to learn [8].

These examples demonstrate that DEP have the potential to develop CrT in high school students. Proper integration of DEP into the educational process helps improve academic performance, increase student engagement, and enhance their ability to solve problems in non-standard ways.

Recommendations for DEP implementation

To successfully select and implement DEP aimed at developing CrT in high school students, teachers need to integrate project-based and problem-oriented activities into the educational process. Examples of real tasks and projects requiring solution development help stimulate CrT, allowing students to explore and present ideas using digital tools. The inclusion of gamified elements, such as points, rewards, and achievement levels, also helps boost student motivation and engagement. Platforms that have successfully applied such methods demonstrate that gamification can actively support learning interest and enhance interaction.

Regular feedback and teacher support play a significant role in creating an environment where students can develop and refine their ideas. Continuous interaction helps students feel more confident while experimenting and expressing themselves. It is also essential to create opportunities for collaborative learning by organizing group projects and virtual classes where students can exchange ideas and work together on tasks. Digital platforms that support real-time collaboration encourage experience sharing and stimulate innovative thinking.

Teaching students' skills in using digital tools, such as programming and working with interactive simulations, helps them better harness platform capabilities and develop CrT. These skills enable them to

effectively use resources for creating digital content, making the learning process richer and more creative.

All these aspects underscore the importance of digital technologies and their integration into the educational process. Platforms that support project-based, interactive, and collaborative learning create an environment that fosters high school students' creativity and innovative thinking.

Conclusion

The introduction of DEP significantly affects the development of computer literacy among high school students, providing new opportunities for interactive, flexible and personalized learning. Through these platforms, students can actively participate in the educational process, design projects, experiment, and find unconventional solutions, which stimulates their creativity and develops critical thinking skills. Effective implementation and use of digital platforms should include teacher support, course adaptation to individual student needs, and the creation of opportunities for collaboration and teamwork.

The use of DEP offers ample opportunities for the development of creative abilities and independence of students. Integrating these technologies is an essential part of the modern educational environment and requires efforts from schools, teachers, and students to achieve high results in developing creative and critical thinking.

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PHILOSOPHICAL SCIENCES

АКСИОМАТИЧЕСКАЯ ТЕОРИЯ ВСЕГО – ФУНДАМЕНТАЛЬНАЯ ОСНОВА УСТОЙЧИВОГО РАЗВИТИЯ МИРА

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AXIOMATIC THEORY OF EVERYTHIN - THE FUNDAMENTAL BASIS OF SUSTAINABLE DEVELOPMENT OF THE WORLD

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АННОТАЦИЯ

В статье сообщается о создании аксиоматической теории, претендующей на статус «Теория Всего». Основным отличием данной теории от своих предшественниц является обобщение и переоформление законов физики как причинно – следственных законов. Такой подход позволил выявить метафизическую сущность шестой проблемы Гильберта и решить ее. На основе принятых аксиом установлен основной метафизический закон, который позволил оформить целостную картину мира в виде диаграммы Эйлера-Венна. Данная научная картина мира позволила установить алгебраическую структуру всеобщих законов природы и построить ноосферную картину мира. Теоремы, характеризующие данную математическую структуру, образуют ядро теории, которое включает 16 всеобщих законов природы. Иерархическая структура этих законов позволила объединить их в единую систему. Основным выводом теории является то, что если человечество действительно хочет мира и встать на путь устойчивого развития, то ему необходимо согласовывать свои жизненные программы с всеобщими законами природы.

ABSTRACT

The article reports on the creation of an axiomatic theory claiming the status of "Theory of Everything". The scientific novelty and the main difference between this theory and its predecessors is the design of the laws of physics as causal laws. This approach made it possible to identify the metaphysical essence of Hilbert's sixth problem and solve it. Based on the accepted axioms, the basic metaphysical law was established, which made it possible to formalize a complete picture of the world in the form of an Euler-Venn diagram.

This scientific picture of the world allowed us to establish the mathematical structure of the universal laws of nature and build a noospheric picture of the world. The theorems characterizing this algebraical structure form the core of the theory, which includes16 universal laws of nature. The hierarchical structure of these laws made it possible to combine them into a single system. The main conclusion of the theory is that if humanity really wants peace and to embark on the path of sustainable development, then it needs to coordinate its life programs with the universal laws of nature.

Ключевые слова: теория всего, всеобщие законы природы, шестая проблема Гильберта, целостная картина мира, ноосферная картина мира, математическая структура, поле рациональных чисел, ядро теории, система всеобщих законов природы.

Keywords: theory of everything, universal laws of nature, Hilbert's sixth problem, holistic picture of the world, noospheric picture of the world, mathematical structure, field of rational numbers, core of the theory, system of universal laws of nature.

Характерной особенностью науки и образования XXIвека является ожидание создания Теории Всего и на ее основе установления системы всеобщих законов природы.

Постановка проблемы. На сегодняшний день выход из кризисного состояния и становление на путь устойчивого развития является одной из главных проблем человечества. В связи с этой ситуацией Генеральная Ассамблея ООН приняла в качестве итогового документа «Преобразование нашего мира: Повестка дня в области устойчивого развития на период до 2030 года».В своей книге "Туркменистан на пути к достижению целей устойчивого развития" Национальный Лидер туркменского народа Гурбангулы Бердымухамедов пишет: "Успешная реализация Повестки дня Программы устойчивого развития невозможна без установления отношений, направленных для удовлетворения потребностей человечества и Земли между правительствами, частным сектором и гражданским обществом на глобальном, региональном и местном уровнях, основанных на общих взглядах, общих целях, принципах и ценностях… С экологической точки зрения устойчивое развитие должно обеспечивать биологическую и физическую целостность природных систем» [1, стр.428, стр. 36].. Из этих строк автора следует вывод о том, что если человечество хочет мира и встать на путь устойчивого развития, то ему необходимо корректировать свои жизненные про-

граммы не только между собой, но и на основе универсальных законов природы, определяющих судьбу человечества. Несмотря на огромные усилия ученых, до сих пор не удалось открыть эти законы.

Цель статьи. Новизной данного исследования является создание аксиоматической Теории Всего, в результате которого открыта система всеобщих законов природы. В рамках данной теории решается шестая проблема Гильберта, целостная и ноосферная картины мира оформляются в наглядно-обозримом виде, вскрыта алгебраическая структура всеобщих законов природы.

Анализ последних исследований и публикаций. Анализ современных физических теорий, претендующих на статус «Теория всего» показывает, что данная наука не только не смогла создать единую универсальную теорию, но и не оформила свои законы как законы природы [2, стр. 203].

Выделение нерешенных ранее частей общей проблемы. Все попытки объяснить, какие законы природы, приводят к необходимости ясного представления о причинно-следственных связях и их математической формализации не увенчались успехом. Проблема оказалась непростой, решение ее требовало перехода от эмпирической парадигмы к аксиоматической, суть которой сводится к решению шестой проблемы Гильберта.

Решение шестой проблемы Гильберта

Шестая проблема Гильберта - одна из 23 задач, которая была предложена Давидом Гильбертом 8 августа 1900 года в Париже на II конгрессе математиков, которая называется «Математическое описание аксиом физики». Несмотря на многочисленные попытки ученых, проблему решать до конца не удалось, она до сих пор остается открытой. Нерешенность данной проблемы ученые связывают с некорректной постановкой проблемы.

Для решения шестой проблемы Гильберта представляет особый интерес онтологическая модель, предложенный С. Д. Эскобедо, согласно которому, «если совокупность предложений P разделить на два непересекающихся множества, при этом $A \cup B$, которые оба называются аксиомами. Тогда мы говорим, что модель М называется аксиоматической» [3, стр.3].

Предложенная модель указывает на необходимость разделения каждой трехзвенной формулы физического понятия или закона на две независимые части. Такое разделение требует представление этих формул как триады в виде $A \to B \to C$, которую можно разделить на две независимые диады: $A \to B$ и $B \to C$. Для этого систематизация физических величин, входящих в трехзвенные формулы понятий и законов на основе принципа причинности, является необходимым и достаточным условием (табл.1).

Таблица 1.

Систематизация трехзвенных математических выражений физических понятий и законов на основе принципа причинности

	Физические понятия и законы	Физическая величина, характеризующя причину, a	Физическая величина, характеризующая следствие, b	Физическая величина, характеризующая условие, c
1.	Скорость, $\upsilon = \dfrac{S}{t}$	υ	S	$\dfrac{1}{t}$
2.	Ускорение, $a = \dfrac{\Delta\upsilon}{t}$	$\Delta\upsilon$	a	Δt
3.	Второй закон Ньютона, $F = ma$	F	m	a
4.	Закон Гука $F = k\Delta x$	F	Δx	κ
5.	Давление , $P = \frac{F}{S}$	F	P	S
6.	Количество теплоты, $Q = cm\Delta T$	Q	ΔT	cm
7.	Закон Ома для участка цепи, $U = IR$	U	I	R
8.	Освещенность, $E = \frac{\Phi}{S}$	$\varPhi$	E	S
9.	Энергия кванта, $E = h\upsilon$	υ	E	h

Систематизация и упорядочение трехзвенных формул физических понятий и законов на основе принципа причинности позволяет представить решение шестой проблемы Гильберта в следующем виде:

Аксиома 1. Зависимость между физическими величинами, характеризующими причину и следствие, входящих в данную формулу, является прямо пропорциональной, т.е. $a \sim b$.

Аксиома 2. Зависимость между физическими величинами, характеризующие следствие и условия (состояние объекта), является прямо, либо обратно пропорциональной, т.е. $b \sim c$ или $b \sim \frac{1}{c}$.

Вышеизложенные аксиомы являются решением шестой проблемы Гильберта.

Целостная картина мира и математическая структура всеобщих законов природы.

Как свидетельствует история развития физики, созданию каждой фундаментальной теории предшествует построение новой научной картины мира. А. Эйнштейн считал, что высшая задача физики состоит в открытии наиболее общих элементарных законов, из которых можно было логически вывести картину мира. Объединение выше принятых аксиом, которые представлены как решение шестой проблемы Гильберта, позволило установить эти элементарные законы в следующем виде: $a = bc$ (1) и $a = \frac{b}{c}$ (1a). В теории множеств эти отношения считаются равными, следовательно, в дальнейшем будем пользоваться только формулой (1), которая, по сути, является основным всеобщим законом природы. Данный закон позволяет представить целостную картину мира в виде диаграммы Эйлера-Венна (рис. 1).
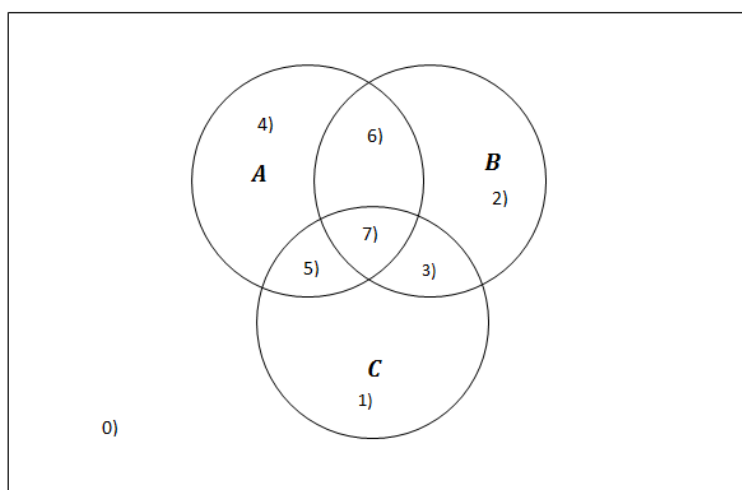

Рисунок 1. Целостная картина мира.

Представление целостной картины мира в данном виде является логической основой для установления математической структуры всеобщих законов природы.

Целостная картина мира как логическое устройство имеет 3 входа и 8 выходов, приведем его таблица истинности.

Таблица 2.

Таблица истинности целостной картины мира

A	B	C	Номер области	Пересечение множеств
0	0	0	0)	$\bar{A} \cap \bar{B} \cap \bar{C}$
0	0	1	1)	$\bar{A} \cap \bar{B} \cap C$
0	1	0	2)	$\bar{A} \cap B \cap \bar{C}$
0	1	1	3)	$A \cap B \cap \bar{C}$
1	0	0	4)	$A \cap \bar{B} \cap \bar{C}$
1	0	1	5)	$A \cap \bar{B} \cap C$
1	1	0	6)	$A \cap B \cap \bar{C}$
1	1	1	7)	$A \cap B \cap C$

В таблице истинности множества A, B и C являются входными, а соответствующие их пересечения $A \cap B \cap C$, $A \cap B \cap \overline{C}$, $A \cap \overline{B} \cap C$,

$A \cap \overline{B} \cap \overline{C}$, $\overline{A} \cap B \cap \overline{C}$, $\overline{A} \cap B \cap \overline{C}$, $\overline{A} \cap \overline{B} \cap C$, $\overline{A} \cap \overline{B} \cap \overline{C}$ - выходными сигналами. Из обозначений выходных сигналов можно сделать следующие логические выводы:

1. Для каждого элемента множеств A, B и C существуют обратные элементы относительно операции умножения:

$$a \cdot a^{-1} = 1; \quad b \cdot b^{-1} = 1; \quad c \cdot c^{-1} = 1. \quad (2)$$

2. Для любых a и b $a \prec b$, знак «$\prec$» означает слово «предшествует».

Математическое выражение закона (1) и логические выводы, приведенные выше, позволяют интуитивно предполагать, что алгебраической структурой всеобщих законов природы является область целостности в поле рациональных чисел. Теоремы, характеризующую данную алгебраическую структуру образуют ядро теории.

Ядро теории

Как правило, когда физическая теория создается на основе набора доказанных готовых теорем математической структуры, физические предложения присоединяются к теоремам. Следуя этому правилу, ядро теории представляется в следующем виде [4, стр. 145-147].

Теорема 1. Пусть, $\mathscr{F} = \langle F, +, -, \cdot, 1 \rangle$–поле. Тогда для любых элементов поля a, b, c, где a, b, c – физические величины, характеризующие соответственно причину, следствие и условие выполняются следующие отношения:

Если $ab = 1$, то $a \neq 0$ и $b = a^{-1}$; (3)
если $ac = bc$ и $c \neq 0$, то $a = b$; (4)
если $ab = 0$, то $a = 0$ или $b = 0$; (5)
если $a \neq 0$ и $b \neq 0$, то $ab \neq 0$; (6)

$$\frac{a}{b} = \frac{c}{d} \text{ тогда и только тогда, когда}$$

$ad = bc, b \neq 0$ we $a \neq 0$, где d - физическая величина, характеризующая внешнее условие (7);

$$\frac{a}{b} \pm \frac{c}{d} = \frac{ad \pm bc}{bd} \quad (8);$$

$$\frac{a}{b} + \frac{(-a)}{b} = 0 \text{ и} -\left(\frac{a}{b}\right) = -\frac{a}{b} \quad (9);$$

если $a \neq 0$ и $b \neq 0$, тогда $\left(\frac{a}{b}\right)^{-1} = \frac{b}{a}$; (10)

$$\frac{ac}{bc} = \frac{a}{b}; \quad (11)$$

Теорема 2. Для любой области целостности существует поле частных. Если $\mathscr{F}$ и $\mathscr{P}$ – поля частных в кольце $\mathscr{K}$, то существует изоморфизм поля $\mathscr{F}$ на поле $\mathscr{P}$, переводящий каждый элемент кольца $\mathscr{K}$ в себя. (12)

Теорема 3. Бинарное отношение $\prec$ в причинно – следственных связях обладает следующими свойствами:

1) для любых a, b, $c \in Q$ если $a \prec b$ и $b \prec c$, то $a \prec c$ (транзитивность); (13)

2) для любых a, $b \in Q$ имеет место одно и только одно из трех соотношений; $a \prec b$, $a = b$, $b \prec a$; (14)

3) для любых a, b, $c \in Q$, если $a \prec b$, то $a + c \prec b + c$; (15)

4) для любых a, b, $c \in Q$, если $a \prec b$ и $0 \prec c$, то $ac \prec bc$. (16)

Математические предложения (1) – (16) по сути, являются метафизическими законами.

Интерпретация законов теории

Интерпретация законов теории позволяет соотнести ее с реальностью и произвести ее верификацию. Методом интерпретации из небольшого числа исходных отношений – законов теории получается неограниченное число следствий. В данной статье мы ограничимся изложением некоторых из них.

Следствие 1. Метафизический закон (1) по сути, является законом композиции и пропорциональности, известного еще с глубокой древности закона под названием «триединства сущностей», согласно которому все фундаментальные природные проявления зависят друг от друга таким образом, что обязательно объединяются в отдельные группы – по три в каждой из них (триада). Физики выражают такие фундаментальные зависимости в виде широко известных трехзвенных формул типа $F=ma$, $s = \vartheta \cdot t$ и т.п. [5, p. 22].

Следствие 2. В математике метафизический закон (2) означает что, коммутативное и ассоциативное кольцо с единицей, в котором для любого отличного от нуля элемента а, найдется обратный элемент a^{-1}, которое называется полем. Данный метафизический закон выражает глубокую суть понятия « поле». Хотя в физике данный закон пока не имеет статуса научного закона, однако остро ощущается необходимость данного закона для выяснения понятия «физическое поле».

Следствие 3. В математике предложение (3) теоремы 1 означает существование для любого отличного от нуля рационального числа a обратное ему относительно умножения число b, т.е. такое, что $ab = 1$. В физике данный закон может быть интерпретирован как закон, утверждающий существование обратной величины для заданной величины относительно операции умножения. Философской точки зрения данный закон может быть интерпретирован как закон единства и борьбы противоположностей.

Следствие 4. Предложение 4 теоремы 1 выражает сократимость алгебраической операции умножения в множестве A. Согласно теореме Нётер, в физике данное отношение может быть интерпретировано как закон сохранения энергии в физике [6, стр.2]. С философской точки зрения закон сохранения энергии, как и другие законы сохранения, является естественно-научным обоснованием закона

единства природы, поскольку показывает закономерный характер превращения энергии из одной формы в другую [6].

С точки зрения социальной философии закон сохранения энергии может быть интерпретирован как закон справедливости. Социальная справедливость измеряется такими критериями, как справедливое распределение материальных благ между этническими группами, равенство возможностей и преимуществ. Неслучайно Организация Объединенных Наций, влиятельная организация, более серьезно относящаяся к вопросам устойчивого развития, считает принцип справедливости важным условием вступления мирового сообщества на путь устойчивого развития. ООН признает, что ни одно общество, ни одно государство не может гарантировать свою стабильность и безопасность, не следуя по пути устойчивого развития, а общество не может достичь устойчивого развития, не следуя закону справедливости [7, стр.449].

Следствие 5. В математике предложение (5) теоремы 1 гласит о том, что всякое числовое кольцо является областью целостности: если $ab = 0$, то $a = 0$ или $b = 0$ [8, с. 246]. Данный метафизический закон можно интерпретировать как первый закон Ньютона. Согласно этому закону, если тело не взаимодействует с другими телами (нет причины) или взаимодействия компенсируются, то тело сохраняет исходное состояние. С философской точки зрения этот указывает на то, что мир, в котором мы живём, является областью целостности. В социальной физике этот закон трактуется следующим образом: «Все живые существа движутся к смерти линейно и симметрично, если на них не действует ускоряющая сила» [9, стр. 74].

Следствие 6. В математике предложение (6) теоремы 1 гласит, если ни один из множителей не равен нулю, то их произведение так же не равно нулю. В физике этот закон можно интерпретировать как закон, утверждающий что, если тело взаимодействует с другими телами (есть причина) и это взаимодействие не компенсируется (есть следствие), то оно находится в движении. С философской точки зрения, согласно этому закону, взаимодействие и сотрудничество между людьми, государствами является залогом их устойчивого развития.

Следствие 7. В математике предложение (7) теоремы 1 есть условие равенства дробей. С философской точки зрения этот закон можно интерпретировать как закон перехода количественных изменений в качественные. Закон перехода количественных изменений в качественные играет важную роль в развитии природы, общества и мышления. Анализ этого закона подтверждает, что количественные изменения являются эволюционным типом развития, а качественные – наоборот, революционным. Взаимосвязь количественных и качественных изменений приводит к важному выводу о единстве эволюционной и революционной форм развития. В физике закон сообщающихся сосудов, закон гидравлического пресса, закон преломления

света можно трактовать как частные проявления этого метафизического закона.

Следствие 8. В математике формула (8) в теореме 1 есть формула сложения (вычитания) дробей. В физике не существует такого рода закона. Однако, формулу линзы можно вывести из этого метафизического закона и считать его частным проявлением. Данный метафизический закон ждет своего экспериментального подтверждения.

Следствие 9. Согласно предложению (9) теоремы 1, любому числу относительно операции сложения существует число с противоположным знаком. Данное утверждение, по сути, является математическим выражением закона диалектики отрицание отрицания. Данный метафизический закон указывает направление развития и раскрывает объективную тенденцию развития природы, общества и мышления. Через отрицание удаляются ситуации, тормозящие развитие, сохраняются ситуации, способствующие развитию на новом уровне, а через их использование развитие переходит от простого к сложному. В физике данный метафизический закон (9) можно интерпретировать как третий закон Ньютона. Согласно социальной физике ускорения двух взаимодействующих в среде тел равны, векторы их ускорений и используемых сил противоположны» [9, стр.74]. В священной книге Корани - Керим имеются следующие строки: «Кто же преступает против вас, - то и вы преступаете против него подобно тому, как он преступил против вас» [10, стр. 35]. Эти строки еще раз указывают на необходимость преодоления противопоставления науки и религии, а представления их как дополнительных [11, стр. 56]

Следствие 10. Согласно предложению (10) теоремы 1 дробь в минус первой степени равна обратной дроби в первой степени. С физической точки зрения данное математическое предложение может быть интерпретировано как поворот системы как целого в пространстве. Симметрия законов относительно такого преобразования означает эквивалентность всех направлений в пространстве (изотропию пространства). Изотропии пространства соответствует закон сохранения момента импульса.

Следствие 11. Формула (11) теоремы 1 с математической точки зрения гласит, если числитель и знаменатель дроби одновременно разделить на одно и то же число, то получится равная ей дробь. Частными проявлениями данного метафизического закона являются газовые законы изопроцессов.

Следствие 12. Согласно теореме 2, существуют объединенные законы природы, для которых характерно разделение их на две изоморфные дробные части. Согласно этому метафизическому закону определенные причины обуславливают появление соответствующих следствий, причем элементы симметрии причин должны повторяться в соответствующих следствиях. Данный метафизический закон может быть назван законом симметрии. Как отмечает Ю.А. Урманцев, изучение симметрии природы с точки зрения симметрии приводит к достаточно глубоким общим выводам, связанным с

глубокими человеческими исканиями [12, стр. 23]. Закон всемирного тяготения, закон Кулона являются частными проявлениями этого закона, и их объяснение с точки зрения закона симметрии изложено в работе автора [13, стр. 10].

Следствие 13. Предложение (1) теоремы 3 выражает неизменность временной последовательности причинно-следственных событий и не может быть нарушено или, говоря обыденным языком, время течет в одном направлении от прошедшего к настоящему. Данный метафизический закон выражает транзитивный характер причинно-следственной связи. С физической точки зрения закон (13) означает, что взаимодействия не мгновенные, а происходят в течение фиксированного периода времени и упорядочены во времени.

Следствие 14. Первая часть предложения (14) теоремы 3 представляет собой метафизический закон, указывающий невозможность сосуществования в заданной системе необратимого, прямого или обратимого процессов.

Следствие 15. Предложение (15) теоремы 3 на языке математики выражает монотонность отношения порядка относительно сложения. В физике данное свойство может быть интерпретировано как первый постулат специальной теории относительности Эйнштейна, согласно которому физические процессы одинаковы во всех инерциальных системах отсчета. С точки зрения социальной физики данный метафизический закон требует того, чтобы законы существования были одинаковыми для любой социальной системы, независимо от скорости развития.

Следствие 16. Согласно предложению (16) теоремы 3 означает, что отношение порядка сохраняется при умножении обеих частей на одно и то же положительное число, что выражает статистическую взаимосвязь между причиной и следствием. В физике данный метафизический закон интерпретируется как второй закон термодинамики [14, стр.26]. Данный метафизический закон подтверждает масштабную инвариантность причинно-следственной связи и определяет направление развития сложной системы. Согласно этому закону, большое число физических, биологических и социальных объектов имеют общие законы и направления развития. Становится очевидным, что сложноорганизованным социальным и природным системам нельзя навязывать пути развития — необходимо понять, как способствовать их собственным тенденциям развития, как выводить системы на эти пути развития. Важно понять законы совместной жизни природы и человечества, т. е. их коэволюцию [12, стр. 7].

