UNIVERSITY OF CENTRAL ASIA

SCHOOL OF ARTS AND SCIENCES

Diploma Brochure: Class of 2026

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Message from the Rector of the University of Central Asia

On behalf of the management, faculty, and staff of the University of Central Asia, I extend my warmest congratulations to each of you on the successful completion of your diploma projects.

The work presented in this volume reflects not only your academic achievement, but also your curiosity, resilience, creativity, and commitment to understanding the world around you. Completing a major independent research project is among the most demanding and rewarding experiences of university life.

This year's projects demonstrate the remarkable breadth and maturity of scholarship emerging from UCA. They explore issues as diverse as artificial intelligence, climate change, environmental risk, public health, economic development, cultural identity, digital transformation, and social change. Some seek practical solutions to pressing challenges facing our communities; others deepen our understanding of the societies, histories, environments, and cultures that shape our region. Together, they illustrate the power of research not only to generate knowledge, but also to inform action and improve lives.

These achievements are also a tribute to the dedication of your supervisors, faculty members, and mentors, whose guidance and encouragement have supported you throughout your journey. On behalf of the University, I thank them for their commitment to nurturing the next generation of researchers, professionals, and leaders.

As you graduate, I encourage you to retain the habits that I see have been cultivated: intellectual curiosity, critical thinking, humility, respect for evidence and a determination to use your knowledge in service of others. The challenges facing our societies are complex, but so too are the opportunities to make a meaningful difference.

I wish you every success in the years ahead. May you continue to learn, to question, to innovate, and to contribute to the communities and regions you call home.

With pride and warm wishes,

Professor Christopher J Gerry
Rector
University of Central Asia

Message from the Dean of the School of Arts and Sciences

It is with great pride and admiration that I introduce this Diploma Brochure: Class of 2026. Over the past five years, our students have undertaken a rigorous and transformative journey toward their Bachelor of Science and Bachelor of Arts degrees. Their bachelor theses represent not only the culmination of their undergraduate education, but also their first substantial independent academic work — projects through which they learned to formulate research questions, engage critically with literature and data, and contribute thoughtfully to knowledge production in their respective fields. I have had the privilege of observing this process closely, from the first presentation of research ideas in the autumn semester to the final defence of the completed projects. Watching these ideas evolve into mature and meaningful research has been one of the most rewarding aspects of this academic year.

The theses collected in this volume demonstrate a remarkable engagement with the social, environmental, technological, and economic realities of Kyrgyzstan, Tajikistan, and the wider Central Asian region. Our Computer Science students explored socially impactful technological innovation, developing AI-driven and multilingual systems addressing challenges such as education inequality, digital accessibility, smart agriculture, cybersecurity, and public services in resource-constrained environments. In Communications and Media, students examined questions of identity, memory, migration, gender, and cultural representation through creative and qualitative approaches, reflecting deeply on the changing social fabric of post-Soviet societies. The Global Economics cohort investigated pressing issues including financial inclusion, migration, energy insecurity, labour productivity, and sustainable development, offering empirically grounded analyses relevant to regional policymaking and economic resilience. Meanwhile, students in Earth and Environmental Sciences addressed urgent environmental challenges facing mountain regions, including glacial lake expansion, climate-related hazards, pollution, and resource sustainability, applying interdisciplinary scientific methods to questions of direct regional importance.

Across all programmes, the theses reflect intellectual curiosity, methodological creativity, and a strong sense of responsibility toward the communities and environments in which our students live and work. Equally important has been the collaborative relationship between students and their supervisors. I would like to express my sincere gratitude to all faculty supervisors for their dedication, guidance, patience and support throughout this demanding process. Their mentorship has been instrumental in helping students refine their ideas, overcome challenges, and complete projects of impressive quality and relevance.

As Dean, I congratulate all our graduates on this important achievement. I hope that the experience of conducting independent research will remain an enduring foundation for your future academic, professional, and personal paths. May you continue to approach the world with curiosity, critical inquiry, and the confidence to ask important questions and seek meaningful solutions. I wish each of you continued success and fulfilment in the journeys ahead.

Dr Diana Pauna
Dean of the School of Arts and Sciences
University of Central Asia

Communications and Media

Communicative Ecology of Professional Women in Naryn region: The Role of Social Media in Everyday Life

Aigerim