Ноосферная картина мира

Высшим синтезом теоретического знания является научная картина мира. В современной науке на роль общенаучной картины мира все более претендует ноосферная картина мира. Хотя такая картина еще только складывается, но ее ядро уже отчетливо проявилось и является работающим инструментом современного вузовского и школьного образования [15, стр.64].

Законы (11) и (16) теории служат основой для оформления ноосферной картины мира в виде четырехмерной диаграммы Эйлера - Венна (рис. 2).
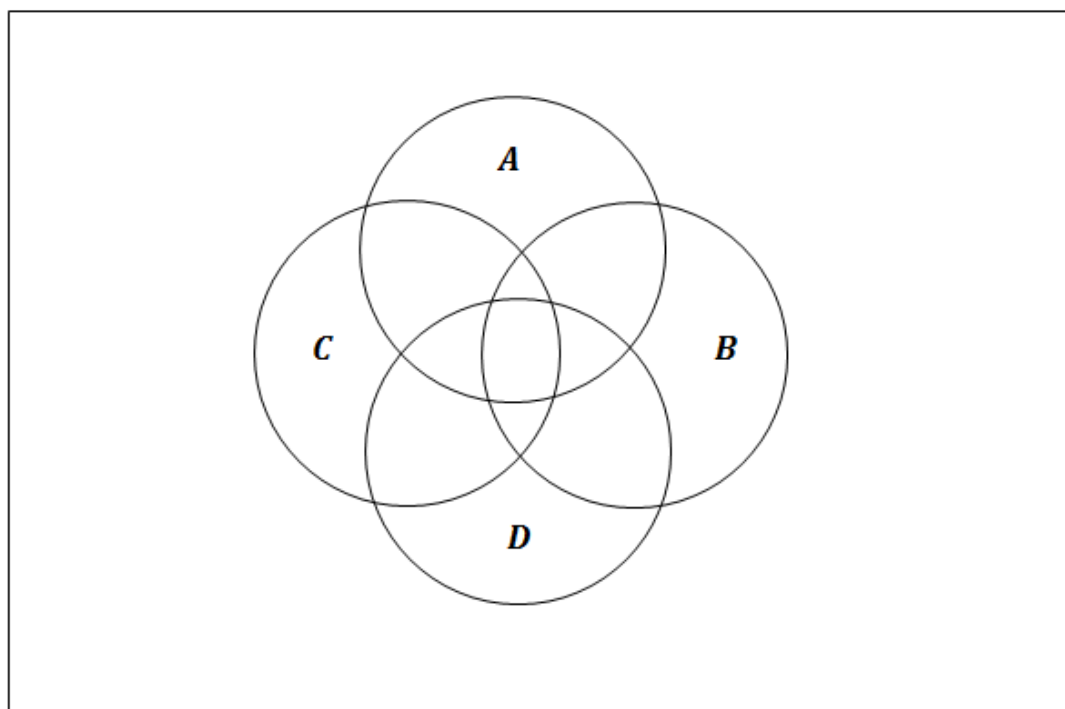

Рис.2 Ноосферная картина мира

Научная картина мира, представленная на рис.2, позволяет утверждать, что мир четырехмерен, управляется точными законами, четырехмерный континуум причинности является более фундаментальным, чем пространственно-временной

континуум. Как логическая структура, ее таблица истинности доказывает полноту законов теории.

Оформление ноосферной картины мира имеет важное научное и образовательное значение. Использование данной картины мира позволяет утвердить синтетическое соединение естественно-научного, гуманитарного, религиозного, экологического и технического знания. В центре ноосферной картины мира находится человек. От его эволюционных материальных и духовных позиций зависят параметры ноосферного развития, его векторность, темпы, в конечном итоге – возможность выходов из сложнейших кризисных ситуаций, с которыми сталкивается цивилизация [15, стр. 63].

Система всеобщих законов природы

Анализ группы автоморфизмов, выражающий свойство одинаковости и строения математических выражений законов теории позволил нам представить их иерархическую структуру в следующем виде (рис.3).
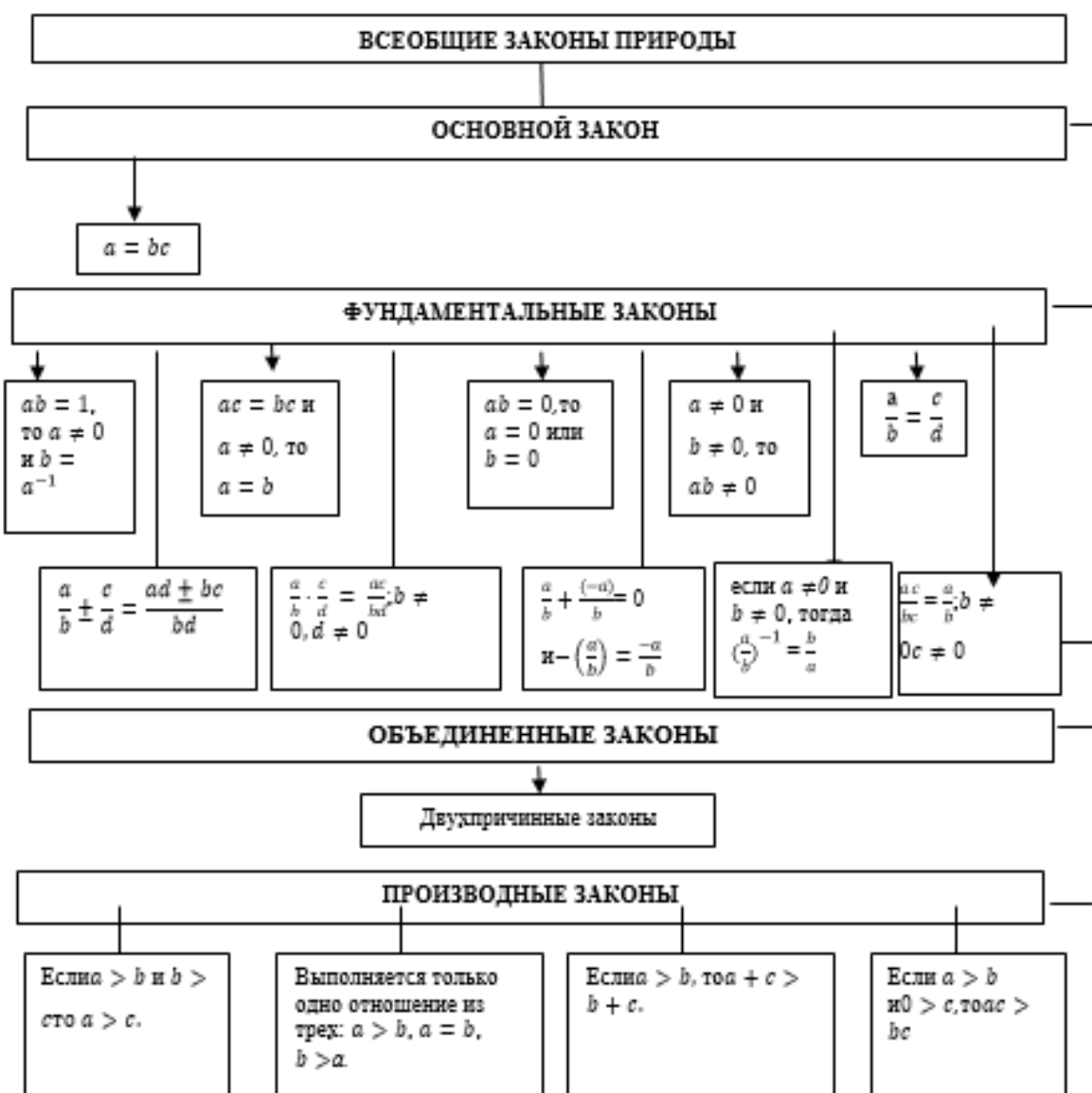

Рис.3. Иерархическая структура всеобщих законов природы

Как видно из рис.3, в иерархической структуре первую группу автоморфизмов представляет единственный закон, который является основным законом метафизики. Вторую группу законов представляют законы, характеризующие простые свойства поля, которые являются фундаментальными. Третью группу автоморфизмов представляет объединенные законы, а четвертую группу – производные законы, которые выводятся из первой и второй группы.

Иерархическая структура, представленная на рис.3, позволяет систематизировать всеобщие законы природы, подобно периодической системе химических элементов (см. табл.4)

Таблица 4.

Система всеобщих законов природы

Система всеобщих законов природы

ВСЕОБЩИЕ ЗАКОНЫ ПРИРОДЫ

ОСНОВНОЙ ЗАКОН

$$a = bc$$

ФУНДАМЕНТАЛЬНЫЕ ЗАКОНЫ

$ab = 1,$ то $a \neq 0$ и $b = a^{-1}$	$ac = bc$ и $a \neq 0$, то $a = b$	$ab = 0,$ то $a = 0$ или $b = 0$	$a \neq 0$ и $b \neq 0$, то $ab \neq 0$	$\dfrac{a}{b} = \dfrac{c}{d}$
$\dfrac{a}{b} \pm \dfrac{c}{d} = \dfrac{ad \pm bc}{bd}$	$\dfrac{a}{b} \cdot \dfrac{c}{d} = \dfrac{ac}{bd}; b \neq 0, d \neq 0$	$\dfrac{a}{b} + \dfrac{(-a)}{b} = 0$ и $-\left(\dfrac{a}{b}\right) = \dfrac{-a}{b}$	если $a \neq 0$ и $b \neq 0$, тогда $\left(\dfrac{a}{b}\right)^{-1} = \dfrac{b}{a}$	$\dfrac{ac}{bc} = \dfrac{a}{b}; b \neq 0 c \neq 0$

ОБЪЕДИНЕННЫЕ ЗАКОНЫ

Двухпричинные законы

ПРОИЗВОДНЫЕ ЗАКОНЫ

Если $a > b$ и $b > c$ то $a > c$.	Выполняется только одно отношение из трех: $a > b, a = b, b > a$.	Если $a > b$, то $a + c > b + c$.	Если $a > b$ и $0 > c$, то $ac > bc$

Представленная на табл. 4 система всеобщих законов природы, по сути, является метафизическим универсумом и позволяет казуально объяснить законы природы, общества и мышления.

Обсуждение

Аксиоматическая Теория Всего утверждает, что мир управляется и развивается по универсальным законам природы. Открытия этих законов, которые является фундаментальной основой устойчивого развития, способствует решению многих насущных проблем человечества, которое требует оформления законов естествознания, общества и мышления в соответствии с этими законами. Знание универсальных законов природы и следование этим законам является основой для взаимопонимания, сотрудничества, справедливой глобализации. Представленные в теории научные картины мира являются ментальной моделью – процессом мышления необходимым для придания смысла жизненному опыту, объяснения причин и следствий. Причинно-следственное моделирование, не сопряженное с необходимостью освоения громоздкого современного математического аппарата, вполне доступно широкому кругу специалистов, работающих в самых различных областях, в том числе далеких от теоретической физики и математики. Причинно-следственное моделирование решает очень важную проблему интеграции знаний, которое имеет немаловажное значения для перехода на ноосферную модель образования. Построение причинно-следственных диаграмм дает в руки исследователя своеобразный метаязык, позволяющий «объединять» знания, относящие к общему изучаемому явлению. Построение адекватных причинно-следственных моделей должно рассматриваться в качестве полноценного результата наряду с такими традиционными результатами как экспериментальное обнаружение (уточнение) новых

научных фактов, построение численной модели или разработка аналитической теории.

Заключение

Аксиоматическая теория всего – открытие XXI века, сделанное целой плеядой ученых. Как озвучивающему это открытие автору приходится теперь решать массу проблем, связанные приданием статуса социально-значимого феномена, включение его в систему культур, активную позицию личности, распространение, решение которых непосильно одному человеку. В решении этих проблем должны участвовать не только те, кому небезразлично будущее человечества и устойчивое развитие мира, но и государственные органы, отвечающие за развитие науки и образования. В этом ведущая роль принадлежит учреждению ЮНЕСКО, которое рассматривает естественные науки в контексте междисциплинарного взаимодействия с образованием и культурой.

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PHYSICS AND MATHEMATICS

PROOF OF THE EXISTENCE OF OTHER MUTUALLY INVISIBLE UNIVERSES NEIGHBORING TO OUR VISIBLE UNIVERSE BY ASTRONOMICAL OBSERVATIONS IN THE PORTALS OF CONSTELLATIONS INVISIBLE OUTSIDE THE PORTALS[2]

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ABSTRACT

The article explains that the special theory of relativity (SRT), created in the early twentieth century, which is an outstanding scientific achievement, was ahead of its time, because in physics at that time lacked some knowledge necessary for its creation – physical reality of imaginary numbers was not proved and the its physical meaning was not explained, dark matter and dark energy were not discovered, discrete mathematics and hyper-complex numbers were not used, and WMAP and Planck space-crafts were not launched into space yet. Therefore absence of the mentioned knowledge was justifiably replaced by postulates. But not everything was guessed. And present now in the version of SRT studied in all physics textbooks, the postulate called the principle of non-exceeding the speed of light turned out to be incorrect. Therefore the corrected version of SRT in which this postulate is replaced by the experimentally proved principle of physical reality of imaginary numbers is offered. In this corrected version of SRT also offered a experimental proof of the existence of mutually invisible parallel universes astronomical observations in portals invisible outside the portals of constellations. And it is explained, why the principle of non-exceeding of speed of light not disproved so far by physical experiments is incorrect. And why the incorrect version of SRT, studied in all physics textbooks, is still in demand.

Keywords: special theory of relativity, principle of non-exceeding the speed of light, principle of physical reality of imaginary numbers, relativistic formulas, dark matter, dark energy, universes, anti-universes, Multiverse, portals, anomalous zones.

1. Introduction

In the 20th century, physics, having changed the thousand-year-old tradition of creating theories on the basis of reliable experiments, began to call hypotheses that were interesting but not experimentally confirmed theories, including the special theory of relativity (SRT).

But what's even worse is that as a result of the struggle for survival, SRT was canonized - in the community of relativistic physicists and in public opinion, a conviction was formed about its infallibility, about the inadmissibility of its criticism and any subsequent corrections. Therefore, for example, in the USSR it was forbidden to criticize the SRT even three times - in 1934 by the decree of the Central Committee of the All-Union Communist Party (Bolsheviks) on the discussion of relativism, in 1942 by the decree of the Presidium of the Academy of Sciences of the Soviet Union on the theory of relativity and in 1964 by a secret decree of the Presidium of the Academy of Sciences of the Soviet Union, which prohibited any criticism of Albert Einstein's theory. And reviewers of some good journals have now started writing in their reviews *"I will not allow criticism of Einstein"*.

Unfortunately, the ban on criticism of scientific theories is not a new phenomenon. For example, Nikolai Copernicus, who spent 40 years in the 16th century creating the heliocentric system of the world, wisely published his theory *"On the Revolutions of the Celestial Spheres"*, which refuted the geocentric system of the world of Claudius Ptolemy after his own death, not wanting to end up in the Inquisition. And Giordano Bruno and Galileo Galilei, who carelessly supported Copernicus' theory, had to deal with the Inquisition. Giordano Bruno was even burned alive at the stake. Therefore, the corresponding to common sense process of creating scientific theories by identifying in them as a result of experimental studies of certain shortcomings and their subsequent correction was not always smooth.

And although created in the early XX century by Joseph Larmor [1], Nobel Prize winner Hendrik Antoon Lorenz [2], Jules Henri Poincaré [3], Nobel Prize winner Albert Einstein [4] and other outstanding scientists STR [5]-[7], rightly recognized as a great scientific achievement, due to the lack of the necessary experimental knowledge at that time, which was forced to be replaced by postulates, as it turned out in the 21st century, nevertheless turned out to be incorrect [8]-[48], because:

- its relativistic formulas were incorrect;

- the relativistic formulas obtained in it were incorrectly explained using the incorrect principle of non-exceeding the speed of light;

- from these incorrect relativistic formulas were made incorrect conclusions about physical unreality of imaginary numbers discovered 400 years before the creation of SRT and about the existence in nature of our only visible universe, in which everything is measured only by real numbers.

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[2] This is reprint of the article "Antonov A. A. Experimental Evidence for the Existence of Other Mutually Invisible Universes Neighboring Our Visible Universe. European Journal of Applied Sciences. Services for Science and Education. United Kingdom. Vol. 12 No 5. DOI: 10.14738 /aivp.125.17785"

However, it continues to be studied all over the world today uncorrected in all educational institutions, even the most prestigious ones.

2. Unsuccessful refutations of the version of the special theory of relativity presented in all physics textbooks

Why? Let's figure out why it happened this way. The relativistic formulas obtained by the creators of STR:

$$m = m_0 / \sqrt{1 - (\tfrac{v}{c})]^2} \qquad (1)$$

$$\Delta t = \Delta t_0 \sqrt{1 - \left(\tfrac{v}{c}\right)^2} \qquad (2)$$

$$l = l_0 \sqrt{1 - (\tfrac{v}{c})]^2} \qquad (3)$$

in which m_0 – rest mass of a moving body;

m – relativistic mass of a moving body;

Δt_0 – rest time of a moving body;

Δt – relativistic time of a moving body;

l_0 – rest length of a moving body;

l – relativistic length of a moving body;

v – speed of motion of a body;

c – speed of light;

were explainable only in the range of subluminal speeds $v < c$, in which the quantities m, Δt and l took on values measured by real numbers. But in the range of superluminal speeds $v > c$ these quantities m, Δt and l already took on values measured by imaginary numbers discovered by Scipione Del Ferro, Niccolò Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari and Rafael Bombelli [49] 400 years before the creation of the STR, the physical meaning of which, however, was not explained by them. But, perhaps, even earlier than them, imaginary numbers were discovered by Paolo Valmes [50], who for this was burned alive at the stake by the sentence of the mercilessly cruel inquisitor Thomas de Torquemada. Even Isaac Newton[3], in order to avoid trouble, preferred not to use imaginary numbers at that time. The creators of the STR also did not know how to explain them. And the physical meaning of imaginary numbers in physics textbooks has not been explained to this day. Moreover, the graph of the function $m(v)$ in the range of velocities $v > c$ (see Fig. 1a) corresponds to a physically unstable process that cannot exist in nature at all.
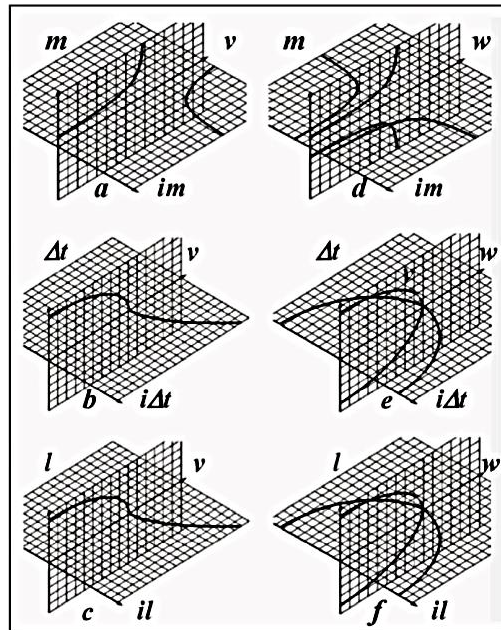

Fig. 1. Graphs of functions $m(v)$, $\Delta t(v)$ *and* $l(v)$ *corresponding to the existing and the corrected versions of the STR in the subluminal* $v < c$ *and superluminal* $v > c$ *ranges*

But such a theory, which even its creators could not explain, was naturally of no use to anyone. And therefore, at that time, a postulate called the principle of not exceeding the speed of light was justifiably introduced into the STR, the essence of which is clear from its name. And according to this postulate, formulas (1)-(3) in the range of speeds $v > c$ no longer needed to be explained, since the functions $m(v), \Delta t(v), l(v)$ allegedly do not correspond to any existing processes in nature in this range. And this was very close to the truth. In any case, at the time this postulate appeared in the STR, such processes were unknown on earth.

Therefore, from formulas (1)-(3) it was quite logical to conclude that imaginary numbers are physically unreal and that in nature there is only one visible universe. And in this form STR is still presented in all physics textbooks.

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[3] And his friend William Whitson, in an atmosphere of the omnipotence of the Inquisition, was stripped of his professorship and expelled from Oxford University for some of his careless statements.

But in 1934, Pavel Alekseevich Cherenkov discovered a process called Cherenkov radiation [51], which refuted the version of STR presented in physics textbooks, since it was explained by the movement of electrically charged particles in a transparent medium with a refractive index $n > 1$ at a speed exceeding the phase velocity of light in this medium. For this discovery P. A. Cherenkov, I. E. Tamm and I. M. Frank even received the Nobel Prize in 1958. Nevertheless, STR withstood, specifying that the principle of not exceeding the speed of light refers to the speed of light only in a vacuum, i.e. in an optical medium with a refractive index $n = 1$.

The next attempt to refute the textbook version of STR was undertaken by the widely publicized OPERA experiment [52] at the Large Hadron Collider in 2011, in which approximately 200 physicists from 36 institutes in 13 countries took part. The goal of the experiment was to detect superluminal neutrinos, and thereby refute the principle of not exceeding the speed of light and the generally accepted version of STR. For which the performers of this experiment expected to receive the Nobel Prize. And on September 23, 2011, an article by the OPERA collaboration appeared in the archive of electronic preprints, in which it was reported that such superluminal neutrinos had been detected by them. However, on March 15, 2012, a message was published about the ICARUS experiment [53] conducted at the same Large Hadron Collider, which refuted the OPERA experiment.

And that's it. No one other than the author[4] of this article has offered any other physical refutations of the corrected principle of not exceeding the speed of light.

3. Successful refutation of the version of special theory of relativity presented in physics textbooks

So why then is it stated above that the version of the special theory of relativity presented in physics textbooks is incorrect?

Because there are other sciences besides physics. Including electrical engineering and radio engineering, which appeared before the STR, and whose very existence proves the physical reality of imaginary numbers and thereby refutes the version of the STR presented in physics textbooks.
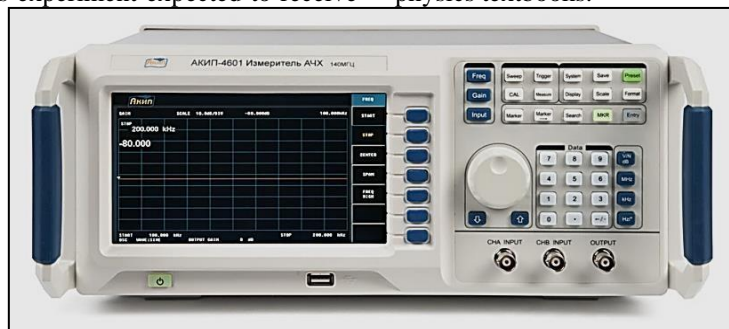

Fig. 2. In any radio-technical laboratory there are devices called frequency response meters, which prove the physical reality of imaginary and complex numbers by their mere existence

Indeed, in electrical engineering and radio engineering, the Ohm's law, as interpreted by Steinmetz [54], discovered in 1893, is fundamental. It is now used daily in practical work by millions of electrical and radio engineers all over the world. Thus, naturally, confirming that it is true. And according to this law, in linear electrical circuits of alternating current, the electrical resistances of capacitors and inductors (also called inductors) are measured by imaginary numbers of different polarities, and only the resistances of resistors are measured by real numbers. Note that the previous phrase states that the imaginary resistances of capacitors and inductors are measured. And indeed, in all electrical and radio engineering laboratories there are many devices (for example, see Fig. 1) that measure the imaginary parameters of electrical circuits. Even every radio amateur has such a simple device, called a tester.

And everything that is measured really physically exists. Physicists know this very well. And this is a fundamental position of any science. If people did not use devices in their activities, but relied on knowledge obtained only from their senses, then science would not exist. And since in electrical and radio engineering the resistances of capacitors and inductors, once called imaginary, are in fact measured by existing devices, then they are not imaginary at all, but the most real physically existing. And the author of this article wrote about this back in 2008-2010 [55]-[59], i.e. before the publication of the results of the OPERA experiment, making it unnecessary. But the OPERA collaboration ignored these publications and carried out its own very expensive, but unsuccessful experiment. Relativistic physicists still ignore subsequent, including other, proofs of the principle of physical reality of imaginary numbers [60]-[66]. According to which the SRT is refuted by the existence of bell ringing, tsunamis and even suspended swings on playgrounds. Since it follows from the generally accepted version of the SRT that they should not be there. That is, the swing should not swing after a push from parents. But you know that they swing.

Nevertheless, these publications prove in the most indisputable way that the named imaginary numbers, contrary to the postulate of the STR about not exceeding the speed of light, are physically real not only in electrical and radio engineering, but always and everywhere in all sciences. And therefore it is time to realize that mathematics cannot be one for Einstein, another for Steinmetz, and a third for someone else. Therefore, imaginary numbers are physically real in all sciences. Including physics. And textbooks on different sciences

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[4] See below for more information on them.

(primarily physics textbooks and radio engineering textbooks) should not contradict each other.

And since the statement following from the postulate of not exceeding the speed of light of the STR about the physical unreality of imaginary numbers turned out to be incorrect, it is obvious that this postulate itself is also incorrect. And therefore the generally accepted version of the STR itself is also incorrect [8]-[48].

And no experiments are ever refuted by postulates.

But how then can we explain the existence in physics of the physically unrefuted principle of not exceeding the speed of light?

4. Correction of relativistic formulas of STR taking into account the experimentally proven principle of physical reality of imaginary numbers

So, we need to think some more.

Since, as has just been proven, imaginary numbers are physically real, the relativistic formulas of STR, taking this circumstance into account, must be explained. And for this, first of all, they must be corrected

so that they correspond to physically realizable processes. For this, the relativistic formulas (1)-(3) in the ranges $-\infty \leq v < 0$ and $c \leq v < +\infty$ must be such that the graphs of the functions $m(v), \Delta t(v), l(v)$ (Fig. 1d,e,f) are similar to the graphs of the same functions $m(v), \Delta t(v), l(v)$ (Fig. 1a,b,c) in the range $0 \leq v < <c,$ i.e. have the form

$$m(q) = m_0 i_1^q / \sqrt{1 - (\tfrac{v}{c} - q)^2} \qquad (4)$$

$$\Delta t(q) = \Delta t_0 i_1^q \sqrt{1 - (\tfrac{v}{c} - q)^2} \qquad (5)$$

$$l(q) = l_0 i_1^q \sqrt{1 - (\tfrac{v}{c} - q)^2} \qquad (6)$$

where $q(v) = \lfloor v/c \rceil$ is the "floor" function of discrete mathematics of the argument v/c (its graph is shown in Fig. 3a), which is the fourth spatial dimension;

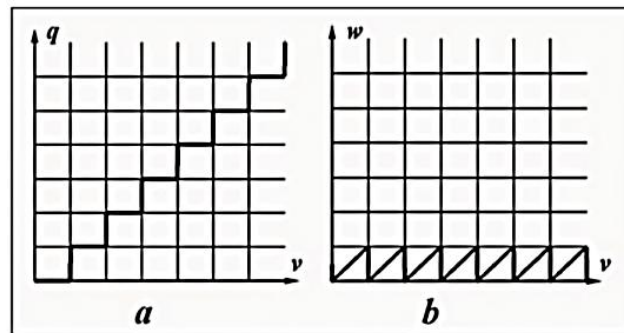$w(v) = v - qc$ is the local velocity for each universe (its graph is shown in Fig. 3b).

Fig. 3. Graphs of the functions q(v) and w(v), illustrating the meaning of the "floor" function of discrete mathematics

Moreover, this function i^q in formulas (4)-(6), defining the essence of each universe, for successive values of $q(v)$ equal to $0,1,2,3,4,5,...$, takes values $+1,+i,-1,-i,+1,+i,$ ... And the value $q(v)=0$ in formulas (1)-(3) for the range of speeds $v < c$ corresponds to our visible universe, which for definiteness we will call the tardion universe. To the value $q(v)=1$ in the superluminal velocity range corresponds some other invisible

universe, since it is beyond the event horizon. For definiteness, therefore, we will call it the tachyon universe. The value $q(v)=2$ will then correspond to the invisible tardion antiuniverse, the value $q(v)=3$ will correspond to the invisible tachyon antiuniverse, the value $q(v)=4$ will correspond to another (and therefore already invisible) tardion universe, the value $q(v)=5$ will correspond to another tachyon universe. And so on.
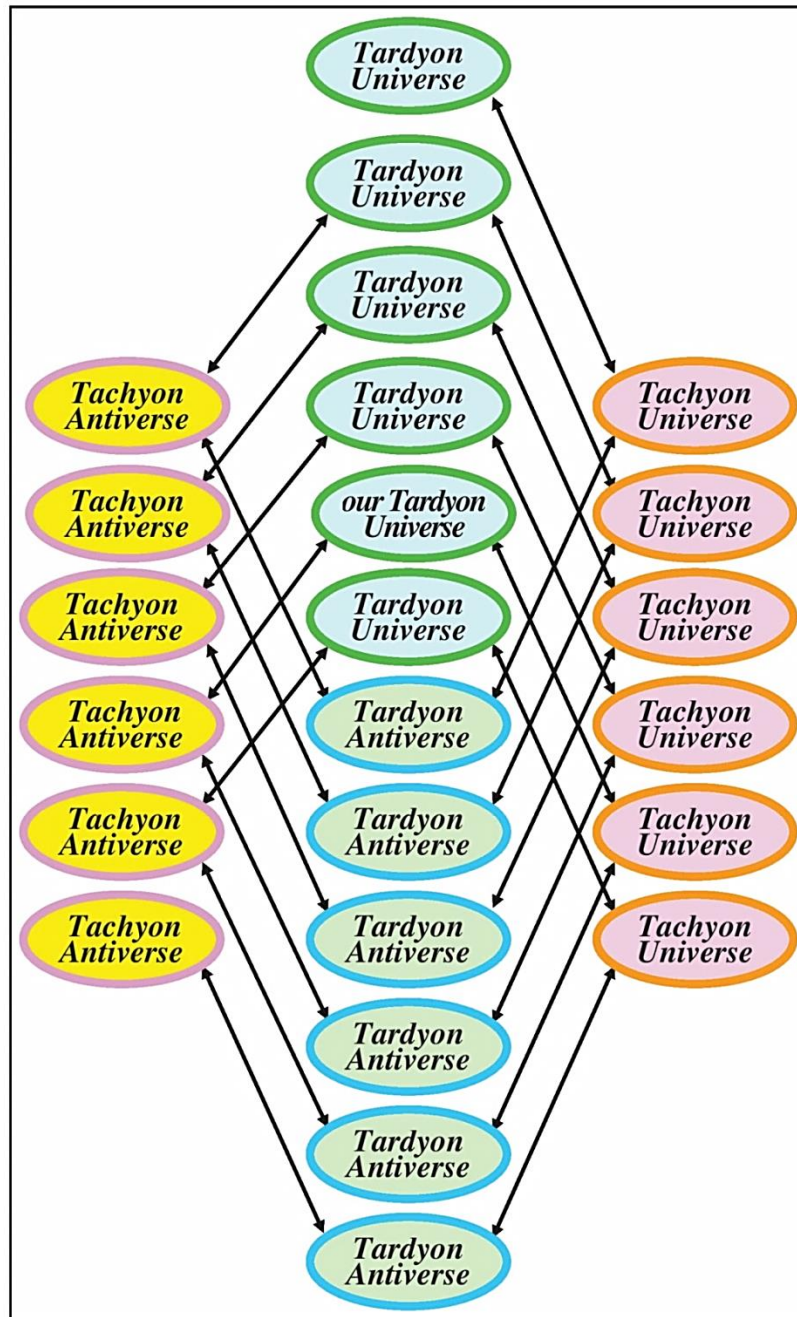
Fig. 4. Structure of the hidden Multiverse corresponding to the principle of physical reality of complex numbers

I.e. according to formulas (4)-(6) there is not one universe in Nature, as it is stated in the generally recognized version of SRT, but a set of mutually invisible universes forming the Multiverse, which therefore we will call hidden. Such a hidden Multiverse, the structure of which is helical, is given in Fig. 4. And in this structure of the hidden Multiverse the distribution of material contents in each three-dimensional parallel universe will be determined by its function $f_q(x,y,z)$, and the value q is the coordinates of these universes. I.e. the hidden Multiverse will be described by the formula $f_q(x,y,z) + iq$.

And this structure of the hidden Multiverse already allows us to explain the problem - where antimatter is located [67]-[71], which is inexplicable within the framework of SRT studied in all physics textbooks. It is clear that it cannot be in our visible universe, because due to its annihilation with matter our universe would cease to exist. But the fact that antimatter still exists has been proven experimentally. In 1995 at CERN a sensational result was obtained - scientists managed to get nine atoms of antihydrogen, which existed for about forty billionths of a second. And just one gram of such antihydrogen would cost 662.5 trillion (i.e., a thousand billion) dollars.

In the structure of the hidden Multiverse shown in Fig. 4, antimatter (in relation to our earthly matter) is in the nearest tardion antiuniverse [72], which is the cosmic antipode of our visible tardion universe. Moreover, in this tardion antiuniverse there also exists anti-time and anti-space [73]-[82]. But if an inhabitant of the Earth got into the tardionic antiverse, he would not notice anything unusual, as antipodeans do not notice it on the Earth.

Such structure of the hidden Multiverse also allows, at last, to explain the problem that has been tormenting us for a long time - how to reconcile the experimentally proven principle of physical reality of imaginary numbers and the supposedly experimentally irrefutable principle of non-exceeding of the speed of light (because of which the wrong version of SRT, presented in all physics textbooks, is still in demand)? And it turns out that everything is explained very simply and clearly. The statement about existence in the nature only our visible universe follows from the refined principle of non-excess of speed of light And the refined principle of non-excess of speed of light of SRT follows from the statement about existence in the nature only our visible universe. But that's self-deception that proves nothing! In fact, the refined principle of the un-exceeded speed of light, irrefutable in the generally recognized version of SRT, is refuted by the existence of other mutually invisible tardion and tachyon universes and antiverse within the hidden Multiverse, since for all of them $v > c$.

And in order to learn something else about the hidden Multiverse, additional experimental knowledge is already needed.

5. Correction of relativistic formulas using experimental data obtained by WMAP and Planck spacecrafts

And as such additional experimental data we will use the data obtained by the WMAP and Planck spacecrafts, although they were launched into space with a different purpose - to study dark matter and dark energy.

The WMAP spacecraft [83] was launched by the National Aeronautics and Space Ad-ministration (NASA) in 2001, and it operated until 2010. And Planck spacecraft [84], launched by European Space Agency (ESA) in 2009, operated until 2013. And according to the data obtained by the WMAP spacecraft, the entire Universe (in fact, of course, the entire hidden Multiverse) consists of 4.6% baryonic matter, 22.4% dark matter and 73.0% dark energy. And according to more recent data obtained by the Planck spacecraft, the entire universe (again, in fact, the entire hidden Multiverse) is 4.9% baryonic matter, 26.8% dark matter and 68.3% dark energy. But what dark matter and dark energy are themselves, was not explained.

And since it was proved above in the most indisputable way that there is not a mono-universe but a hidden Multiverse in Nature, dark matter and dark energy should now be explained in the hidden Multiverse [85]-[89]. In this case it is quite logical to assume that these phenomena are somehow generated by the very structure of the hidden Multiverse and are caused by mutual influence of invisible parallel universes on each other. And then the main features of these phenomena - their invisibility and undetectability of their corpuscular contents - which have been unexplained so far, can be explained clearly and convincingly:

- dark matter and dark energy are in fact not any material physical entities, but only phenomena (pre-sumably gravitational shadow) generated by the existence, besides our visible tardion universe, by other invisible parallel universes and antiverse of the hidden Multiverse;

- dark matter is a phenomenon generated by the existence of invisible parallel universes of the hidden Multiverse neighboring our visible universe;

- dark energy is a phenomenon generated by the existence of other invisible parallel universes of the hidden Multiverse besides our visible universe and its neighboring invisible universes;

- and precisely because dark matter and dark energy are merely phenomena, they have no material content[5].

Therefore, attempts to detect some subatomic particles of dark matter and dark energy by the current research at the Large Hadron Collider are probably of little promise.

Such an explanation of these phenomena also allows us to clarify the structure of the hidden Multiverse. Indeed, assuming, in accordance with the law of communicating vessels, that the mass of different invisible parallel universes in the hidden Multiverse is almost identical with a high degree of accuracy due to the presence of a large number of portals between them that have existed for billions of years, it is possible to determine:

- how many parallel universes form the hidden Multiverse. And according to the above data obtained by the WMAP spacecraft, their number is 100% / 4.6% = 21.74. And according to the data obtained by the Planck spacecraft, their number is 100% / 4.9% = = 20.41. Therefore, their real number is presumably 20 ... 22 parallel universes.

- how many parallel universes are neighboring our universe and give rise to the phenomenon of dark matter. According to the data obtained by the WMAP spacecraft, their number is 22.4% / 4.6% = 4.87. And according to the data obtained by the Planck spacecraft, their number is 26.8% / 4.9% = 5.47. Therefore, their real number is most likely 5 ... 6 parallel universes.

- how many parallel universes generate the phenomenon of dark energy. And according to the data obtained by the WMAP spacecraft, their number is 73.0% / 4.6% = 15.87. And according to the data obtained by the Planck spacecraft, their number is 68.3% / 4.9% = =13.94. Therefore, their real number is presumably 14...16 parallel universes.

And as can be seen, the experimental data obtained by the WMAP and Planck spacecrafts did not confirm the above conclusions about the structure of the hidden Multiverse, since our visible universe in this structure has not two neighboring invisible parallel universes - one tachyon universe and one tachyon antiuniverse - but five or six.

Therefore, it is obvious that there was some error in the previous reasoning. And it turns out that we were wrong in assuming that in the hidden Multiverse[6] there is only one additional dimension q and, consequently, its correspondence to physically real complex numbers

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[5] Just as our shadow on a sunny day has no material content

[6] Just like in the only visible universe in the generally accepted version of STR

containing only one imaginary unit. And in order for six[7] other parallel universes to be neighbors with our visible universe in the really existing hidden Multiverse – three tachyon universes and three tachyon antiuniverses – it is necessary to have three additional dimensions q, r, s,

where $q(v) = \lfloor v_q/c \rfloor$ – is the "floor" function of discrete math from the argument v_q/c, which is the coordinate q of the fourth spatial dimension v;
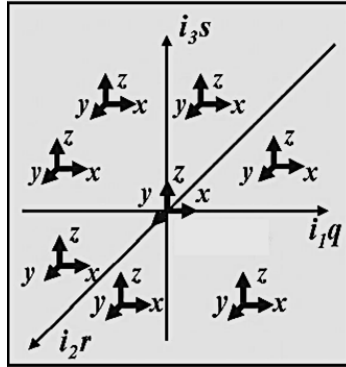
$r(v) = \lfloor v_r/c \rfloor$ – is the "floor" function of discrete math from the argument v_r/c, which is the r coordinate of the fourth spatial dimension;

$s(v) = \lfloor v_s/c \rfloor$ – is the "floor" function of discrete math from the argument v_s/c, which is the s coordinate of the fourth spatial dimension;

$\overline{v_q}, \overline{v_r}, \overline{v_s}$ – projections of the velocity vector $\overline{v}$ [8] on orthogonal coordinates q, r, s.

Consequently, the space of such a hidden Multiverse will be six-dimensional (see Fig. 5). And its structure will correspond to quaternions $\sigma + i_1\omega_1 + i_2\omega_2 + i_3\omega_3$, i.e. hypercomplex numbers [90], containing three imaginary units i_1, i_2, i_3, which are related to each other by the relations

$$i_1^2 = i_2^2 = i_3^2 = -1 \qquad (7)$$

$$i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1 \qquad (8)$$

$$i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1 \qquad (9)$$

Fig. 5. Six-dimensional space of the hidden Multiverse, where q, r, s are the coordinates of invisible parallel universes, and x, y, z are the coordinates of the matter content in each parallel universe

In such a quaternion structure of the hidden Multiverse [91], [92], unlike the structure considered earlier (in Fig. 4), the distribution of the material content in each three-dimensional parallel universe will be determined by some function $f_{q,r,s}(x, y, z)$, and the quantities $i_1 q$, $i_2 r$ and $i_3 s$ are the coordinates of these universes. That is, the hidden Multiverse will be described by the formula $f_{q,r,s}(x, y, z) + i_1 q + i_2 r + i_3 s$. This is exactly what Lisa Randall predicted: *"We live in a three-dimensional pocket of higher dimensional space".* And therefore, the relativistic formulas (7)-(9) should be corrected once again as follows

$$m(q,r,s) = \frac{m_0 i_1^q i_2^r i_3^s}{\sqrt{1 - [v/c - (q + r + s)]^2}} \qquad (10)$$

$$\Delta t(q,r,s) = \Delta t_0 i_1^q i_2^r i_3^s \sqrt{1 - [v/c - (q + r + s)]^2} \qquad (11)$$

$$l(q,r,s) = l_0 i_1^q i_2^r i_3^s \sqrt{1 - [v/c - (q + r + s)]^2} \qquad (12)$$

And from formulas (10)-(12) it follows that such a hidden Multiverse still has a helical structure. In this case, it is possible to move to the tardion antiuniverse from the tardion universe and to the tardion universe from the tardion antiuniverse in different ways, but not in an arbitrary way, but only in such a way (see Fig. 6) in which the quantity $i_1^q \, i_2^r \, i_3^s$ will successively take the values **+1**, $+i_1 \oplus +i_2 \oplus +i_3$, **-1**, $-i_1 \oplus -i_2 \oplus -i_3$, **+1**, **...** and so on, where $\oplus$ is the symbol of the

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[7] Or less. Then some parallel universes of our hidden Multiverse may be missing and replaced by universes of neighboring Multiverses.

[8] Which in the space $i_1 q$, $i_2 r$, $i_3 s$ it is obviously reasonable to orient it in such a way as to ensure equality of magnitude of its projections v_q, v_r, v_s.
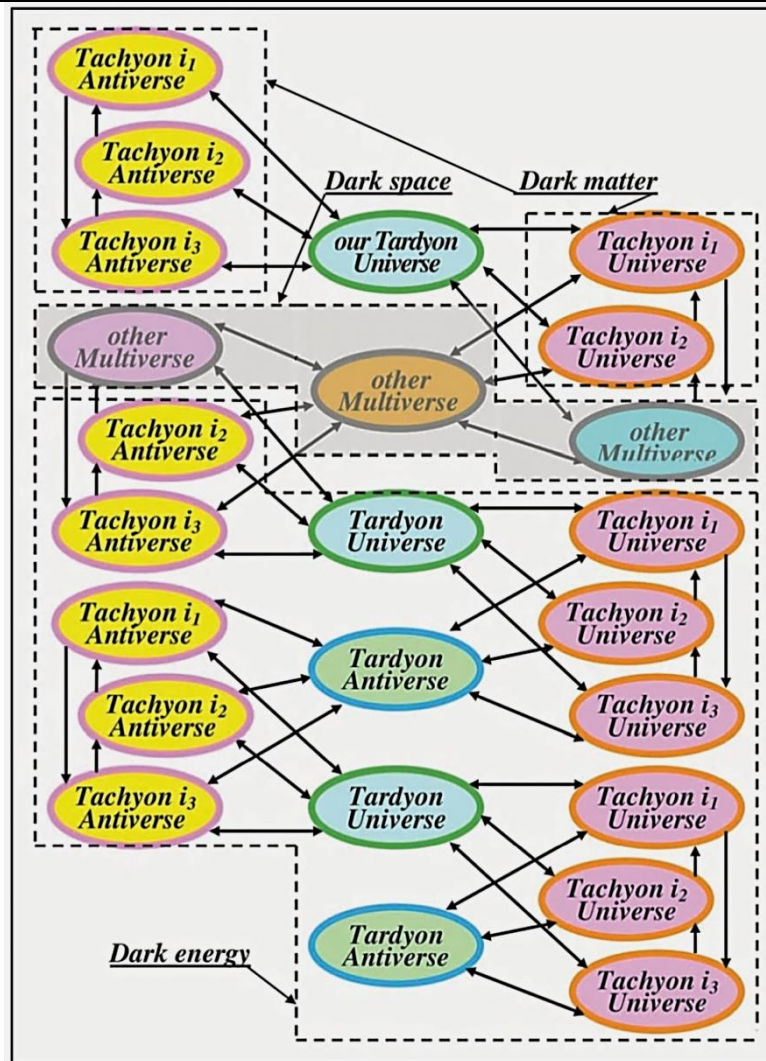
Fig. 6. Possible quaternion structure of the hidden Multiverse containing twenty-two parallel universes, including six invisible universes adjacent to our visible universe

logical operation of discrete mathematics 'exclusive OR'. In this case, different trajectories of movement from some universes (or antiuniverses) to others can differ only due to the replacement of some tachyon universes from i_1, i_2, i_3 with others and some tachyon antiuniverses from i_1, i_2, i_3 with others. Therefore, the tachyon universes i_1, i_2, i_3 in the hidden Multiverse are placed parallel to each other. The tachyon antiuniverses i_1, i_2, i_3 for the same reasons are also placed parallel to each other. And therefore, in the hidden Multiverse, when moving from any tardyon universe to a tardyon antiuniverse and then to another tardyon universe, parallel universes and antiuniverses must alternate in the following sequence – 'tardyon uni-

verse', 'one of the tachyon universes', 'tardyon antiuniverse', 'one of the tachyon antiuniverses', 'tardyon universe', 'one of the tachyon universes', etc.

One of the simplest to explain such quaternion structures of the hidden Multiverse is shown in Fig. 6. It differs from the structure shown in Fig. 4 in that it contains several different tachyon universes and antiuniverses arranged in parallel, corresponding to three imaginary units $\boldsymbol{i}_1, \boldsymbol{i}_2, \boldsymbol{i}_3$. Another difference is that such a structure of the Multiverse contains not only bidirectional portals corresponding to formula (7) and designated by double-sided arrows, but also unidirectional portals[9] corresponding to formulas (8), (9) and designated by single-sided arrows.

Moreover, naturally, movement from our tardyon universe to a tardyon antiuniverse through some tachyon universe – for example $\boldsymbol{i}_1$ – does not necessarily have to proceed through a tachyon antiuniverse $\boldsymbol{i}_1$. It

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[9] Why in such portals movement is possible only in one direction - from the entrance to the exit - is difficult for us, living in a space in which movement in nature is possible in any direction, to imagine. The processes that determine the possibility of such movement in nature are yet to be understood.

But for visitors who find themselves in such one-way portals, they are more dangerous than two-way portals, since it is impossible to return from them to your universe. Although in the metro with one-way movement on escalators we still encounter. But the metro is not nature.

can proceed through tachyon antiuniverses and. The same reservation applies to the situation if the movement from the tardion universe to the tardion antiuniverse begins through tachyon universes $\boldsymbol{i}_2$ or $\boldsymbol{i}_3$.

All these transitions are shown in Fig. 6. Moreover, since the data obtained by the WMAP and Planck spacecraft correspond to open helical structures of our hidden Multiverse, united through corresponding portals with other Multiverses, then all together they form the Hyperuniverse.

6. How can we be sure that there are other mutually invisible universes neighboring our visible universe?

Thus, we have finally fully proven and explained that the version of STR studied in all physics textbooks is incorrect and have proposed a corrected version of this theory. But for this corrected version to have every right to be called a theory, it must be fully confirmed experimentally. We have already proven the physical reality of imaginary numbers. Therefore, it remains to prove the real physical existence of other mutually invisible universes and anti-universes in addition to our visible universe.

And again, it turns out that this is possible and not even very difficult. It would seem that for this it is necessary to visit other universes. But this is not necessary. It is enough to at least look into them. As in order to be convinced that in addition to the room visible to us, in which we are now, there is a neighboring invisible room, it is enough to look into the neighboring room from the corridor connecting these rooms. The corridor connecting neighboring universes is the portals [93]-[95]. And the entrances to the portals are at least some of the so-called anomalous zones, of which there are many on Earth – more than one hundred thousand [96]-[99]. And in order to be sure, while in the portals, that you are no longer in our universe, but on the way to a neighboring universe, you need to look at the starry sky through a telescope and see other constellations in it [100]-[105]. This is a very reliable experiment, since you cannot draw constellations in the sky.

Fig. 7. Main Astronomical Observatory of the National Academy of Sciences of Ukraine

But people avoid visiting these anomalous zones, because people who get there usually do not return. And they are right to avoid them, because portals are labyrinths, and invisible ones at that. Therefore, getting out of them is really very difficult. But if you know this, then portals can still be used for scientific research, taking appropriate precautions. Well, at least in the form of Ariadne's thread, which helps to find the way back. And even better with the use of unmanned robotic vehicles, which are now very successfully used in military operations. It is also possible to create portal orientation tools (similar to a compass for sailors), using the phenomenon of weakening the level of terrestrial radio radiation when immersed in portals.

It is even possible to take advantage of the fact that since there are a great many anomalous zones, observatories are already located in some of them. For example, the Main Astronomical Observatory of the National Academy of Sciences of Ukraine, which is located in the Goloseevsky Forest just 12 km from the center of the capital of Ukraine, Kiev (Fig. 7). Of course, in the anomalous zone at the very entrance to the portal, the change in the configuration of the observed constellations is very small and is imperceptible to the human eye, but with the help of a computer, into which information from several observatories located close to each other in the anomalous zones and outside the anomalous zones will be entered, these changes can be detected (see Fig. 8). Otherwise, astronomers with a telescope will have to go deeper into the portal. After all, the English astrophysicist Sir Arthur Stanley Eddington [106] managed to confirm the deflection of light rays in the gravitational field of the Sun predicted by the general theory of relativity back in 1919 with his famous experiment, similar to the one we are proposing.

The proposal to conduct such a simple and low-cost experiment was published several years ago. And it is even strange that it has not been done yet, since in the case of a successful discovery of neighboring parallel universes, one could receive a Nobel Prize for their discovery, and in the case of their failure to discover them, one could very authoritatively prove the validity of the generally accepted version of STR studied in all physics textbooks. So in any case, a very valuable scientific result would have been obtained.
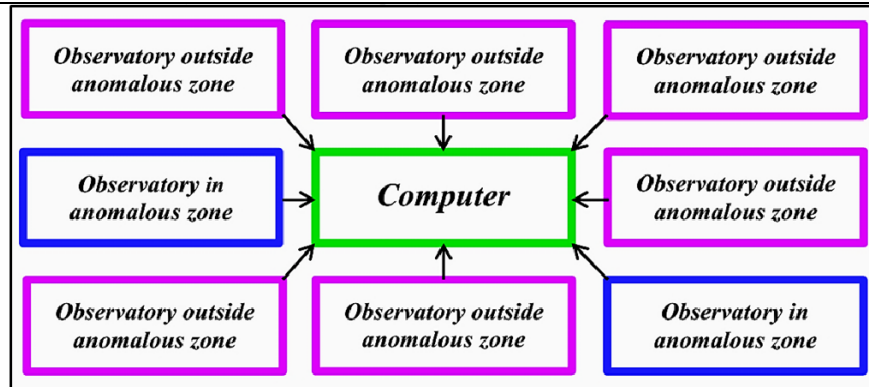
Fig. 8. Scheme of an astronomical experiment to detect invisible universes

But when such an experiment is done, then if the existence of neighboring invisible universes is proven, sooner or later there will be a desire to study them. And first of all, to find out how many there are. But it will be difficult to answer this question with the help of astronomical observations, since all the observatories are located in different places and their observations will therefore be difficult to compare. And in this situation it will therefore be useful to additionally use geophysical research of portals [107]-[116].

7. Conclusion.

Thus, the article has proven experimentally and explained theoretically that the version of STR presented in all physics textbooks is indeed incorrect, since:

• the relativistic formulas obtained in it are incorrect;

• the relativistic formulas obtained in it are incorrectly explained using the incorrect principle of not exceeding the speed of light;

• from these incorrect relativistic formulas, incorrect conclusions are made about the physical unreality of imaginary numbers and the existence in nature of our only visible universe, in which everything is measured only by real numbers.

But in the generally accepted version of STR, from the relativistic formulas obtained in it, it follows that speed is the fourth spatial dimension, in which, therefore, other parallel universes exist. And these parallel universes, in order to exist without plunging into each other, are mathematically described by alternating real and imaginary numbers, as a result of which they are all mutually invisible.

However, without understanding this, the creators of STR, without completing their derivation, left their relativistic formulas such that the incorrect mathematical description of the invisible universes adjacent to our visible universe made them physically unrealizable. And, unable to explain all this, they postulated the principle of not exceeding the speed of light, by which from the fourth spatial dimension realizing the principle of relativism they left only our visible universe, because only in this way could they explain anything. But in this article the author offers a description of an astronomical experiment in portals, by which the existence of mutually invisible parallel universes can be proven and thereby also the existence of the fourth spatial change in full.

Therefore, the article once again presents the corrected version of the STR proposed by the author [117]-[125], from which incorrect principle of not exceeding the speed of light is excluded and replaced by an experimentally proven general scientific principle of the physical reality of imaginary numbers discovered 500 years ago, which finally explains their physical meaning.

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ON THE GEOMETRY OF HAMILTONIAN SYSTEMS

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ABSTRACT
The paper studies the geometry of integrable Hamiltonian system. The basic concept of a Hamiltonian system of differential equations forms the basis of much of the more advanced work in classical mechanics, including motions of rigid bodies, celestial mechanics, quantization theory and so on. More recently, Hamiltonian methods have become increasingly important in the study of the equations of continuum mechanics, including fluids, plasmas and elastic media. It is shown that the level surfaces are three-dimensional surfaces with the positive or negative Gauss curvature at the point, where it is depend on which canonical form it has. All surfaces can be characterized by their Gaussian curvature, which describes the geometry of the surface: Euclidean, elliptic, or hyperbolic. Furthermore, curvature dictates how a vector may be transported across the surface or within the space.

Keywords: Poisson bracket, Hamiltonian function, completely integrable Hamiltonian system in the sense of Liouville, hyper space, 3-dimensional surfaces on 4-dimensional space, Gauss curvature.

1. INTRODUCTION AND PRELIMINARIES

Let M be a smooth manifold of dimension *m*.

Definition 1 [3-5]. A *Poisson bracket* on a smooth manifold M is an operation that assigns a smooth real-valued function $\{F, H\}$ on M to each pair F, H of smooth, real-valued functions, with the basic properties:

(a) *Bilineality*:

$$\{cF + c'P, H\} = c\{F, H\} + c'\{P, H\},$$
$$\{F, cH + c'P\} = c\{F, H\} + c'\{F, P\}. \quad c, c' \in \square$$

(b) *Skew-Symmetry*:

$$\{F, H\} = -\{H, F\}$$

(c) *Jacobi Identity*:

$$\{\{F, H\}, P\} + \{\{P, F\}, H\} + \{\{H, P\}, F\} = 0$$

(d) *Leibniz' Rule*:

$$\{F, H \cdot P\} = \{F, H\} \cdot P + H \cdot \{F, P\}$$

A manifold M with a Poisson bracket is called *Poisson manifold*, the bracket defining *Poisson structure* on M.

Example 1.[3-4]. Let M be the Euclidean space $\square^m$, $m = 2n + l$ with coordinates

$(p, q, z) = (p^1, ..., p^n, q^1, ..., q^n, z^1, ..., z^l)$. If $F(p, q, z)$ and $H(p, q, z)$ are smooth functions, we define their Poisson bracket to be the function:

$$\{F, H\} = \sum_{i=1}^{n} \{\frac{\partial H}{\partial p^i} \cdot \frac{\partial F}{\partial q^i} - \frac{\partial H}{\partial q^i} \cdot \frac{\partial F}{\partial p^i}\}$$

We note the particular bracket identities:

$$\{p^i, p^j\} = 0, \{q^i, q^j\} = 0, \{q^i, p^j\} = \delta_j^i.$$
$$\{p^i, z^k\} = \{q^i, z^k\} = \{z^t, z^k\} = 0.$$

in which i and j run from 1 to n, when t and k run from 1 to l. δ_j^i is the Kronecker symbol, which is 1 if $i = j$ and 0 otherwise.

Definition 2 [4-5]. Let M be a Poisson manifold and $H : M \to \square$ a smooth function. The *Hamiltonian vector field* associated with H is the unique smooth vector field *sgradH* on M satisfying

$$sgradH(F) = \{F, H\} = -\{H, F\} \tag{1}$$

for every smooth function $F : M \to \square$.

The equations governing the flow of *sgradH* are referred to as *Hamilton's equations* for the *Hamiltonian function H*.

In the case of the Poisson bracket on $\square^m$ $m = 2n + l$, the Hamiltonian vector field corresponding to $H(p, q, z)$ is clearly

$$sgradH = \sum_{i=1}^{n} \left(\frac{\partial H}{\partial p^i} \cdot \frac{\partial}{\partial q^i} - \frac{\partial H}{\partial q^i} \cdot \frac{\partial}{\partial p^i} \right)$$

The corresponding flow is obtained by integrating the system of ordinary differential equations

$$\frac{dq^i}{dt} = \frac{\partial H}{\partial p^i}, \frac{dp^i}{dt} = -\frac{\partial H}{\partial q^i}, i = 1, ..., n \quad \frac{dz^j}{dt} = 0, j = 1, ..., l$$

Which are *Hamiltonian systems* in this case. [1-3].

Proposition 1 [1,4,6]. Let M be a Poisson manifold and $F, H : M \to \square$ be smooth functions with corresponding Hamiltonian vector fields *sgradF, sgradH*. The Hamiltonian vector field associated with the Poisson bracket of F and H is, up to sign, the Lie bracket of the two Hamiltonian vector fields:

$$sgrad\{F, H\} = [sgradF, sgradH]$$

Let M^{2n} be a Poisson manifold and *sgradH* Hamiltonian vector field with a smooth Hamiltonian function H.

Definition 3 [2,4]. Hamiltonian system *sgradH* is called *completely integrable in the sense of Liouville*, if exists set of smooth functions $f_1, ..., f_n$ as:

1) $f_1, ..., f_n$ are first integrals of *sgradH* Hamiltonian vector field,

2) they are functionally independent on M, that is, almost everywhere on M their gradients are linearly independent,

3) $\{f_i, f_j\} = 0$ for any i and j,

4) the vector fields *sgradf$_i$* are complete, that is natural parameter on their integral trajectories is defined on the whole number line [1].

Denote by Q the Riemannian ambient manifold. Let $dimQ = N$. For its metric is g^Q. Denote by M the n-dimensional manifold $(n < N)$, the embedding $f : M \to Q$.

There are three vector bundles:

1) $TM = (P, X)$, $P \in M$, $X \in T_P M$,

2) Normal bundle: NM, (P, ξ), $P \in M$, $\xi \in N_P M$,

$$m = dimN_P M = N - n$$

3) Q-bundle: (P, ξ), $P \in M$, $\xi \in N_P Q$.

$$T_P Q = T_P M \oplus N_P M$$

Definition 4 [2]. An n-dimensional surface M in an $N-$dimensional Euclidean space is called a hyper surface if $N = n + 1$.

If $Q = \square^N$ and $\dim M = n$, $N = n + 1$, then $T_P M$ is a hyper surface.

Definition 5 [2]. *The normal section of the submanifold M at the point P,* corresponding to

existing pair $X \in T_P M$ and $\xi \in N_P M$ is the intersection of M with the 2-plane passing through X and ξ.

The normal section in a neighborhood of the point P is smooth regular curve on M.

Theorem 1 [2]. For any point $P \in M$ in the space $T_P M$ there is a basis $X_1, ..., X_n$ in which the matrix of the first quadratic form is identity and matrix of the second quadratic form is diagonal:

$$\begin{pmatrix} \lambda_1 & ... & 0 \\ \vdots & \ddots & \vdots \\ 0 & ... & \lambda_n \end{pmatrix} \tag{2}$$

Definition 6 [2]. The numbers λ_j are called the *principal curvatures* of the manifold M at the point P, and the lines passing through the vectors X_j are the *principal directions*.

The *Gaussian curvature* of the manifold M at the point P is:

$$K = \prod_{j=1}^{n} \lambda_j. \tag{3}$$

Let $Q = \square^4$ and $M \in \square^4$ and $dimM = 3$.

Definition 7. At each point p of a 3-dimensional differentiable surface on 4-dimensional Euclidean space one may choose a unit normal vector. A normal plane at p is one that contains the normal vector, and will therefore also contain a unique direction tangent to the surface and cut the surface in a plane curve, called normal section. This curve will in general have different curvatures for different normal planes at p. The principal curvatures at p, denoted k_1, k_2 and k_3, are the extreme values of this curvature and that the corresponding directions called principal directions X_1, X_2, X_3 at p which are orthogonal.

Definition 8. The Gauss curvature of the 3-dimensional differentiable surface on 4-dimensional Euclidean space at a point is defined at the product of the principal curvatures where denoted by $K = k_1 \cdot k_2 \cdot k_3$.

2. RESULTS AND DISCUSSION

Let given 3-dimensional differentiable surface with the parametric equation as:

$$\begin{cases} p_1 = f^1(u,v,w) \\ p_2 = f^2(u,v,w) \\ q_1 = f^3(u,v,w) \\ q_2 = f^4(u,v,w) \end{cases} \tag{4}$$

At each point of this surface has tangent plane whith the basic vectors and a normal vectors as:

$$r_1 = \{f_u^1, f_u^2, f_u^3, f_u^4\},$$
$$r_2 = \{f_v^1, f_v^2, f_v^3, f_v^4\},$$
$$r_3 = \{f_w^1, f_w^2, f_w^3, f_w^4\},$$
$$\xi = \{\xi_1, \xi_2, \xi_3, \xi_4\}.$$

And vectors

$$r_{11} = \{f_{uu}^1, f_{uu}^2, f_{uu}^3, f_{uu}^4\},$$
$$r_{12} = \{f_{uv}^1, f_{uv}^2, f_{uv}^3, f_{uv}^4\},$$
$$r_{13} = \{f_{uw}^1, f_{uw}^2, f_{uw}^3, f_{uw}^4\},$$
$$r_{22} = \{f_{vv}^1, f_{vv}^2, f_{vv}^3, f_{vv}^4\},$$
$$r_{23} = \{f_{vw}^1, f_{vw}^2, f_{vw}^3, f_{vw}^4\},$$
$$r_{33} = \{f_{ww}^1, f_{ww}^2, f_{ww}^3, f_{ww}^4\}.$$

where f_j^i is partial derivative of f with respect to u,v,w, and f_{jk}^i is the mixed derivative of the second order and $i = \overline{1,4}$.

These vectors are enough to write matrix of first quadratic form A and matrix of second quadratic form B.

$$A = \begin{pmatrix} \langle r_1, r_1 \rangle & \langle r_1, r_2 \rangle & \langle r_1, r_3 \rangle \\ \langle r_1, r_2 \rangle & \langle r_2, r_2 \rangle & \langle r_2, r_3 \rangle \\ \langle r_1, r_3 \rangle & \langle r_2, r_3 \rangle & \langle r_3, r_3 \rangle \end{pmatrix} = \begin{pmatrix} g_{11} & g_{12} & g_{13} \\ g_{12} & g_{22} & g_{23} \\ g_{13} & g_{23} & g_{33} \end{pmatrix}$$

$$B = \begin{pmatrix} \langle r_{11}, \xi \rangle & \langle r_{12}, \xi \rangle & \langle r_{13}, \xi \rangle \\ \langle r_{12}, \xi \rangle & \langle r_{22}, \xi \rangle & \langle r_{23}, \xi \rangle \\ \langle r_{13}, \xi \rangle & \langle r_{23}, \xi \rangle & \langle r_{33}, \xi \rangle \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{12} & b_{22} & b_{23} \\ b_{13} & b_{23} & b_{33} \end{pmatrix}$$

where bracket is inner product.

According to Theorem 1 we have following determinant:

$$\begin{vmatrix} b_{11} - kg_{11} & b_{12} - kg_{12} & b_{13} - kg_{13} \\ b_{12} - kg_{12} & b_{22} - kg_{22} & b_{23} - kg_{23} \\ b_{13} - kg_{13} & b_{23} - kg_{23} & b_{33} - kg_{33} \end{vmatrix} = 0 \tag{5}$$

By calculating the determinant of the matrix we obtain for us a third-order equation required function k, where we can find formula for Gauss curvature of 3-dimensional surface on 4-dimensional space:

$$K = \frac{b_{11}(b_{22}b_{33} - b_{23}^2) + b_{12}(b_{13}b_{23} - b_{12}b_{33}) + b_{13}(b_{12}b_{23} - b_{13}b_{22})}{g_{11}(g_{23}^2 - g_{22}g_{33}) + g_{12}(g_{12}g_{33} - g_{13}g_{23}) + g_{13}(g_{13}g_{22} - g_{12}g_{23})} \tag{6}$$

Let us consider the Hamiltonian functions $H : M^4 \to \square$ on the Poisson manifold M^4 which are given by the formulas

$$H(p_1, p_2, q_1, q_2) = (-1)^i p_1^2 + (-1)^j p_2^2 + (-1)^k q_1^2 + (-1)^l q_2^2. \qquad i,j,k,l = 1,2.$$

There generates 3-dimensional surfaces on 4-dimensional space in each value of Hamiltonian function with the equations as

$$(-1)^i p_1^2 + (-1)^j p_2^2 + (-1)^k q_1^2 + (-1)^l q_2^2 = c. \; i,j,k,l = 1,2.$$

Theorem 2. Let surface can be written in canonical form as

$$(-1)^i p_1^2 + (-1)^j p_2^2 + (-1)^k q_1^2 + (-1)^l q_2^2 = 1.$$

If the value of all or one of i,j,k,l is equal to 2, then 3-dimensional surface has the positive Gauss curvature. In other cases, if the value of two or three of i,j,k,l is equal to 2, then 3-dimensional surface is the surface with the negative Gauss curvature.

Proof. First case: If all values of i,j,k,l are equal to 2, then

$$p_1^2 + p_2^2 + q_1^2 + q_2^2 = 1$$

the surface is the standart 3-dimensional sphere, so it is obvious that it`s Gauss curvature is always positive.
Second case: If the one of values of i,j,k,l is equal to 2, then the equation of the surface can be as:

$$p_1^2 - p_2^2 - q_1^2 - q_2^2 = 1$$

Now we find A and B matrix for this surface.
Gauss curvature is not depend on choosing parameterization method, so we will parameterize it as:

$$\begin{cases} p_1 = chu \\ p_2 = shusinv \\ q_1 = shucosvcosw \\ q_2 = shucosvsinw \end{cases}$$

We have coefficients

$$g_{11} = ch2u, \quad g_{12} = 0, \qquad g_{13} = 0,$$
$$g_{22} = sh^2u, \quad g_{23} = 0, \quad g_{33} = sh^2ucos^2v,$$
$$b_{11} = -1, \qquad b_{12} = 0, \qquad b_{13} = 0,$$
$$b_{22} = -sh^2u, \quad b_{23} = 0, \quad b_{33} = -sh^2ucos^2v.$$

where vectors are

$$r_1 = \{shu, chusinv, chucosvcosw, chucosvsinw\},$$
$$r_2 = \{0, shucosv, -shusinvcosw, -shusinvsinw\},$$
$$r_3 = \{0, 0, -shucosvsinw, shucosvcosw\},$$
$$\xi = \{-chu, shusinv, shucosvcosw, shucosvsinw\},$$
$$r_{11} = \{chu, shusinv, shucosvcosw, shucosvsinw\},$$
$$r_{12} = \{0, chucosv, -chusinvcosw, -chusinvsinw\},$$
$$r_{13} = \{0, 0, -chucosvsinw, chucosvcosw\},$$
$$r_{22} = \{0, -shusinv, -shucosvcosw, -shucosvsinw\},$$
$$r_{23} = \{0, 0, shusinvsinw, -shusinvcosw\},$$
$$r_{33} = \{0, 0, -shucosvcosw, -shucosvsinw\}.$$

Now we ready to write the formula for the Gauss curvature

$$K = -\frac{b_{11}b_{22}b_{33}}{g_{11}g_{22}g_{33}} = \frac{shu^4cos^2v}{ch2ushu^4cos^2v} = \frac{1}{ch2u}$$

So, we proved that the surface has positive Gauss curvature.
If the surface is given with the equation as:

$$p_2^2 - p_1^2 - q_1^2 - q_2^2 = 1 \quad or$$
$$q_1^2 - p_1^2 - p_2^2 - q_2^2 = 1 \quad or$$
$$q_2^2 - p_1^2 - p_2^2 - q_1^2 = 1$$

We can choose a parameterization since the coefficients will be the same as the coefficients of the given surface.

Third case: If the two of values of i,j,k,l is equal to 2, then the equation of the surface can be as:

$$p_1^2 + p_2^2 - q_1^2 - q_2^2 = 1$$

Now we find A and B matrix for this surface.

Gauss curvature is not depend on choosing parameterization method, so we will parameterize it as:

$$\begin{cases} p_1 = chuchvcosw \\ p_2 = chuchvsinw \\ q_1 = chushv \\ q_2 = shu \end{cases}$$

where vectors are

$$r_1 = \{shuchvcosw, shuchvsinw, shushv, chu\},$$
$$r_2 = \{chushvcosw, chushvsinw, chuchv, 0\},$$
$$r_3 = \{chuchvsinw, chuchvsinw, 0, 0\},$$
$$\xi = \{-chuchvcosw, -chuchvsinw, chushv, shu\},$$
$$r_{11} = \{chuchvcosw, chuchvsinw, chushv, shu\},$$
$$r_{12} = \{shushvcosw, shushvsinw, shuchv, 0\},$$
$$r_{13} = \{-shuchvsinw, shuchvcosw, 0, 0\},$$
$$r_{22} = \{chuchvcosw, chuchvsinw, chushv, 0\},$$
$$r_{23} = \{-chushvsinw, chushvcosw, 0, 0\},$$
$$r_{33} = \{-chuchvcosw, -chuchvsinw, 0, 0\}.$$

We have coefficients

$$g_{11} = sh^2uch2v + ch^2u, \quad g_{12} = 2chuchvshushv, \quad g_{13} = 0,$$
$$g_{22} = ch^2uch2v, \quad\quad g_{23} = 0, \quad\quad g_{33} = ch^2uch^2v,$$
$$b_{11} = -1, \quad\quad b_{12} = 0, \quad\quad b_{13} = 0,$$
$$b_{22} = -ch^2u, \quad\quad b_{23} = 0, \quad\quad b_{33} = -ch^2uch^2v.$$

Now we ready to write the formula for the Gauss curvature

$$K = -\frac{b_{11}b_{22}b_{33}}{g_{33}(g_{12}^2 - g_{11}g_{22})} = \frac{1}{4ch^2vsh^2ush^2v - sh^2uch^22v - ch^2uch2v} = -\frac{1}{sh^2u + ch^2uch2v}$$

So, we proved that the surface has negative Gauss curvature.

If the surface is given with the equation as:

$$p_1^2 - p_2^2 - q_1^2 + q_2^2 = 1 \quad or \quad p_1^2 - p_2^2 + q_1^2 - q_2^2 = 1 \quad or$$
$$p_2^2 - p_1^2 - q_1^2 + q_2^2 = 1 \quad or \quad p_2^2 - p_1^2 + q_1^2 - q_2^2 = 1 \quad or$$
$$q_1^2 + q_2^2 - p_1^2 - p_2^2 = 1 \quad or \quad q_1^2 - q_2^2 - p_1^2 + p_2^2 = 1 \quad or$$
$$q_2^2 - p_1^2 - p_2^2 - q_1^2 = 1$$

We can choose a parameterization since the coefficients will be the same as the coefficients of the given surface.

In the last case: If the three of values of i,j,k,l is equal to 2, then the equation of the surface can be as:

$$p_1^2 + p_2^2 - q_1^2 + q_2^2 = 1$$

Now we find A and B matrix for this surface.

Gauss curvature is not depend on choosing parameterization method, so we will parameterize it as:

$$\begin{cases} p_1 = chucosvcosw \\ p_2 = chucosvsinw \\ q_1 = shu \\ q_2 = chusinv \end{cases}$$

where vectors are

$$r_1 = \{shucosvcosw, shucosvsinw, chu, shusinv\},$$

$$r_2 = \{-chusinvcosw, -chusinvsinw, 0, chucosv\},$$

$$r_3 = \{-chucosvsinw, chucosvcosw, 0, 0\},$$

$$\xi = \{chucosvcosw, chucosvsinw, -shu, chusinv\},$$

$$r_{11} = \{chucosvcosw, chucosvsinw, shu, chusinv\},$$

$$r_{12} = \{-shusinvcosw, -shusinvsinw, 0, shucosv\},$$

$$r_{13} = \{-shucosvsinw, shucosvcosw, 0, 0\},$$

$$r_{22} = \{-chucosvcosw, -chucosvsinw, 0, -chusinv\},$$

$$r_{23} = \{chusinvsinw, -chusinvcosw, 0, 0\},$$

$$r_{33} = \{-chucosvcosw, -chucosvsinw, 0, 0\}.$$

We have coefficients

$$g_{11} = ch2u, \quad g_{12} = 0, \quad g_{13} = 0,$$

$$g_{22} = ch^2u, \quad g_{23} = 0, \quad g_{33} = ch^2ucos^2v,$$

$$b_{11} = 1, \quad b_{12} = 0, \quad b_{13} = 0,$$

$$b_{22} = -ch^2u, \quad b_{23} = 0, \quad b_{33} = -ch^2ucos^2v.$$

Now we ready to write the formula for the Gauss curvature

$$K = -\frac{b_{11}b_{22}b_{33}}{g_{11}g_{22}g_{33}} = \frac{ch^4ucos^2v}{ch^4uch2ucos^2v} = -\frac{1}{ch2u}$$

So, we proved that the surface has negative Gauss curvature.

If the surface is given with the equation as:

$$p_2^2 - p_1^2 + q_1^2 + q_2^2 = 1 \quad or$$

$$p_1^2 - p_2^2 + q_1^2 + q_2^2 = 1 \quad or$$

$$p_1^2 + p_2^2 + q_1^2 - q_2^2 = 1$$

We can choose a parameterization since the coefficients will be the same as the coefficients of the given surface.

So, proof is finished, we have proved theorem 2.

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METHODOLOGY OF TEACHING SOLUTION OF GRAPHIC PROBLEMS

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ABSTRACT

The methodology of teaching graphic problems in physics focuses on the importance of graphing as a tool for visualizing and understanding physical phenomena. Graphs are used to depict the relationship between variables, such as time and position, velocity, or acceleration, providing insights into the behavior of physical systems. The primary goal is to teach students how to interpret, construct, and use graphs effectively to solve problems and analyze the relationship between physical quantities. A graph is a visual representation that shows the relationship between different variables, often using lines or curves. In physics, graphs help to represent functions, such as the relationship between displacement and time, or velocity and time. These relationships can describe various types of motion, including uniform motion (constant velocity) and accelerated motion (uniform or non-uniform acceleration).

Keywords: methodology, graphic, graph showing, physics problems.

There are different ideas about the concept of graphics. A graphic is a visually visible drawing with the help of lines and other graphic elements. A graph is a visual representation of the relationship between numbers and quantities in mathematics. In mathematics, the concept of graph and functional dependence is introduced, but the qualitative analysis of graphs is not considered.

It is necessary to train the students to show the relationship between the quantities characterizing the event. A graph showing the change of a quantity is an additional way to express the relationship between two dependent quantities in addition to a long description or formula given in words. When you skillfully use the graphical method, it becomes more visual, allows you to grasp the various stages of the studied phenomenon at a glance and quickly find one or another of its specific values on the graph of its functions.

Therefore, many problems of the course, including all laboratory work showing the dependence between two quantities, should end with graphing. Graphs are often used in solving problems in physics. By taking measurements on the graph, you can get an idea about the progress of the process. This visualization allows the physical regularities given in the problem condition to be better understood or the analytical calculation to be simplified. For example, a graph showing the change of the route depending on time; a graph showing the change in temperature of a solid body as a function of time when it is heated; a graph showing the pressure dependence of the volume of the same gas mass at a constant temperature; a graph showing the temperature dependence of the saturated vapor pressure; graphs showing the dependence of the current intensity on the resistance, the dependence of the deformation on the elastic force, etc.

In the training process, in addition to the graphs drawn by students individually, it is possible to prepare many graphs (energy distribution in the solar spectrum) in the form of wall charts. Students can also draw such graphs. These charts are hung on the classroom wall or on the blackboard during the lesson to help the teacher. Since it is necessary to widely use graphs during the quantitative experiments carried out in the classroom and when solving the problem, there should be a second board in the classroom with an area of not less than 1m2 and divided into square decimeters by a colored line, and the graphs should be drawn on this board (the functions of the smart board can also be used).

10-20% of physics problems are graphical problems. Therefore, it is necessary to teach students to "read" the graph. So what does that mean? The student should determine: the type of movement described in the graph, the initial and final values of the variable quantity, the meeting place, to perform calculations based on the data to find the physical quantity, etc.

Graphic representation can be used in the consolidation, development and application of knowledge. Graphical tasks and problems can be divided into several groups: graphical tasks, problem solving by graphical method and graphical representation of measurement results. Each of them is used for a specific purpose. It is impossible to say exactly where, in which part of the course, in the teaching of which events this or other group of tasks and issues will be used.

The physical content itself determines their place in the general physics course. In the lesson, depending on the goal, the teacher can choose an arbitrary type of problem. Graphical problems can be used in all classes. However, they do not diminish the role of algebraic problem solving in teaching physics.

Drawing graphs expands the methodological possibilities of teaching. With the help of graphs, it is possible to clearly visualize the functional dependence between physical quantities. It is possible to determine whether the quantities are directly or inversely proportional to each other, how quickly one quantity increases or decreases with the change of another quantity, and when that quantity takes its largest and smallest values. Qrafik bu və ya digər hadisənin necə getməsini təsvir etməyə imkan yaradır, hadisəni maddi tərəflərini görməyə imkan verir, şagirdlərin diqqətini öyrənilə hadisənin ən vacib yerlərinə yönəldir.

Reading graphs can be completed by writing a formula for a graph that describes a physical phenomenon.

In class VII, rectilinear constant velocity and rectilinear constant velocity movements are taught. Me-

chanical movement is graphically described. The dependence between physical quantities is expressed with the help of the function:

X(t) – change of coordinate over time,

S(t) – change of path over time,

ϑ(t) – speed change over time,

a(t) – change of momentum with time.

In rectilinear constant velocity motion of a material point, the path and coordinate is a linear function of time. The graphs of X(t) and S(t) make a certain angle with the time axis. Since the acceleration is zero, the graph of a(t) is a straight line on the time axis. The graph of ϑ(t) is a straight line parallel to the time axis – velocity is independent of time.

In rectilinear uniform motion, the graphs of x(t) and S(t) are parabola, quadratic dependence on time; if the arm of the parabola points up, the motion is uniform, if the arm of the parabola points down, the motion is uniform.Təcil zamana görə dəyişmir, a(t) – qrafiki zaman oxuna paralel düz xəttdir.

ϑ(t) is a straight line whose graph passes through the coordinate origin (or a certain initial value of the velocity). This line slopes up or down as the speed increases or decreases.
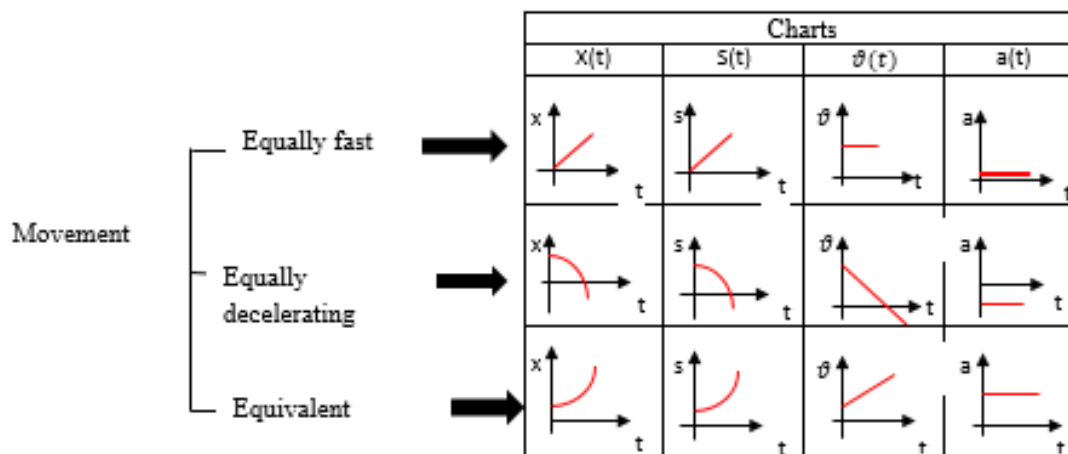
The following types of graphical problems can be shown:

a)
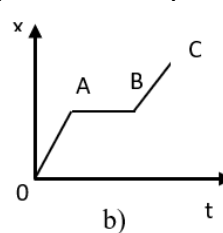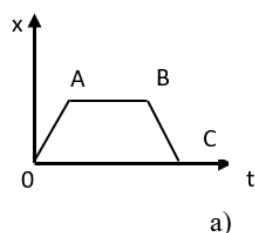
Problem 1. The graphs characterizing the movement of the pedestrian are given in the picture. Illustrate this motion using both graphs.

Answer: graph of change of coordinate is given in figure a). From here it can be seen that the pedestrian has returned to the place where he started his movement. Figure b) shows the road map. It is possible to

1. **Reading graphs,** gathering information about the physical phenomena shown by examining the graph dependence in the problem.

b)

determine the path of the pedestrian to point C along the ordinate axis. In the graph, segments OA and BC correspond to uniform motion. AB is a stop. In both cases, the speed of movement is the same. This is determined by the inclination of the lines OA and BC to the time axis.
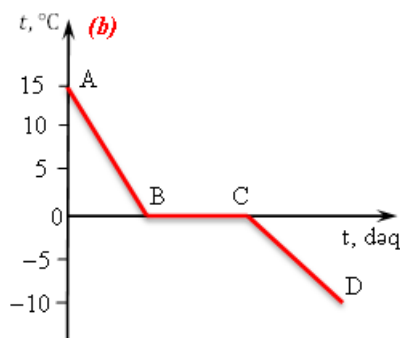

Problem 2. "Read" the solidification graph of the liquid. The temperature-time graph of the water placed in the refrigerator's freezer is given.

Discuss the result:

- What does AB, BC and CD represent in the graph?
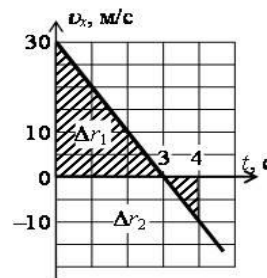
- Why doesn't the temperature change in BC?

2. Construction of graphs. The graphs are built with the help of the tabular values obtained as a result of the calculation.
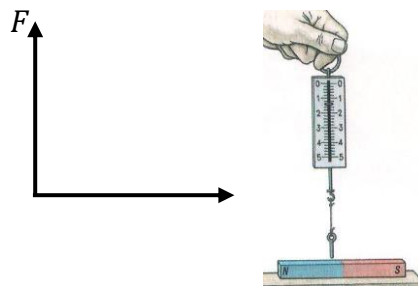
Problem 1. One end of the rope is attached to a nail, and the other end is attached to a dynamometer. The nail is caught on the left edge of the magnet. Then it is slowly moved along the magnet. At this time, how will the traction force of the dynamometer change.

Problem 1. Based on the given picture, find the displacement and the path traveled on the time-dependent graph of the projection of the velocity of the object. At t=3 seconds, the velocity of the object has changed its direction.

$s_1 = \frac{a_1 b_1}{2}$ - t=3 per second, $s_2 = \frac{a_2 b_2}{2}$ - t=1 the area of the triangle if equal to the second;

$$a_1 = \Delta t_1 = 3san \; ; \; b_1 = \vartheta_{1x} = 30 \frac{m}{san}$$
$$a_2 = \Delta t_2 = 1san \; ; \; b_2 = \vartheta_{2x} = \frac{10m}{san}$$

According to the movement of the object in the direction of the x axis, the displacement vector $\Delta r_1 > 0$, ($\vartheta_{1x} > 0$). the object moves against the x-axis, $\Delta r_2 < 0$, ($\Delta \vartheta_{2x} < 0$).

Then : $\Delta r_{1x} = s_1 = 45m \; ; \; \Delta r_{2x} = s_2 = -5m$

Displacement of the object $\Delta r_x = 40m$; distans traveled S=50m-dir.

1.2.Steps of solving graphic problems.

Graphical issues are mainly solved in the following stages:

- to determine the dependence between quantities;
- show quantities using a scale (abscissa, ordinate, area, area, etc.);
- construct a graph based on the values in the given table.

One of the problem solving methods is the algorithmic method. By solving many problems, students feel a rule in the solution system. Series of issues are resolved by this rule.

Algorithm for solving problems related to the determination of the type of movement of the object.

Make a graph of the dependence of that force on the coordinate of the nail in your notebook. Take the position of the left edge where the nail stands as the coordinate origin.

4. Problems expressed by a conditional graph.

1. Determine the physical quantity on the vertical and horizontal axes of the graph.

2. Determine the units of measurement of physical quantities, if necessary, express the units of measurement in basic units of measurement.

3. Recall the equations of x(t) or S(t) in constant-velocity and constant-velocity motion (rectilinearly accelerating, rectilinearly decelerating), how is this dependence (linear or parabolic), i.e.

- uniform motion: $x = x_0 + \vartheta t$ – straight line

- smooth motion: $x = x_0 + \vartheta_0 t + \frac{at^2}{2}$ – arm of parabola

$$S_x = x - x_0$$

In rectilinear uniform motion, the acceleration vector is equal to zero: a=0

In rectilinear uniform motion, the acceleration vector is a constant quantity: a=const Acceleration in rectilinear uniform motion:

$$a = \frac{\vartheta - \vartheta_0}{t - t_0}$$

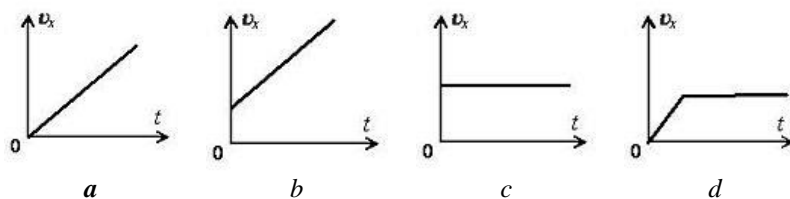Speed in rectilinear uniform motion:

$$\vartheta_x = \frac{S_x}{t}$$

Velocity in rectilinear uniform motion:

$$\vartheta = \vartheta_0 + a(t - t_0)$$

4. Determine the type of motion: uniform speed, uniform acceleration or uniform deceleration.

Problem. Which graph shown in the figure (figure 1) correctly describes the time dependence of the velocity projection during uniform motion of a material point ($\vartheta_{0x} \neq 0$)?

a   b   c   d

Velocity projection during uniform motion: $\vartheta_x = \vartheta_{0x} + a_x t$ is in the form of. The graph is a straight line, the ϑ_x axis starts from a certain point ($\vartheta_{0x} \neq 0$); the
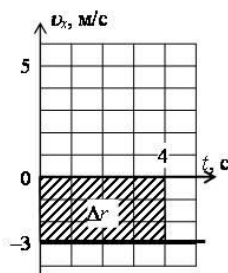
tangent of the angle formed by the graph with the t-axis gives the instant $a_x \neq 0$. The sought graph corresponds to b.

a   b
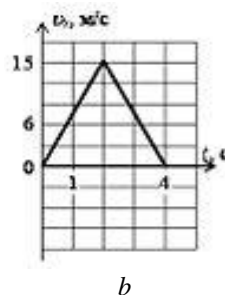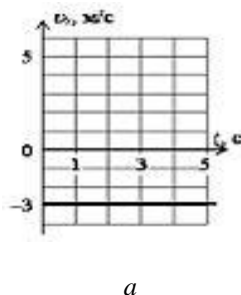
Problem 2. Define as a graph:
1. Displacement projection in the first 4 sec.

2. The path taken during that time

a) $\Delta t = t_2 - t_1 = 4sec$ (during the first 4 seconds) the projection of the displacement vector is calculated as the area of the figure formed by the abscissa

axis of the graph (dashed area). Projection of the displacement vector as the object moves in the opposite direction of the x-axis

b) $\Delta r_x < 0 = -S = -12m$
Since the path is $S > 0$, S = 12m.
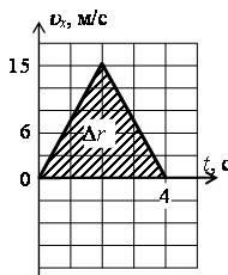
c) $s = \frac{ab}{2}$ the area of the triangle is calculated.
$a = \Delta t = 4sec.; b = \vartheta_x = 15\ m/sec$
Projection of the displacement vector $\Delta r_x > 0$ so that the object moves in the direction of the OX axis ($\vartheta_x > 0$). Then $\Delta r_x = 30m, S = 30m$.

Algorithm for solving graphical problems.
1. To write the short condition of the problem by expressing the quantities in the BS system of units.
2. Carefully look at the coordinate axes (ordinate, abscissa). To determine the graph, which function is given: a=a(t), $\vartheta = \vartheta(t)$, S=S(t), və ya x=x(t).

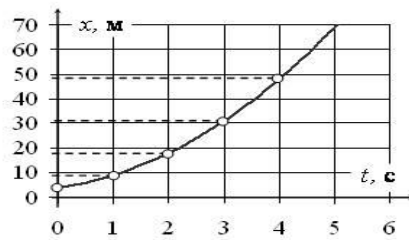3. Determine the type of movement according to the graph.
4. Write equations according to the conditions of the problem:
$a_x = a_x(t), \vartheta_x = \vartheta_x(t), S_x = S_x(t)$və ya $x = x(t)$
5. To calculate by writing the prices instead.

t, san	1	2	3	4	5
x, m	8	18	31	48	70

Problem. The equation of motion of a material point is given as follows: x=4+3t+2t^2. You need to fill in the following table:

According to the values in the table, the time dependence graph of the coordinate will be as follows:

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PSYCHOLOGICAL SCIENCES

АПРОБАЦИЯ ТЕХНИКИ ПСИХОТЕРАПИИ ТРАВМЫ С ПРИМЕНЕНИЕМ НЕЙРОГАРНИТУРЫ

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TESTING TRAUMA PSYCHOTERAPY TECHNIQUES WITH NEURO-HEADSET APPLICATION

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АННОТАЦИЯ

Проблематика посттравматических стрессовых расстройств и психоэмоциональных нарушений становится все более актуальной на фоне глобальных кризисов и роста случаев стресса. Психотерапия травмы предполагает интеграцию передовых методов, таких как ЭЭГ, для объективной оценки и коррекции эмоционального состояния клиентов. Данные, полученные с помощью электроэнцефалографических (ЭЭГ) технологий, позволяют измерять мозговую активность до, во время и после психотерапевтических техник, отслеживая изменения альфа- и бета-волн. ЭЭГ-гарнитуры предоставляют уникальную возможность мониторинга мозговой активности в реальном времени, что позволяет детально изучить эффекты психотерапии, затем при необходимости адаптировать и улучшить терапевтические инструменты для достижения устойчивых результатов. Исследование также позволит разработать новые техники, что даст практическое применение для психологов и психотерапевтов в терапии клиентов, которые пережили травматичные жизненные события, особенно в ранний период детства.

ABSTRACT

The issue of post-traumatic stress disorders and psycho-emotional disturbances is becoming increasingly relevant against the backdrop of global crises and rising stress cases. Trauma psychotherapy involves the integration of advanced methods, such as EEG, for objective assessment and correction of patients' emotional states. Data obtained using electroencephalographic (EEG) technologies allow measurement of brain activity before, during, and after psychotherapeutic techniques, tracking changes in alpha and beta waves. EEG headsets provide a unique opportunity for real-time brain activity monitoring, enabling a detailed study of psychotherapy effects and, if necessary, adaptation and enhancement of therapeutic tools to achieve sustainable results. The study also aims to develop new techniques with practical applications for psychologists and psychotherapists in treating clients who have experienced traumatic life events, especially in early childhood.

Ключевые слова: психотерапия травмы, посттравматическое стрессовое расстройство (ПТСР), нейротехнологии, ЭЭГ-гарнитура, мозговая активность, альфа-волны, бета-волны, психоэмоциональное состояние, мониторинг мозга, интеграция нейротехнологий, техника психотерапии, объективная оценка терапии, адаптация терапевтических методов, персонализированная психотерапия, психотерапия и нейронаука, эмоциональная регуляция, электроэнцефалография (ЭЭГ), стабилизация эмоционального состояния, снижение тревожности, методология.

Keywords: trauma psychotherapy, post-traumatic stress disorder (PTSD), neurotechnologies, EEG headset, brain activity, alpha waves, beta waves, psycho-emotional state, brain monitoring, neurotechnology integration, psychotherapy technique, objective therapy assessment, therapeutic method adaptation, personalized psychotherapy, psychotherapy and neuroscience, emotional regulation, electroencephalography (EEG), emotional state stabilization, anxiety reduction, methodology.

В условиях современных кризисов и возросшего уровня стресса посттравматические стрессовые расстройства (ПТСР), возникшие в результате детской травмы, а также различные психоэмоциональные нарушения, становятся одной из актуальных проблем в психотерапии. Традиционные методы лечения, хотя и обладают доказанной эффективностью и отражают субъективные результаты и оценку изменений психического состояния как самим терапевтом, так и клиентом, но нередко требуют объективных способов оценки и мониторинга эмоционального состояния до, в процессе и после терапии. Внедрение нейротехнологий, таких как

электроэнцефалография (ЭЭГ), открывает новые возможности для объективного отслеживания изменений в мозговой активности, что способствует повышению точности и эффективности психотерапевтического процесса.

Современные исследования подтверждают высокую значимость интеграции ЭЭГ-гарнитур и других нейротехнологий в психотерапию для более глубокого понимания влияния психотерапевтических методов на эмоциональное состояние и благополучие человека. Работы ученых, таких как Линдауэр и Лиао, демонстрируют изменения в мозговых структурах и активности волн, связанных с применением когнитивно-поведенческой терапии (КПТ) при ПТСР и депрессии. Это подтверждает, что использование ЭЭГ в реальном времени может не только контролировать терапевтические изменения, но и корректировать подходы, адаптируя их к индивидуальным особенностям клиента.

Несмотря на положительные результаты, достигнутые в применении нейротехнологий в психотерапии, остаются открытыми вопросы касательно разработки стандартизированных методов использования ЭЭГ для различных психоэмоциональных состояний. Кроме того, необходимо уточнить, какие конкретные изменения в альфа- и бета-волнах связаны с улучшением психоэмоционального состояния и какие методики наиболее эффективно стимулируют эти изменения.

Научная новизна и практическая значимость исследования.

Исследование предполагает оценку эффективности психотерапии травмы, направленной на снижение тревожности и стабилизацию эмоционального состояния. Использование ЭЭГ-гарнитуры в данном исследовании позволило отслеживать активность мозга, чтобы более точно определить, какие изменения происходят в нервной системе в ходе терапии. Эти данные помогают разработать рекомендации для интеграции нейротехнологий в психотерапию, что способствует созданию более персонализированных и точных подходов к лечению посттравматических состояний.

Методология и дизайн исследования.

Исследование проводилось на группе из двенадцати человек с психоэмоциональными травмами. Перед исследованием осуществлялся отбор участников исследуемой и контрольной группы, где участники проходили тест на определения травмы, количества травматичных событий и уровня травматизации. Каждому участнику было предложено пройти серию из шести психотерапевтических сеансов, в ходе которых использовались ЭЭГ-гарнитуры для регистрации электрической активности мозга в реальном времени. Перед началом и по завершении каждого сеанса участники заполняли анкету по оценке эмоционального состояния с целью получения данных об изменении психоэмоционального состояния.

Этапы проведения каждого сеанса:

1. **Замер 1 (до начала сеанса)** — определение исходного состояния мозга для фиксации уровня альфа- и бета-волн до начала сеанса.

2. **Замер 2 (во время сеанса)** — наблюдение за изменениями мозговой активности под влиянием психотерапевтической техники.

3. **Замер 3 (после сеанса)** — фиксация мозговой активности для оценки эффекта завершенного сеанса.

ЭЭГ-гарнитура регистрировала изменения в частотах альфа- и бета-волн, которые анализировались для выявления паттернов в изменениях эмоционального состояния участников.

Тип волны	Диапазон частот (Гц)	Основные характеристики
Тета	4-8	Легкий сон, медитация, интуиция
Альфа	8-13	Расслабление, спокойное бодрствование, медитация
Бета	13-30	Активное мышление, концентрация, тревога

Результаты

Результаты исследования являются предварительными и не окончательными, в связи с тем, что исследование продолжается и результаты количественной группы находятся в процессе обработки. Следовательно, ниже предоставленные данные базируются на анализе и интерпретации результатов только исследуемой группы.

1. Динамика изменений в мозговых волнах

Альфа- и бета-волны демонстрировали характерные изменения на каждом этапе исследования.

• **Альфа-волны:** Рост альфа-активности у участников наблюдался с первого до шестого сеанса, особенно с 3-го по 5-й сеансы. Перед началом терапии уровень альфа-активности составлял 45-55%, что указывает на умеренное спокойствие. Во время сеансов и после их завершения альфа-волны у большинства участников поднимались до 65-70%. Данный рост свидетельствует о расслабляющем эффекте терапии и достижении устойчивого состояния спокойствия и расслабления.

• **Бета-волны:** В начале исследования активность бета-волн указывала на значительную тревожность (20-30%), но по мере прохождения терапии показатели снижались до 10-15%, особенно выражено это было во время и после сеансов. Снижение активности бета-волн показывает уменьшение когнитивной нагрузки и тревожности, что является одним из терапевтических целей психотерапии травмы.

Активность мозговых ритмов - Сеанс 1

β 21 %
θ 25 %
α 54 %
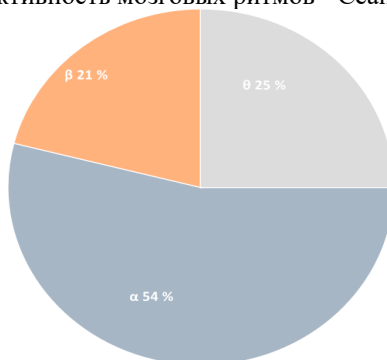
Активность мозговых ритмов - Сеанс 6

β 17 %
θ 11 %
α 72 %
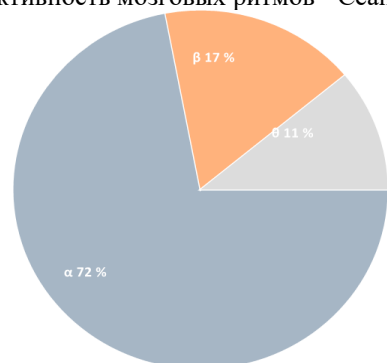
2. Анализ данных анкеты «Оценка текущего эмоционального состояния»

Эмоциональное состояние участников также демонстрировало положительную динамику по ключевым параметрам анкеты:

- **Общее настроение:** Показатели настроения улучшались с первого до третьего сеанса и достигали максимума к пятому сеансу. Это совпадает с ростом альфа-активности и снижением бета-активности, что свидетельствует о том, что психотерапия оказывала положительное воздействие на субъективное восприятие эмоционального состояния.

- **Уровень энергии:** Отмечено постепенное улучшение уровня энергии, особенно к четвертому сеансу, что свидетельствует о снижении усталости и эмоционального истощения у участников. Это могло быть связано с ростом уверенности в процессе терапии и накопительным эффектом техники.

- **Уровень тревожности:** Тревожность снизилась в среднем на 25% с первого до шестого сеанса. Этот показатель коррелирует с уменьшением бета-активности, что подтверждает эффективность методики в стабилизации психоэмоционального состояния.

Обратная связь

После завершения всех сеансов некоторые участники дали обратную связь в целом о своем опыте участия в данном исследовании. Информация предоставлялась ими в свободной форме.

Краткое резюме: Обратная связь от участников исследования показывает, что терапевтические сеансы оказали глубокое положительное влияние на их эмоциональное состояние и способность к саморегуляции. Перед началом сеансов многие участники ощущали повышенную тревожность и напря-

жение в теле, как привычное им исходное состояние стресса в рабочем/учебном режиме дня. Уже с первых сеансов участники отмечали появление чувства безопасности и возможность расслабиться. Слова и фразы, использованные в терапевтическом материале, способствовали напоминанию о важности принятия эмоций, таких как гнев или грусть, и восприятия их как естественных и нормальных. Восприятие мира в его позитивных аспектах также укрепилось, что поддерживало улучшение состояния и способствовало появлению новых перспективных подходов к ежедневным стрессовым ситуациям. Многие отмечали, что к завершению курса у них появились навыки «остановки» и саморефлексии в моменты тревоги. Напоминания о праве испытывать свои эмоции привели к укреплению самооценки и улучшению взаимоотношений с окружающими. В результате участники лучше стали понимать себя и свои эмоции, что способствовало развитию положительных изменений и формированию устойчивого чувства внутреннего покоя. Рекомендацией для улучшения процесса стало предложение добавить консультирование и обсуждение впечатлений после сеансов, чтобы участники могли глубже осмыслить терапевтический опыт.

Обсуждение результатов

Анализ полученных данных показал, что психотерапевтические сеансы, поддерживаемые ЭЭГ-мониторингом, оказывали положительное влияние на участников. Увеличение альфа-активности и снижение бета-активности демонстрируют, что психотерапия способствовала достижению состояния глубокого расслабления и снижению тревожности, т.е. активации парасимпатической системы. Кроме того, результаты анкеты оценки текущего эмоционального состояния указывают на значи-

тельные улучшения в эмоциональном самочувствии участников, что подтверждается снижением уровня тревожности и повышением уверенности и энергии.

Практическая значимость.

Внедрение ЭЭГ-гарнитур в психотерапевтическую практику открывает возможности для более точной и объективной оценки эффективности терапевтических методов. Результаты подтверждают, что нейротехнологии позволяют корректировать и адаптировать терапевтические техники, что в свою очередь улучшает восприятие клиентами терапии и повышает её результативность. ЭЭГ-данные дают представление о процессах, происходящих в мозге в ходе терапии, что позволяет создавать более персонализированные подходы к лечению и улучшает возможности оценки эффективности интервенций. Также этот метод может использоваться как научное доказательство эффективности терапии, что позволяет наглядно объяснить и показать клиентам влияние терапии на мозговую активность с помощью конкретных научных подходов и технологий.

Рекомендации

На основе результатов исследования можно выделить некоторые рекомендации для улучшения опыта практикующих психологов и психотерапевтов:

• **Интеграция ЭЭГ-мониторинга**: Использование ЭЭГ-гарнитур во время психотерапевтических сеансов помогает объективно отслеживать изменения психоэмоционального состояния и позволяет модулировать программу терапии для более эффективного воздействия. Отслеживание активности мозга в реальном времени позволяет зафиксировать реакции на определенные события и затем вернуться к ним для подробного обсуждения и исследования состояния, а также отношения к этому событию. Включение нейротехнологий в терапию полезно как для повышения эффективности, так и для формирования обратной связи с клиентом.

• **Адаптация терапевтических техник**: Данные исследования показывают, что эффект терапии проявляется через несколько сеансов. Рекомендуется, начиная с шестого сеанса, вводить более интенсивные терапевтические практики для точечной и глубокой проработки травматических состояний, поскольку к этому моменту достигается максимальная стабильность альфа-активности, что указывает на улучшение состояния.

• **Оценка прогресса**: ЭЭГ-гарнитура позволяет фиксировать прогресс участников на каждом этапе лечения. Рекомендуется использовать полученные данные для визуальной обратной связи для клиентов, что позволяет улучшить их вовлеченность в терапевтический процесс и увеличить осведомленность о собственном прогрессе.

• **Создание персонализированной психотерапии**: Использование нейротехнологий предоставляет возможность настраивать терапию под конкретного клиента, на основе индивидуальных реакций мозга. Это может повысить эффективность терапии за счет адаптации интервенций под уникальные особенности когнитивных и эмоциональных процессов, а также созданию персональных техник для самопомощи вне терапевтических часов.

• **Посттерапевтическое сопровождение**: Рекомендуется внедрить посттерапевтические сессии с ЭЭГ-мониторингом, чтобы контролировать долгосрочные изменения в мозговой активности, особенно при лечении клиентов с хроническими стрессовыми и тревожными состояниями. Это поможет поддерживать достигнутые результаты и отслеживать потребность в дополнительных интервенциях.

Заключение

Настоящее исследование продемонстрировало значительное влияние психотерапевтической техники на психоэмоциональное состояние участников, подтвержденное объективными ЭЭГ-данными. Увеличение альфа-активности и снижение бета-активности на протяжении шести сеансов указывают на стабилизацию эмоционального состояния и снижение тревожности. Применение ЭЭГ-гарнитуры позволяет точно измерять изменения в состоянии участников, что открывает возможности для разработки более персонализированных подходов в психотерапии. Дальнейшие исследования, включающие большие группы участников и разнообразные терапевтические методы, позволят углубить полученные данные и создать стандарты интеграции нейротехнологий в психотерапию травмы.

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TECHNICAL SCIENCES

РОЗРАХУНОК ПЕРЕКРИТТЯ ПІДЗЕМНОЇ СПОРУДИ ЗА ДІЇ ВИБУХОВОЇ ХВИЛІ

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CALCULATION OF THE FLOOR OF AN UNDERGROUND BUILDING FOR THE EFFECT OF A BLAST WAVE

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АНОТАЦІЯ

Запропоновано методику розрахунку перекриття, на верхній грані якого розташований шар ґрунту. Цей шар моделюється за допомогою пружин із певною жорсткістю і він зменшує коефіцієнт динамічності. Виведено диференціальне рівняння для вирішення наведеної системи. Наведено таблицю, де показано, що коефіцієнт динамічності залежить від кількох факторів: відношення жорсткостей верхнього шару та балки; періоду коливань балки; часу дії тиску вибухової хвилі.

ABSTRACT

A calculation method for a floor covering with a soil layer is proposed. This layer is modeled using springs with a certain rigidity. The soil layer reduces the dynamic coefficient. A differential equation is derived for solving such a system. A table is given showing that the dynamic coefficient depends on several factors: the ratio of the rigidities of the upper layer and the beam; the period of beam oscillations; the time of action of the blast wave pressure.

Ключові слова: коефіцієнт динамічності, період коливань, рівняння Лагранжа, вибухова хвиля, кінетична енергія, потенціальна енергія.

Keywords: coefficient of dynamism, oscillation period, Lagrange equation, explosive wave, kinetic energy, potential energy.

Аналіз досліджень і постановка задачі.

Для зниження динамічних зусиль від надмірного тиску вибухової хвилі слід застосовувати різні пристрої, що збільшують деформацію конструкції. Відомо, що чим менша жорсткість конструкції, тим більше її деформації і менше динамічні зусилля [2, 3, 4, 9, 12]. В роботі авторів [1] запропоновано застосовувати пружно піддатливі опори для балок. При цьому показано, що застосування пружин суттєво зменшує коефіцієнт динамічності. В [1] для зменшення динамічних зусиль запропоновано використовувати гнучкі нитки замість балок також для зменшення динамічних зусиль, але для їх використання слід розробляти окремі проекти, а також пристрої для кріплення настилу перекриття до гнучких ниток.

Відомо, що в залежності від часу дії динамічного навантаження залежить максимальне значення коефіцієнту динамічності. Це може бути перша фаза, коли тиск від вибухової хвилі ще діє [4] або друга фаза, коли вибухова хвиля вже не діє, але конструкція ще піддана динамічним коливанням. В

[4] показано, що при малому часі τ дії вибухової хвилі, коли він менше 1/3 від періоду коливань **T**, максимальне значення коефіцієнту динамічності приходиться на другу фазу. Саме в зв'язку з цим фактом в стандарті [7] прийнято, що при відношенні $\tau/\mathbf{T}<3$ конструкцію слід розраховувати за методикою імпульсу. В [11] показано, що розрахунок за методикою миттєвого імпульсу іде в запас міцності, бо при цьому коефіцієнт динамічності є максимальним. Відомо також, що найбільш безпечними є підземні захисні споруди. При цьому маса ґрунту, що знаходиться на перекритті, зменшує коефіцієнт динамічності за рахунок збільшення маси перекриття [1, 2]. Але ґрунт окрім того, що збільшує масу перекриття, ще є і своєрідним демпфером. Але його в такій якості не використовують, хоча попередні розрахунки показують, що він може грати немалу роль в зменшенні динамічного тиску.

З огляду на вищесказане метою статті є розроблення методики розрахунку згинальних підземних конструкцій з врахуванням демпфуючої властивості ґрунту, що розташований на перекритті, а також

дослідження величини коефіцієнта динамічності в залежності від фази динамічного розрахунку.

Викладення основного матеріалу.

Для пояснення суті пропонованої методики розглянемо однопрольотну шарнірно обперту балку, на верхньої грані якої укладено шар ґрунту товщиною h. На поверхню ґрунту діє рівномірно розподілене по довжині навантаження $q(t)$, яке змінюється в часі за певним законом, наприклад за лінійним законом зміни навантаження в часі:

$$q(t) = P_{s0}b\left(1 - \frac{t}{\tau}\right) \quad (1)$$

де P_{s0} – задане значення надмірного тиску, яке нормується в залежності від кількості вибухової речовини, її виду та відстані від епіцентру до споруди, що розглядається [6, 7]; b – ширина полоси навантаження; τ - час дії позитивної фази вибуху. Схема балки наведена на рис. 1.
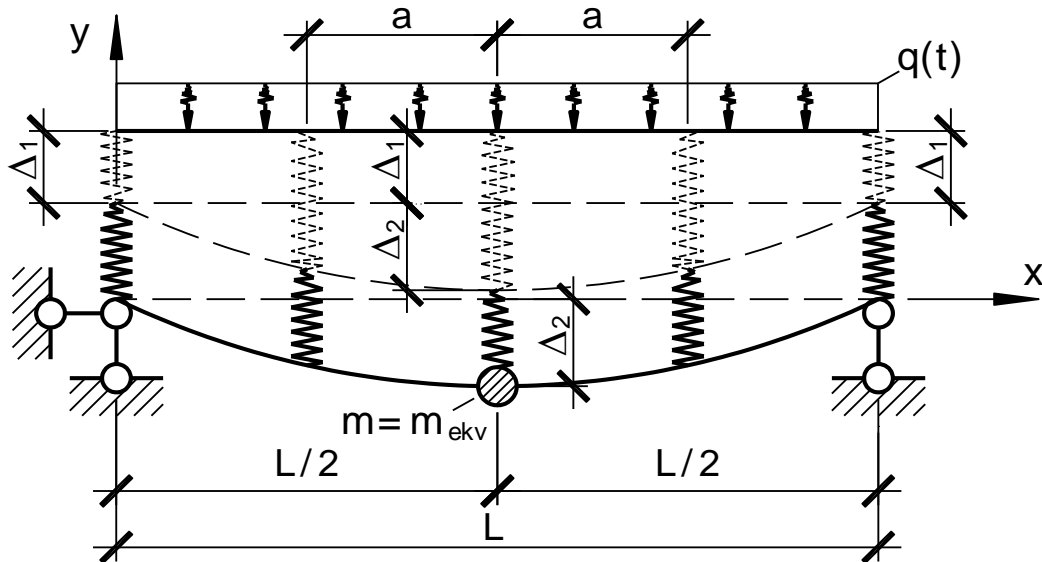

Рис. 1. Схема балки з ґрунтом, який моделюється пружинами

На рис. 1 ґрунт моделюється пружинами, які не пов'язані одна з одною. Таке моделювання схоже з моделлю Вінклера, коли розглядаються конструкції на пружній основі [10, 11]. Нехай загальна кількість пружин дорівнює n і вони розташовані на однаковій відстані a (див. рис. 1). Жорсткість кожної пружини залежить від модуля пружності ґрунту, його товщини h і площі поперечного перерізу S, яка дорівнює ширині b, помноженій на відстань a між пружинами.

Вся маса балки M_b зосереджена в її центрі і дорівнює еквівалентній масі, яка в такому випадку до-

рівнює $m_{ekv}=0.493{\cdot}M_b$. Це відомий прийом будівельної механіки, коли розподілена маса приводиться до еквівалентної з умов рівності кінетичної енергії системи з розподіленою масою і кінетичній енергії системи з однією масою m_{ekv} [11].

Враховуючи симетрію навантаження і симетрію розподілення пружин по довжині балки, можна вважати, що переміщення всіх пружин без врахування прогину балки будуть однаковими (див. рис. 1). Тому схему за рис. 1 можна замінити еквівалентною більш спрощеною схемою, яка показана на рис. 2.
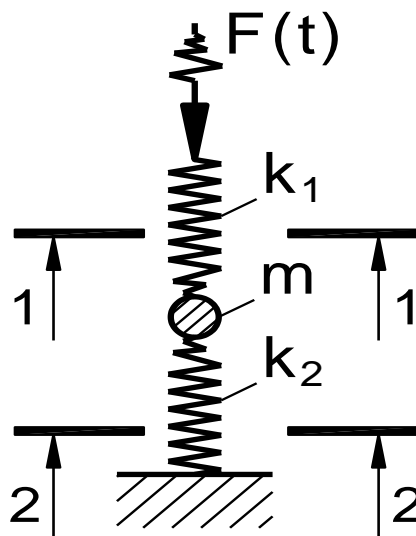

Рис. 2. Спрощена еквівалентна схема

На рис. 2 через k_1 позначена сумарна жорсткість всіх пружин, що моделюють роботу ґрунту; k_2 – жорсткість балки. Вирази для k_1 та k_2 мають вигляд:

$$k_1 = n \cdot k_{od}; \; k_2 = \frac{384 \cdot EI}{5 \cdot L^4} \qquad (2)$$

де k_{od} – жорсткість однієї пружини, n – кількість пружин

Позначимо через Δ_1 переміщення верхньої узагальненої пружини (переміщення ґрунту), а через Δ_2 – переміщення нижньої пружини (переміщення маси m від згину). Ці переміщення позначені на рис. 1.

Схеми за рис. 1 та 2 є схемами з одним невідомим – переміщенням Δ_2 маси m. Однак жорсткість пружин впливає на переміщення маси. Тому слід вивести залежність між переміщеннями Δ_1 та Δ_2. Для цього розглянемо рівновагу сил в різних перерізах системи. В будь яке значення часу t в системі дотримується рівновага всіх активних сил і сил інерції. Тому в перерізі 1-1 на рис. 2 будемо мати рівняння:

$$F = k_1 \Delta_1 \qquad (3)$$

В виразі (3) для короткості замість $F(t)$ позначено F

В перерізі 2-2 рівновага сил дає вираз:

$$F = k_2 \Delta_2 + m \cdot \ddot{\Delta}_2 \qquad (4)$$

де дві точки над переміщенням Δ_2 позначають другу похідну переміщення в часі t, тобто прискорення маси. Другий член виразу (4) – це сила інерції від прискорення маси m.

Підставивши значення F з виразу (3) в вираз (4), будемо мати:

$$\Delta_1 = \frac{k_2}{k_1} \Delta_2 + \frac{m}{k_1} \cdot \ddot{\Delta}_2 \qquad (5)$$

Таким чином ми пов'язали переміщення Δ_1 з переміщенням Δ_2 маси m і її прискоренням і звели задачу до задачі визначення коливань системи з однією масою. Така система буде мати одну узагальнену координату. Приймемо за єдину узагальнену координату Δ_2 – переміщення маси m.

Кінетична енергія системи:

$$T = \frac{m}{2} \dot{\Delta}_2^2 \qquad (6)$$

Потенціальна енергія системи:

$$U = \frac{k_1}{2} \Delta_1^2 + \frac{k_2}{2} \Delta_2^2 \qquad (7)$$

З врахуванням виразу для Δ_1 за (5) після простих перетворень будемо мати вираз для потенціальної енергії:

$$U = A \cdot \Delta_2^2 + B \cdot \Delta_2 \cdot \ddot{\Delta}_2 + C \qquad (8)$$

Де прийняті позначення:

$$A = \frac{k_2^2}{2 \cdot k_1} + \frac{k_2}{2}; \; B = k_2 \frac{m}{k_1}; \; C = \frac{m^2}{2 \cdot k_1} \quad (9)$$

В подальшому для короткості позначимо $y = \Delta_2$. Тоді рівняння Лагранжа другого роду для цієї системи буде виглядати:

$$\frac{d}{dt} \left(\frac{\partial L_k}{\partial \dot{y}} \right) - \frac{\partial L_k}{\partial y} = Q \qquad (10)$$

де L_k – кінетичний потенціал, який визначається з виразу $L_k = T - U$; Q – узагальнена сила для системи. Вираз для кінетичного потенціалу (враховуючи вирази 6 та 8):

$$L_k = \frac{m}{2} \dot{y}^2 - A \cdot y^2 - B \cdot y \cdot \ddot{y} - C \quad (11)$$

Для визначення узагальненої сили Q слід задати віртуальне переміщення δ_c маси m в напрямку переміщення від згину балки [12], визначити роботу всіх активних сил (в даному випадку це сили $F(t) = q(t) \cdot a$) на переміщенні δ_i. Коефіцієнт при значенні елементарної роботи δA від цих сил і буде узагальненою силою Q. Схема таких переміщень показана на рис. 3.
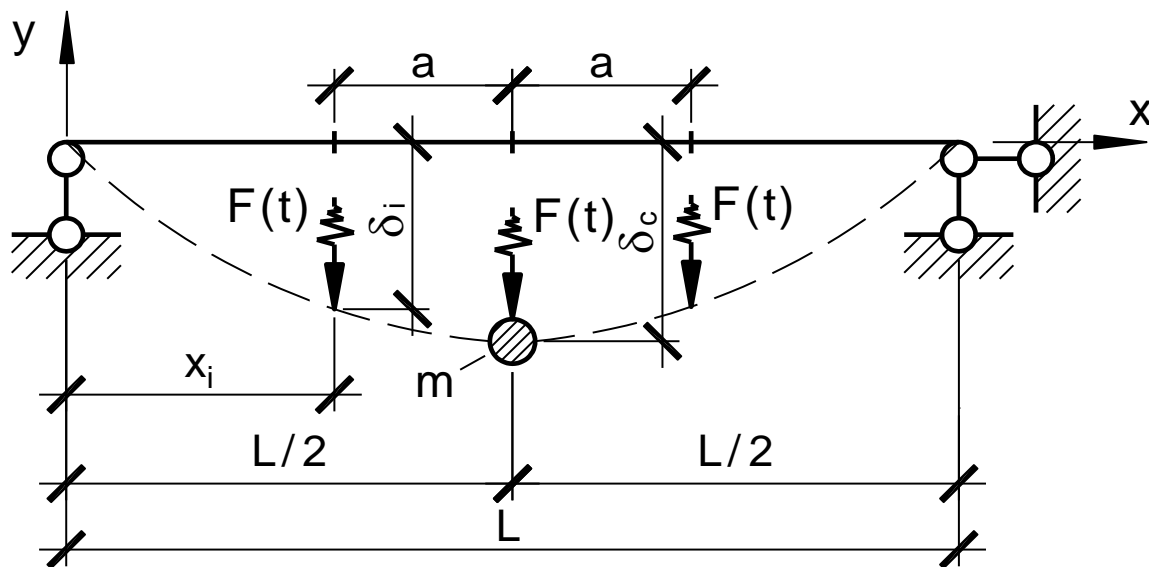

Рис. 3. До визначення узагальненої сили Q

Відмітимо, що переміщення δ_i визначаються лише від переміщень від згину балки. Тому стиск верхніх пружин не враховується. Залежність переміщень δ_i від переміщення δ_c можна визначити з виразу:

$$\delta_i = \alpha_i \delta_c \qquad (12)$$

α_i – це коефіцієнт залежності переміщення на відстані x_i від лівої опори від переміщення в центрі балки, на яку діє зосереджена сила в середині прольоту [10]. Для значень $x_i \le L/2$ він визначається з виразу [10]:

$$\alpha_i = 3 \frac{x_i}{L} - 4 \frac{x_i^3}{L^3} \qquad (13)$$

Для значень відстані $x_i > L/2$ вираз для α_i – визначається дзеркально.

Враховуючи вище сказане, а також факт, що сили **F(t)=q(t)·a** однакові, вираз для елементарної роботи **δA** буде мати вигляд (для **n** – не парного):

$$\delta A = F(t)\left[2\sum_{i=1}^{(n-1)/2}\alpha_i + 1\right]\delta_c \quad (14)$$

Звідси вираз для узагальненої сили **Q**:

$$Q = F(t)\left[2\sum_{i=1}^{(n-1)/2}\alpha_i + 1\right],\text{або:}\ Q = F(t)\cdot H \quad (15)$$

Підставляючи вираз для **Q** з (15) в рівняння Лагранжа (10) з врахуванням виразу для кінетичного потенціалу (11), проводячи диференціювання спочатку $\partial L_k/\partial y^I$ **та** $\partial L_k/\partial y$**,** а потім по часу **t**, після простих спрощень отримаємо диференціальне рівняння руху:

$$\ddot{y} + \omega^2 y = P\cdot f(t) \quad (16)$$

де **f(t)** будь яка функція зміни навантаження в часі. В (16) прийняті позначення:

$$D = m + B;\ G = 2A;\ P = P_{s0}\frac{b}{D}H\frac{L}{n};\ \omega^2 = G/D \quad (17)$$

Величина **P_{s0}·b·L/n** представляє собою зосереджену силу **F(t)=q(t)·a** за рис. 1. Вирази для **A, B** – за (9), вираз для **H** – за (15).

Рішення диференціального рівняння (16) не представляє складнощів з будь якою правою частиною, будь то лінійний розподіл тиску вибухової хвилі, будь то нелінійний розподіл, наприклад, за Фрідлендером [5].

Для випадку, коли навантаження змінюється в часі за лінійним законом (1) рішення диференціального рівняння (16) має вигляд:

$$y(t) = -\frac{P}{\omega^2}Cos(\omega\cdot t) + \frac{P}{\tau\cdot\omega^3}Sin(\omega\cdot t) + \frac{P}{\omega^2} - \frac{P}{\tau\cdot\omega^2}t \quad (18)$$

Відомо [4, 7], що при малому значенні часу **τ** дії вибухової хвилі (при **τ/T<1/3**, де **T** – період коливань балки) максимальне значення коефіцієнта динамічності приходиться на другу фазу деформування, коли змінна в часі сила вже не прикладена. В цьому випадку слід визначити швидкість переміщення маси **v(t)=dy/dt** при часі **t=τ**, а також переміщення **y(t)=y(τ)** і підставити ці значення в рішення рівняння (16) без правої частини як початкові умови з введенням нової перемінної часу **t_1=t-τ**. В результаті отримуємо залежність переміщень маси в другій фазі коливань:

$$y_2(t) = \frac{1}{\omega}\dot{y}(\tau)\cdot Sin(\omega\cdot t_1) + y(\tau)Cos(\omega\cdot t_1) \quad (19)$$

Тобто рівняння (19) – це рівняння вільних коливань балки при часі **t>τ** з початковими умовами **v(t)=v(τ)**; **y(t)=y(τ)**.

Аналогічний підхід до визначення динамічних переміщень приймається і для плит. Вирішується диференціальне рівняння (16). При цьому еквівалентна маса, приведена до центру плити, в випадку шарнірного обпирання по контуру дорівнює **m_{ekv}=0.25M_{pl}**, а для жорсткого защемлення по контуру **m_{ekv}=9·M_{pl}/64**, де **M_{pl}** – повна маса реальної плити [3]. Узагальнена сила **Q** в цьому випадку буде визначатися з (15) з тією різницею, що **α_i** визначається в залежності від обох координат по площині плити, а сила **F(t)=q_{kv}·a·b**, де **a,b** – розмір площі навантаження, яка приходиться на одну силу (**a=L_1/n; b=L_2/m**, де **n** – кількість ділянок, на яку розбивається прольот L_1, **m** - кількість ділянок, на яку розбивається прольот L_2, а **q_{kv}** – динамічне навантаження на одиницю площі. Крім цього, жорсткість пружин **k_1**, що імітують роботу ґрунту, приймається як сума жорсткостей окремих стовпів з розмірами в плані **a×b**. Таким чином рівняння (16) використовується як для балок, так і для плит. Різниця лише в визначенні констант **A, B, H** і узагальненої сили **Q**.

Розглянемо розрахунок за розробленою методикою балки шириною 1 м і товщиною 0.4 м з прольотом 6 м (умовно це смуга перекриття шириною 1 м). Модуль деформацій **E_{cd}=25000 МПа**. Величина надлишкового тиску **P_{s0}=270 КПа**, час позитивної фази тиску вибухової хвилі **τ=14.8 мс** [1, 6]. Висота шару ґрунту прийнята рівною 1 м. Будемо варіювати прольот балки і модуль деформації ґрунту (жорсткість умовних пружин **k_1**).

В таблиці 1 представлені результати розрахунку за розробленою методикою для лінійного розподілу тиску вибухової хвилі за виразом (1).

Таблиця 1.

Результати розрахунку при варіюванні різних параметрів.

Варіант №	Прольот L (м)	Модуль де-форма-цій ґрунту E_{gr} (МПа)	Коефіцієнт динамічності k_d для фази коливань		Відно-шення τ/T	Макси-ма-льне перемі-щення ґру-нту (мм)
			Першої k_{d1} $t<=\tau$	Другої k_{d2} $t>\tau$		
1	2	3	4	5	6	7
1	3	∞	2	2	2.58	0
2	3	21	0.668	0.668	2.58	4.1
3	3	15	0.527	0.527	2.58	5.8
4	3	10	0.385	0.385	2.58	8.7
5	3	7	0.286	0.286	2.58	12.4
6	3	2	0.091	0.091	2.58	43.5
7	6	∞	0.256	0.852	0.46	0
8	6	21	0.241	0.802	0.46	2.07
9	6	15	0.235	0.783	0.46	2.9
10	6	10	0.226	0.753	0.46	4.3
11	6	7	0.215	0.717	0.46	6.2
12	6	2	0.154	0.514	0.46	21.7
13	9	∞	0.051	0.467	0.166	0
14	9	21	0.051	0.463	0.166	1.38
15	9	15	0.051	0.461	0.166	1.93
16	9	10	0.05	0.458	0.166	2.9
17	9	7	0.05	0.455	0.166	4.14
18	9	2	0.047	0.429	0.166	14.5

В таблиці розглянуті дві фази коливань: перша фаза (при $t<=\tau$) коли тиск вибухової хвилі ще діє; друга фаза (при $t>\tau$) – фаза вільних коливань. Значення коефіцієнтів динамічності в першій фазі k_{d1} (графа 4) та другій фазі k_{d2} (графа 5) визначаються як відношення максимального динамічного переміщення маси m до її максимального переміщення за дії статичного навантаження. Крім того в таблиці 1 наведені значення відношення часу дії вибухової хвилі τ до періоду коливань балки T (графа 6), а також максимальне переміщення пружин (графа 7). Значення модуля деформацій ґрунту, що дорівнює нескінченності, в таблиці 1 означає, що система розраховується без врахування послаблюючої дії пружин. Це зроблено для порівняння значень коефіцієнтів динамічності з врахуванням послаблюючої дії пружин і без такого врахування. Значення $E_{gr}=2$ МПа прийняті умовно, коли замість ґрунту розглядається шар пінополістиролу з відповідним модулем деформації.

З наведеної таблиці 1 можна бачити, що врахування роботи ґрунту над балкою суттєво впливає на зменшення коефіцієнта динамічності. При чому це залежить від відношення τ/T. При малих відношеннях τ/T вплив ґрунту мінімальний. Збільшення цього відношення призводить до збільшення впливу ґрунту на коефіцієнт динамічності. Крім того, з таблиці можна бачити, що при малих значеннях цього відношення коефіцієнт динамічності в другій фазі k_{d2} значно більше, ніж коефіцієнт динамічності в першій фазі k_{d1}. Цей факт слід враховувати при реальному проектуванні і мати на увазі не величину прольоту як показано в [1], а саме відношення τ/T, яке в свою чергу залежить, в тому числі, і від прольоту.

На величину коефіцієнта динамічності впливає

і жорсткість балки. Її зменшення призводить до зменшення коефіцієнта динамічності. А жорсткість зменшується при утворенні тріщин. Крім того, збільшення маси балки (збільшення шару ґрунту над нею) також призводить до зменшення коефіцієнта динамічності (побічно це впливає на величину періоду коливань). Ці факти були розглянуті в [1] і тому тут не аналізуються.

Виведене диференціальне рівняння (16) дозволяє розраховувати балку як з врахуванням ґрунту над нею, так і без врахування. Крім того, права частина цього рівняння може мати будь який інший вигляд. При цьому змінюється лише функція $f(t)$ в правій частині і вирішується диференціальне рівняння. Від цього зміниться не саме рівняння, а його рішення.

Після визначення коефіцієнтів динамічності k_{d1} та k_{d2} слід взяти максимальне значення з цих двох величин і потім визначити еквівалентне статичне навантаження q_{ekv}, яке дорівнює динамічному навантаженню $q(t)$, помноженому на величину коефіцієнта динамічності. Після цього, як показано в [1], можна підбирати армування балки, розраховуючи її на умовне статичне навантаження, як це прийнято в нормативному документі [8].

Наприкінці відмітимо, що розглянута методика може бути застосована для врахування негативної фази тиску вибухової хвилі. Негативна фаза дії вибухової хвилі може накладатись на переміщення балки при коливаннях в негативну сторону (вверх). Накладання чи гасіння цих коливань буде залежати від того, співпадає негативна фаза коливань балки з негативною фазою тиску вибухової хвилі чи ні. Цей факт можна врахувати рішенням рівняння (16) прийнявши повну функцію $F(t)$ при $t>\tau$ до значення $t=\tau+\tau^I$, де τ^I -час дії негативної фази вибуху. Але

при цьому слід застосувати вже повну криволінійну функцію дії вибухової хвилі, наприклад за [5].

Висновки. Врахування шару ґрунту, що розташований на балці (плиті), дозволяє суттєво зменшити коефіцієнт динамічності. Це зменшення залежить від відношення жорсткості ґрунту до жорсткості балки, відношення часу дії вибухової хвилі до періоду коливань балки, від маси балки і ґрунту над нею, а також від жорсткості балки, яка зменшується при утворенні тріщин. В статті розроблена інженерна методика розрахунку балки, над якою розташований шар ґрунту. Виведено диференціальне рівняння з застосуванням рівнянь Лагранжа другого роду, яке дозволяє визначити коефіцієнт динамічності в обох фазах деформування балки (при дії вибухової хвилі і при вільних коливаннях). Показано, що коефіцієнт динамічності в другий фазі може бути суттєво більшим ніж в першій фазі. Це залежить від відношення часу дії тиску від вибухової хвилі до періоду коливань балки.

На основі розрахунку за запропонованою методикою наведені дані, де показаний вплив жорсткості ґрунту, відношення часу дії хвилі до періоду коливань на величини коефіцієнтів динамічності в першій да другій фазах. Підбором параметрів верхнього шару, таких, як маса, модуль пружності, висота, можна домогтися максимального зменшення коефіцієнта динамічності. Чим менше модуль пружності шару над балкою, тим менше коефіцієнт динамічності. Це дозволяє застосовувати такі матеріали, як пінополістирол та інші в поєднанні з ґрунтом. Варіюванням вказаних параметрів завжди можна домогтися суттєвого зменшення коефіцієнту динамічності, що дозволить в свою чергу зменшити витрати матеріалів і часу на виготовлення захисних споруд.

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CLASSIFICATION, MANAGEMENT, AND SUSTAINABILITY OF PORT OPERATIONS: A COMPREHENSIVE ANALYSIS OF MARITIME-LAND TRANSPORT SYNERGIES

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ABSTRACT

Port cargo handling operations are of critical importance to the global supply chain, facilitating the movement of goods between maritime and land transportation modes. This research paper examines the aforementioned operations, with a particular focus on their classification, management, and impact on transportation networks. The examination encompasses a variety of cargo types, the technologies utilized, the processes involved, and the role of land transportation in supporting port operations. The implementation of effective management strategies and the integration of advanced technologies, such as automation and AI, have the potential to enhance operational efficiency and reduce the occurrence of errors. Furthermore, the implementation of sustainable practices serves to reduce the carbon footprint associated with logistics operations. The study concludes that optimization of port operations and their connection with land transport is essential for the improvement of efficiency and sustainability in the global supply chain.

Keywords: port cargo handling operations, global supply chain, maritime transport, land transport, operational efficiency, environmental sustainability, automated systems.

1. Introduction

The operations conducted at ports for the handling of cargo play a pivotal role in the field of global logistics, facilitating the transfer of goods between the maritime and land transportation systems. The effective management of port cargo handling operations is of paramount importance for the seamless operation of the global supply chain and the economic development of nations.

Prior research has focused on specific aspects of port cargo handling operations, including technologies, environmental impacts, and risk management. However, an integrated examination of these elements is currently lacking. A comprehensive investigation is necessary to evaluate port cargo handling operations with regard to their categorization, management, and impact on the broader transportation system.

The objective of this research is to conduct a comprehensive and detailed analysis of the various processes involved in the handling of cargo at ports. In particular, the study will focus on the categorization, management, and impact of these activities on the broader transportation system. The paper posits that the effective categorization, administration, and optimization of port cargo handling activities can enhance efficiency and sustainability in the international supply chain, thereby facilitating economic development and improving environmental outcomes.

2. Classification and management of port cargo handling operations: a comprehensive analysis

Port cargo handling activities are of critical importance to global logistics and supply chain management, as they facilitate the transfer of goods between maritime and land transportation modes through a range of actions. These operations can be classified from a variety of perspectives, including the types of cargo processed, the technologies employed, and the operational procedures involved. This synthesis will provide a comprehensive examination of these classifications, with references to a variety of scholarly sources to substantiate each assertion.

The initial categorization of cargo handling activities is based on the type of goods being processed. In general, ports engage with a multitude of cargo categories, including containerized cargo, bulk cargo (liquid and dry), breakbulk cargo, and roll-on/roll-off (RoRo) cargo. Among these, containerized cargo[1] is the most prevalent in contemporary ports, as it enables efficient handling and transportation due to the standardized dimensions of containers. Bulk cargo, which encompasses materials such as coal, grain, and oil, requires the use of specialized handling machinery and storage facilities in order to address the unique characteristics of these items[2][3]. Breakbulk cargo is defined as a collection of discrete items that require individual handling and loading/unloading procedures. These procedures necessitate the use of specialized equipment and techniques, as the cargo is not suitable for bulk handling[4]. Roll-on roll-off (RoRo) operations are defined as the loading and unloading of vehicles onto and from vessels, respectively. This in turn requires the implementation of specific terminal layouts and operational procedures[4].

In addition to the classification of cargo, port operations can be further distinguished by the technological systems employed in the management of cargo. The advent of digital technologies[5] has significantly impacted the operational landscape of ports, enabling more efficient management of cargo movements. As an illustration, the integration of automated systems and artificial intelligence in the domain of cargo handling has yielded positive outcomes, including enhanced operational efficiency, a reduction in human error, and an improvement in service quality[6][7]. The implementation of digital infrastructure facilitates the real-time monitoring of cargo and vehicles, thereby enhancing the communication of information among the various parties engaged in the logistics network[8]. Furthermore, the utilisation of sophisticated data analysis and machine learning techniques facilitates the forecasting of cargo handling durations, which has the potential to

significantly enhance turnaround times and alleviate congestion at ports[9][10].

The processes involved in cargo handling can be classified into several essential activities, including loading and unloading, storage, and transportation. The operations of loading and unloading are of paramount importance, as they directly influence the efficiency of port activities. The operational time of cargo handling equipment, including cranes and forklifts, is a crucial factor in evaluating the overall efficacy of these operations[11][12]. The effective management[13] of these processes requires meticulous planning and collaboration in order to reduce delays and enhance the utilisation of resources[14]. The management of storage operations entails the organization of the short-term retention of goods at the port, with the objective of facilitating rapid retrieval and minimizing dwell times[15]. The movement of goods to and from storage zones within the port is of paramount importance for maintaining operational continuity and efficiency[15][16].

Furthermore, the environmental impact of cargo handling operations has emerged as a pivotal consideration in port administration. Ports are a significant source of emissions due to the heavy equipment and vehicles utilized in cargo handling operations, in addition to the ships themselves. It has been demonstrated that improvements to cargo handling procedures can lead to a reduction in emissions and an enhancement of air quality in port areas[17][18]. The implementation of sustainable practices[19][20], including the utilisation of low-emission handling equipment and the incorporation of energy-efficient technologies, is imperative for the reduction of the environmental impact of port operations[21][22]. Furthermore, the formation of collaborative relationships between public and private entities (PPPs) has been identified as a viable strategy for enhancing cargo handling efficiency while concurrently addressing environmental concerns[23].

The classification of cargo handling operations within port facilities also includes the oversight of potential hazards associated with the transportation of hazardous materials. Ports engaged in the handling of chemicals and other hazardous materials are obliged to implement rigorous safety protocols with the objective of minimizing risks to public health and the environment[24]. The implementation of risk assessment frameworks is of paramount importance in the identification of potential hazards and the formulation of effective strategies for their management[24]. This entails the dissemination of knowledge to port employees regarding the secure handling of hazardous materials, as well as the assurance of their compliance with international standards such as "*the International Maritime Dangerous Goods (IMDG) Code*"[25].

As the research paper progresses to the subsequent section, it is essential to recognize the intricate interconnection between port cargo handling operations and the broader transportation network. The efficacy and productivity of port operations are inextricably linked to the functionality and operation of land transportation systems. This interconnection highlights the necessity for a comprehensive approach to port logistics that extends beyond the boundaries of the port itself. The following section will examine the various ways in which land transport infrastructure and operations enhance the overall effectiveness of marine ports. It will analyze the synergies and challenges that occur at this essential junction of global supply chains.

3. The role of land transport in supporting marine port operations: a multifaceted analysis

Land transportation is a crucial component of marine port operations, facilitating activities through a multitude of interconnected elements. These include infrastructure development, intermodal connectivity, economic efficiency[26], environmental sustainability, and regional development. Each of these elements is of vital importance in enhancing the efficacy of port operations and optimizing the efficiency of the supply chain.

Infrastructure Development

The development of robust land transportation infrastructure is of paramount importance for the optimal functioning of marine ports. The effective functioning of ports is contingent upon the availability of well-maintained roads and railways, which facilitate the uninterrupted transfer of goods between maritime and inland transportation systems. Liu et al. indicate that the objective of constructing international land-sea transport corridors is to enhance the efficiency of transportation and reduce the costs associated with logistics, which, in turn, stimulates international trade and regional economic collaboration[27]. This infrastructure facilitates the expeditious and secure transportation of goods from seaports to inland regions via diverse modes of conveyance, including railways and roads[27]. Furthermore, as Derpich et al. have highlighted, the integration of diverse modes of transportation is vital for optimizing operational efficiency while minimizing costs and emissions[28].

The significance of infrastructure is further underscored by the findings of Hossain et al., which demonstrate that the efficacy of inland waterway ports is closely linked to the efficiency of land transportation networks[29]. The establishment of inland terminals has the potential to alleviate congestion at seaports and enhance connectivity with surrounding regions, thereby attracting greater cargo volumes and enhancing the overall competitiveness of ports[30]. Moreover, as underscored by Cao and Shahraki, the configuration of transportation infrastructure networks is of paramount importance for sustainable development. This enables ports to manage the growing volume of cargo in an effective manner while simultaneously reducing their environmental impact[31].

Intermodal Connectivity

The intermodal connectivity of land transportation plays a pivotal role in the enhancement of marine port activities. The seamless integration of disparate transportation modalities—including road, rail, and inland waterways—facilitates the expeditious transfer of cargo from maritime ports to inland destinations. As noted by Hanaoka and Regmi, the establishment of dry ports provides a vital support system for intermodal transportation, acting as central points for multimodal logistics operations[32]. This enhances operational efficiency and reduces transportation expenses[32]. This

is especially relevant in regions where direct access to seaports is restricted, as inland ports can serve as crucial links in the supply chain, improving accessibility and connectivity[33].

Furthermore, the interaction model of maritime and land transportation, as proposed by Baginova et al., underscores the paramount importance of synchronized operations between marine and land transport providers, particularly in the context of the transportation of perishable items[34]. This collaboration is of paramount importance for the maintenance of the reliability of the supply chain and the facilitation of prompt deliveries. In addition, Kotowska et al. emphasize the significance of inland shipping as a sustainable alternative to road transportation, advocating a transition to alternative modes of freight transportation to mitigate the environmental impact of current practices[35]. This alteration serves not only to facilitate the attainment of sustainability objectives but also to enhance the comprehensive efficacy of the transportation system.

Economic Efficiency

The operational efficiency of ports is significantly influenced by the functionality of the land transport systems in place. As posited by Park et al., maritime transport plays a pivotal role in the handling of high-volume inter-regional cargo. Its efficacy is inextricably linked to the efficiency of land transport[36]. The extant evidence suggests that improvements in transportation efficiency can engender substantial economic growth, particularly in regions that are well-connected to maritime trade routes [36]. The existence of effective land transportation networks has a significant impact on total logistics expenses, which is a crucial factor in maintaining competitiveness in the international marketplace.

Furthermore, Yang et al. posit that the efficacy of port operations is inextricably linked to the caliber of land transportation services[37]. The effective management of cargo and the reduction of vessel stay periods are of critical importance for the optimization of throughput and the mitigation of delays. As González-Cancelas et al. have demonstrated, the integration of advanced technologies and digital solutions in land transportation can significantly enhance operational efficiency by streamlining procedures and fostering collaboration across different transport modes[38]. The integration of this technology is crucial for addressing the evolving demands of international trade and sustaining the competitiveness of ports.

Environmental Sustainability

The impact of transportation systems on the environment is becoming an increasingly pivotal consideration in port operations. The transition to greener transport options, such as rail and inland shipping, is of paramount importance for the reduction of carbon emissions associated with logistics activities. Kotowska et al. emphasize the necessity of promoting environmentally friendly transportation alternatives to mitigate the detrimental effects of road transportation on the natural environment[35]. The establishment of dry ports and the adoption of multimodal transportation methods have the potential to significantly reduce road traffic and greenhouse gas emissions, thereby fostering a more sustainable transportation network[39].

Furthermore, the study conducted by Lättilä et al. underscores the advantageous effects of employing dry ports on transportation costs and CO_2 emissions[40]. This indicates that enhancing hinterland operations can facilitate the adoption of more environmentally conscious logistics practices[40]. The incorporation of sustainability metrics into the planning and operations of ports is a crucial step in ensuring that environmental considerations are given due priority alongside economic objectives. This strategy is consistent with the broader objectives of sustainable development and represents a growing recognition of the imperative for environmentally conscious transportation solutions.

Regional Development

Land transportation is of paramount importance to regional growth, as it facilitates enhanced accessibility to ports and fosters trade. The establishment of efficient transport networks has the potential to invigorate local economies by attracting businesses and generating employment opportunities. As observed by Seo and Park, the existence of ports fosters regional employment by offering a range of job opportunities related to terminal operations, shipping, logistics, and transportation services[41]. The creation of jobs has a cascading effect on the surrounding economy, facilitating comprehensive economic growth and development.

Furthermore, the importance of inland ports as regional distribution centers, as emphasized by Zhuang et al., underscores their pivotal function in enhancing accessibility and strengthening the competitiveness of ports[33]. The establishment of effective links between seaports and inland regions has the potential to foster local economic growth and enhance the expansion of regional trade networks. As emphasized by Ilona and Urbanyi-Popiolek, the strategic enhancement of transportation infrastructure is of paramount importance for enabling ports to efficiently support their hinterlands and facilitate regional economic integration[42].

The comprehensive analysis demonstrates that land transportation plays a multifaceted and indispensable role in supporting marine port operations. The intricate interdependence between infrastructure expansion, intermodal connectivity, economic viability, environmental stewardship, and regional growth underscores the complexity and paramount importance of this relationship. As the author prepares to conclude this study, it is essential to integrate these insights and reflect on their broader implications for the future of international trade, sustainable practices, and the evolving dynamics of transportation logistics. The subsequent section will present the principal findings derived from this analysis and investigate potential avenues for future research and policy recommendations in this crucial field of study.

4. Conclusion

The comprehensive analysis presented in this research paper highlights the pivotal role of port cargo handling operations within the global supply chain and their intricate interconnections with land transportation systems. The investigation has explored the various dimensions of port operations, including their classification, management, and impact on the broader transportation network.

The findings suggest that the effective classification and management of port cargo handling activities are vital for enhancing efficiency and sustainability in the global supply chain. The study has revealed that ports manage a variety of cargo types, each of which requires distinct equipment and operational procedures. The integration of advanced technologies, including automated systems and artificial intelligence, has significantly impacted the operational landscape of ports, leading to enhanced efficiency, reduced human error, and an improved quality of service.

Furthermore, the research highlights the critical role of land transportation in supporting marine port operations. The establishment of robust infrastructure, intermodal linkages, and efficacious transport networks is indispensable for the optimal functioning of ports. The study highlights the importance of seamless coordination between diverse transportation modes, including road, rail, and inland waterways, in facilitating efficient cargo movement and reducing overall logistics costs.

The document underscores the significance of environmental sustainability in port operations and associated land transportation systems. The transition to more sustainable transport methods and the adoption of eco-friendly practices are of paramount importance for the reduction of the carbon footprint of logistics activities and the alleviation of the negative impacts on the environment.

In conclusion, the findings of this study demonstrate that the effective classification, management, and optimization of port cargo handling activities, in conjunction with efficient land transportation systems, can significantly enhance the efficiency and sustainability of global supply chains. The results substantiate the initial hypothesis and provide valuable insights for policymakers, port officials, and logistics experts. It is recommended that future studies pursue the development of innovative solutions that will further enhance the integration of port activities with land transport systems, improve environmental sustainability, and adapt to the evolving requirements of international trade.

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INTEGRATING UNMANNED AERIAL VEHICLES IN MARITIME OPERATIONS: A COMPREHENSIVE ANALYSIS OF HAZARDS AND RISK MITIGATION STRATEGIES

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ABSTRACT

The employment of Unmanned Aerial Vehicles (UAVs) has demonstrated considerable promise for enhancing surveillance, safety, and communication in the context of maritime operations. However, the integration of these systems requires a comprehensive understanding of the associated hazards. This paper examines the risks associated with UAVs, categorizing them into the following domains: operational hazards (e.g., mid-air collisions and battery limitations), environmental challenges (e.g., weather and wildlife interactions), technical failures (e.g., software and hardware issues), security threats (e.g., misuse and cyberattacks), and regulatory compliance. The principal findings underscore the necessity for the implementation of robust risk management strategies that are specifically tailored to the context of maritime UAVs operations. In order to ensure the safe integration of UAVs in maritime environment, it is essential to implement collision avoidance systems, enhance UAV design for maritime conditions, establish rigorous testing procedures, strengthen cybersecurity, and create standardized regulations. Adherence to these measures will facilitate the enhancement of the efficiency and security of UAV operations within the maritime industry.

Keywords: Unmanned Aerial Vehicles (UAVs), Maritime operations, Hazard classification, Risk assessment, Environmental hazards, Technical failures, Security threats, Regulatory compliance.

1. Introduction

The deployment of Unmanned Aerial Vehicles (UAVs - also called drones) in maritime and port operations has emerged as a topic of significant interest in recent years. The capacity of these devices to enhance surveillance, optimize operational efficiency, and facilitate search and rescue operations has led to a notable increase in their utilization.

The successful integration of UAVs into maritime operations is contingent upon a comprehensive understanding of the hazards associated with their deployment in marine environment. Such knowledge enables us to navigate potential challenges and guarantee the safety and efficacy of operations.

While previous research has explored the benefits of drones in maritime and port operations, there is a paucity of comprehensive analysis on the hazards and potential risks associated with their deployment in marine environment. This paper addresses the existing knowledge gap by providing a comprehensive analysis of the hazard classification and potential risks associated with the operation of UAVs in maritime environment.

The rationale behind this research is to contribute to the development of robust risk management strategies for the successful integration of drones into maritime operations. The research question posed by the paper, "What are the hazards and potential risks associated with the deployment of UAVs in marine environments, and how can they be managed to ensure safe and effective operations?" is of significant interest to the maritime community and forms the core of this exploration.

The objective of this paper is to conduct a comprehensive analysis of the hazard categorization and potential risks associated with drone activities in maritime environment. It is proposed that the effective incorporation of UAVs into maritime operations requires a comprehensive understanding of the hazards and potential risks associated with their use in marine environment, in order to ensure the safety and efficiency of operations.

2. Unmanned Aerial Vehicles in maritime operations: enhancing surveillance, safety, and communication

The deployment of UAVs in maritime and port operations has become a crucial aspect of modern maritime management[1][2][3][4][5]. The use of UAVs has the potential to enhance surveillance, optimize operational efficiency, and facilitate search and rescue operations. Drones provide a versatile platform for monitoring expansive maritime regions, which is crucial for ensuring maritime security and safety.

One of the principal advantages of employing UAVs in maritime operations is their capacity to survey expansive areas. They are capable of surveying vast regions more effectively than conventional manned aircraft, thereby facilitating the efficient surveillance of maritime boundaries and the identification of illicit activities such as smuggling and unauthorized fishing[6]. The deployment of sophisticated sensors, including multispectral and thermal imaging, enhances the ability to monitor marine life and marine debris, thereby facilitating environmental conservation initiatives[7][8]. Furthermore, drones can be employed for the purposes of live mapping and data collection, which are of paramount importance for the maintenance of maritime security[9].

In search and rescue operations, drones are indispensable because of their capacity to provide rapid aerial surveillance and assistance in locating individuals in distress at sea. The integration of deep learning algorithms for target identification on drones significantly improves the efficacy of these operations, facilitating rapid detection of objects such as individuals in the water or navigational hazards in maritime environ-

ment[10][11]. The capacity to rapidly disseminate information to command centers enhances the efficacy of decision-making during crises, which in turn increases the probability of successful rescue operations[12].

Furthermore, drones are instrumental in enhancing communication networks within maritime environment. They can serve as airborne communication hubs, providing coverage in areas where conventional terrestrial networks are inadequate. This functionality is of particular importance for enabling the operation of Internet of Things (IoT) applications in intelligent ports and self-navigating systems[13][14]. The integration of UAVs with hybrid satellite-terrestrial networks enables maritime operations to achieve reliable and low-latency communication, which is vital for the coordination of activities among vessels, buoys, and diverse maritime assets[15].

The versatility and economic efficiency of drones are significant factors contributing to their increasing use in maritime and port activities[16]. The rapid and cost-effective deployment of UAVs in comparison to piloted aircraft makes them a compelling choice for a range of applications, including environmental monitoring, infrastructure assessment, and border surveillance[17]. Furthermore, the capacity of UAVs to function independently reduces the risk to human operators, particularly in high-risk environments[17].

The deployment of UAVs in maritime and port operations is of paramount importance for enhancing surveillance, augmenting search and rescue efficacy, and facilitating efficient communication. The adaptability of drones, coupled with cutting-edge sensor technologies and autonomous functionality, renders them indispensable instruments in contemporary maritime management.

As the maritime industry increasingly adopts UAVs due to their various benefits, it is crucial to understand the potential risks and challenges linked with their use in marine environment[18][19]. The following section will examine the classification and assessment of hazards associated with the operation of drones in maritime contexts. It will provide a comprehensive review of the safety factors and potential risks that must be considered to ensure the successful and safe integration of these unmanned systems into maritime activities[19][18].

3. Hazard classification and analysis of UAVs Operations in maritime environment

The deployment of UAVs in the maritime domain and at ports entails a multitude of potential risks that must be identified and understood to guarantee their safe and effective utilisation. The aforementioned risks can be classified into several principal categories, including operational risks, environmental risks, technical malfunctions, security issues, and problems with regulatory compliance. Each of these categories comprises a distinct set of potential threats that could impact the safety and efficiency of UAV operations in maritime settings.

Operational Hazards

The operational risks associated with UAVs are primarily attributable to the complexities inherent in their operations in congested maritime environments. The presence of other aircraft, waterborne vessels, and the dynamic nature of port activities can give rise to collisions in the air and incidents on the ground and water. Zhang et al. highlight the significant concern of midair collisions, particularly as the number of UAVs in shared airspace increases[20]. This airspace is often congested with both piloted and unmanned aircraft, making midair collisions a major safety concern[20]. Additionally, the potential for UAVs to collide with maritime vessels or infrastructure in ports poses a significant risk of adverse consequences, including property damage and, in extreme cases, personal injury[21].

Furthermore, the restricted operational duration of UAVs introduces a considerable operational hazard. As posited by Battulwar et al., UAVs are constrained by limited operational periods, which can be further complicated by the necessity for extended flights across expansive maritime regions[22]. This constraint necessitates the meticulous planning of flight paths to preclude scenarios in which a UAV could lose power and crash into populated regions or critical infrastructure[23].

Environmental Hazards

The functionality of drones in marine environment is contingent upon the prevailing environmental conditions. The stability and maneuverability of UAVs can be influenced by a number of factors, including wind velocity, atmospheric conditions, and the condition of the sea. As an illustration, Ko and Song have demonstrated that adverse meteorological circumstances can impede the efficacy of UAVs, thereby elevating the probability of mishaps[24]. Furthermore, UAVs are particularly vulnerable to adverse weather conditions, including strong winds and turbulent weather patterns. This vulnerability can potentially result in a loss of control and subsequent accidents[22].

The marine environment presents a unique set of challenges, including corrosion from saltwater and the potential for UAVs to collide with birds or other wildlife[25]. The integration of drones into marine ecosystem necessitates the formulation of robust design principles to mitigate potential risks, as underscored by Zhang et al. in their assessment of UAV safety within national airspace systems[20].

Technical Failures

Technical malfunctions represent a significant hazard in drones operations, particularly in complex maritime environment. Such malfunctions may have a variety of causes, including software issues, hardware faults, and communication failures. For example, the dependability of the UAV propulsion system is of the utmost importance for the safe operation of the aircraft, as any malfunction could result in catastrophic consequences[26].

Furthermore, the integration of UAVs into existing air traffic management systems gives rise to concerns pertaining to system compatibility and data exchange[27]. Due to the fact that UAVs are utilized in environments that may not be optimized for their operation, the probability of technical malfunctions increases. Consequently, it is imperative to conduct comprehensive testing and validation of UAV systems prior to deployment[28].

Security Threats

The potential security risks associated with UAVs operations in maritime environment represent a significant challenge. The potential for drones to be employed in illicit activities, including the transportation of contraband or the monitoring of illicit activities, poses a significant challenge to maritime security[25]. In their analysis, Jacobsen and Marandi identify and examine the various security risks associated with UAVs systems. They underscore the necessity for robust security protocols to prevent unauthorized access and exploitation[29].

Moreover, the potential for cyberattacks targeting UAVs systems poses a significant risk to their operational integrity and safety. Rudo and Zeng also note that UAVs are vulnerable to hacking, which could result in a loss of control or the alteration of flight trajectories, thereby creating potential hazards for both the UAV and other parties within the maritime environment[30].

Regulatory Compliance Issues

It is of paramount importance that regulations are adhered to in the context of UAVs operations within ports and maritime settings. It is of the utmost importance to adhere to the local, national, and international regulations that govern the use of UAVs in order to ensure the safety of operations. Jiang et al. emphasize that adherence to these regulations is essential for mitigating the risks associated with UAV operations[31].

Furthermore, the lack of consistent regulations across different jurisdictions may lead to confusion and an increased likelihood of non-compliance, potentially resulting in legal challenges and operational disruptions[25]. The formulation of clear and comprehensive guidelines and frameworks for UAVs operations in maritime settings is of paramount importance for enhancing safety and operational efficacy[32].

Following an analysis of the dangers and potential risks associated with the operation of UAVs in marine environment, it is essential to consolidate these insights and reflect on their broader implications. The following section will conclude this evaluation by summarizing the principal aspects, examining the significance of these dangers for the maritime sector, and proposing measures to mitigate risks and ensure the safe and efficient integration of UAVs into maritime activities.

4. Conclusion

The integration of UAVs into maritime activities presents a significant opportunity to enhance surveillance, safety, and communication within the maritime industry. Nevertheless, this integration gives rise to a number of challenges and risks that must be meticulously addressed in order to guarantee safe and efficient operations.

Key points from the article include:

1. Drones provide benefits for extensive surveillance, rescue missions, and improved communication in maritime settings.

2. The primary risk categories for UAV activities in maritime environments include operational risks, environmental risks, technical malfunctions, security vulnerabilities, and issues related to regulatory compliance.

3. Operational risks encompass the potential for collisions in the air, impacts on the ground, and constraints related to battery duration.

4. Environmental risks include difficulties arising from wind, climatic conditions, ocean conditions, and interactions with wildlife.

5. Technical issues may arise due to a number of factors, including software errors, hardware malfunctions, and communication failures.

6. Security risks encompass the possible exploitation of UAVs for illegal purposes and their susceptibility to cyberattacks.

7. Compliance with regulations arises from the necessity to follow a range of local, national, and international rules.

The significance of these findings lies in their capacity to inform the formulation of comprehensive risk management strategies for the integration of UAVs in maritime operations. It is of the utmost importance to comprehend these risks in order to ensure the safety of personnel, vessels, and infrastructure, while simultaneously capitalising on the advantages offered by UAV technology.

In order to mitigate risks and enhance safety and efficiency, the subsequent suggestions are presented:

1. Create strong risk evaluation procedures that are specifically designed for maritime UAVs activities.

2. Develop sophisticated collision avoidance systems and enhance UAVs flight longevity to mitigate operational risks.

3. Improve the design of UAVs to endure challenging maritime conditions and enhance their performance during unfavorable weather situations.

4. Implement strict testing and validation protocols for UAVs systems to reduce the likelihood of technical malfunctions.

5. Enhance the cybersecurity protocols for UAVs systems to safeguard against unauthorized access and cyber threats.

6. Establish uniform international guidelines for the operation of maritime UAVs to guarantee consistent adherence across different jurisdictions.

7. Allocate resources for training initiatives tailored to UAV operators working in maritime settings.

8. Promote teamwork among maritime agencies, drone manufacturers, and regulatory organizations to establish optimal practices and safety protocols.

9. Establish systems for real-time oversight and management of UAVs fleets functioning in maritime regions.

10. Perform frequent safety evaluations and revise risk management approaches according to new technologies and operational insights.

The implementation of the aforementioned suggestions will enable the maritime sector to pursue a safer and more effective integration of drone technology, thereby enhancing the efficiency and security of maritime operations.

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ЕЩЕ РАЗ О ТРЕХМЕРНОМ ПРОСТРАНСТВЕ И ТЕЧЕНИИ ВРЕМЕНИ В НЕМ

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ONCE AGAIN ABOUT THREE-DIMENSIONAL SPACE AND THE FLOW OF TIME IN IT

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АННОТАЦИЯ

В статье, впервые, рассматривается разновидность существования материи на пяти этапах развития материи в виде вещества, а также зависимость его трехмерного объема от течения времени, которое в нем имеет место. Впервые течение времени рассматривается, как движение материи, а размеры трехмерного пространства с помощью действия сил трех естественных полей, которые действуют в трех взаимно перпендикулярных направлениях. Эта статья имеет большое значение при познании естественного интеллекта.

ABSTRACT

The article, for the first time, examines the variety of existence of matter at five stages of development of matter in the form of substance, as well as the dependence of its three-dimensional volume on the flow of time that passes in it. For the first time, the flow of time is considered as the movement of matter, and the dimensions of three-dimensional space with the help of the action of the forces of three natural fields that act in three mutually perpendicular directions. This article is of great importance in the cognition of natural intelligence.

Ключевые слова: трехмерное пространство, течение времени, материя, вещество, естественный интеллект.

Keywords: three-dimensional space, flow of time, matter, substance, natural intelligence.

Закон природы существования материи на Земле в виде вещества [1] определяет все его свойства. Иными словами, любое явление в природе следует из этого закона. И в этом случае важнейшую роль «играет» пространство и течение времени, в котором оно находится. В современной науке принято считать, что любое состояние материи в виде вещества «диктуется» единственным представлением пространства и времени, присущим земным условиям. Оказалось, что это не так. Различные вещественные разновидности материи имеют свои, отличительные друг от друга, пространственно-временные реализации. В работе [1], до таковых в земных условиях отнесены, по крайней мере, пять представлений, которые познаются следующими фундаментальными науками: физикой, химией, ботаникой, биологией и кибернетикой. В этом случае, еще раз подчеркнем, что материя в каждом таком вещественном представлении «ориентируется» на свое, и трехмерное пространство, и течение времени в нем.

Неодинаковость существование материи в виде вещества на Земле следует рассматривать как результат ее развития. К самому первому и простейшему этапу этого развития необходимо отнести то вещество, которое для своего познания требует научные усилия, объединяемые в фундаментальную науку физику. Течение времени в веществе на этом этапе является следствием простейшего вида движения материальной субстанции, которое обеспечивает интеграцию (накопление) одинаковых сгустков материальной субстанции в одном и том же месте пространства и времени. Еще раз напомним, что, при этом, природа

создает простейшие физические (а не более сложные химические) элементы таблицы Менделеева, каждый из которых состоит из однородных сгустков материальной субстанции. Иными словами, для таких элементов, в процессе интеграции природой указанных сгустков, не требуется преодоления каких-либо расстояний между сгустками, что отражается на их пространственно-временное представление, т.е. на их объеме, и течение времени в нем. Ведь эти сгустки находятся в том месте, в котором формируется будущий элемент известной таблицы. То есть, еще раз подчеркнем, что течение времени и пространственные размеры физического элемента таблицы Менделеева создаются минимальными по сравнению с формами существования материи в последующих этапах ее развития.

Итак, на самом первом этапе развития материи, т.е. физическом, пространство вещества формируется его движением, которое природа обеспечивает, в основном, силам гравитационного поля совокупности сгустков материальной субстанции. Поскольку в земных условиях их величины такие большие, что, «объединяясь», они направлены к центру Земли, тем самым, формируют общее земное притяжение. Эта особенность исключает в земных условиях между вещественными телами гравитационное притяжение, т.е. на Земле, в классическом виде, закон всемирного тяготения не работает. В тоже время, между сгустками материальной субстанции имеет место магнитного взаимодействие, силовые линии которого расположены в профильной плоскости [1] будущего трехмерного пространства. Поскольку его силовые линии существенно слабее гравитационных сил, то формируя профиль-

ное направление в будущем трехмерном пространстве общее магнитное поле Земли, в отличие от гравитационного, «не сосредотачивает» своим общим земным притяжением (положительным и отрицательным полюсами на нашей планете) все сгустки в его окружении. Таким способом магнитные взаимодействия сгустков материальной субстанции, в отличие от гравитационных, имеют место на Земле. То есть, в данном случае речь идет об отсутствии всемирного магнитного притяжения на нашей планете, аналогичного гравитационному, которое этому явлению с гравитацией препятствует. Напомним, что отдельного источника положительного, либо отрицательного магнитного поля не существует, т.е., магнитное поле всегда представлено в виде диполя двух взаимно-противоположных полюсов. Взаимодействие этих диполей друг с другом в элементе природой предусмотрено не во всех случаях. Иными словами, на первом этапе (физическом) могу быть созданы естественные условия, когда между однородными элементами на уровне рассматриваемого поля происходит взаимодействие, и тогда, «объединяясь», они создают общий магнитный диполь в элементе, т.е., магнитный элемент таблицы Менделеева.

Однако, на самом первом этапе развития материи в виде вещества «свободное» магнитное взаимодействие сгустков материальной субстанции имеет место, только вдоль профильной плоскости, т.е., перпендикулярно всеобщему земному гравитационному притяжению. Как будет показано в дальнейших исследованиях нашей статьи для обеспечения произвольного взаимодействия (по всем направлениям трехмерного пространства) необходимо перемещение сгустков материальной субстанции из одного места в другое, что природой предусмотрено уже на биологическом этапе развития материи. Пока же, рост материальной субстанции в веществе на самом первом ее этапе развития осуществляется в двух направлениях – вертикальном и профильном. Иными словами, формируется, только, два направления трехмерного пространства вертикальное и профильное.

Следующий этап в развитии материи в виде вещества принадлежит химическому его состоянию, когда в формировании его элементов подключается электрическое поле, которое проявляется уже в горизонтальной плоскости. Напомним, что это электрическое поле существенно слабее, нежели, магнитное, и согласно [1], оно не может, даже появляться в природе в виде электрических диполей. В этом случае, взаимодействие между другими элементами таблицы Менделеева возможно, только, в определенных условиях, которые обеспечиваются достаточным расстоянием между местами расположения их в пространстве для обеспечения электрических (химических) взаимодействий. Таким образом, на химическом этапе развития природа, для представления вещества, «осваивает» уже все три физических поля (гравитационное, магнитное, и электрическое). То есть, три пространственных направления – вертикальное, профильное и горизонтальное, вдоль которых имеет место и рост материальной субстанции. Следует, также, заметить,

что этот рост в природе ограничивается только естественными возможностями. В случае с физическим этапом, он ограничивается природными возможностям формирования элемента таблицы Менделеева, а в случае с химическими уже ограничениями, которые допускают химические соединения. Например, окисью железа, появлением в природе воды и различных растворов химических элементов в ней, и тому подобное. Обратим внимание еще и на то, что течение времени, на химическом этапе, формируется уже более сложным движением материи, требующим перемещение элементов таблицы Менделеева из одного места пространства в другое, создавая тем самым более сложную вещественную структуру нежели структура физического элемента. И тогда движение материи будет более сложное и более длительное, что незамедлительно сказывается на течении времени в таком химическом пространстве, т.е. оно становится более медленным, нежели на физическом этапе.

Согласно закона природы [1], следующим этапом в развитии материи является ботаническое вещественное ее представление, т. е. существование материи в виде живых растений. Напомним, что, в этом случае, совокупность, появившихся сгустков материальной субстанции в элементе, уже нового этапа, представляет собой физическое и химическое содержимое, соответствующее предыдущим этапам развития материи в виде вещества. Естественного, что такой ботанический элемент является более сложным, и его формирование требует соединение уже фрагментов вещества, которые расположены в пространстве и во времени на более удаленном расстоянии друг от друга, нежели это имело место на предыдущих этапах развития материи. Как и при формировании химических элементов из физических, появляется пространство и течение времени в нем уже иным. То есть, возникает совокупность элементов с более крупной пространственной и временной структурой. Иными словами, на уровня развития материи в виде ботанических структур появляется уже, и новое пространство, и более длительное течение времени в нем.

Следующий этап в рассматриваемом развитии материи в виде вещества относится к формированию в природе биологических веществ. То есть, той живой формы существования материи, которая обладает возможностью перемещаться в пространстве и во времени не только в фиксированном его месте, как это имеет место в ботаническом ее представлении, но, также, и меняя свое месторасположение. Естественно, формирование биологических элементов в природе, как и ботанических состоит из элементов предыдущего этапа развития природы. То есть, в данном случае они формируются из живых ботанических элементов. И в этом случае появляются совокупности вещественных структур с более крупными своими размерами, что, незамедлительно, влияет на то пространство и время, в котором они существуют, по сравнению со всеми предыдущими этапами развития материи. Таким образом, в природе возникает, уже новая форма существования материи со своими особенностями

трехмерного пространства и течения времени в нем.

Согласно важнейшего закона природы существования материи в виде вещества открытого в [1] следующим этапом в ее развитии на Земле является естественный интеллект. На первый план в нем выступает особое свойство материи информация. То, что из себя представляет это загадочное материальное свойство, впервые в истории человечества определил гениальный В.М. Глушков в 1963 году [2]. Он ее определил, как меру неоднородности распределения материи в пространстве и во времени. Именно, манипулируя этим свойством естественный интеллект с помощью своих виртуальных возможностей стал представлять пространство и время уже несколько по-иному, нежели это имеет место в материальном мире на предыдущих четырех этапах его развития (физическом, химическом, ботаническом и биологическом). Эти виртуальные возможности привели к отрыву исследований содержания понятия трехмерного пространства и течение времени в нем от реальной действительности. Особенно, такой тупик наглядно отражается в современных условиях существования фундаментальной науки, когда на первый план выступает мистическое, понимание этого фундаментального понятия. Это следует из теории относительности Эйнштейна, в которой время и пространство подвержены мистическому искривлению пространства и времени, а, в противоречащей этой теории, в квантовой механике пространство и время вообще в природе существования материи отсутствуют [3].

Естественное понимание содержания трехмерного пространства и течения времени весьма важно в познании закона [1]. Особенно, на этапе появления в природе интеллекта, т.е. в науке кибернетики. Новизна понимания этих форм материи на Земле в настоящей статье состоит в том, что по мере ее развития происходит изменение, и ее объемные вещественные показатели, скорость течения времени в них. Иными словами, пространство и время не является одним и тем же на всех этапах развития материи. Более того, показана связь объемного представления с течением времени, из которой следует, что чем сложнее структура сформировавшегося элемента нового этапа в развитии, тем течение времени в нем более замедлено.

Литература

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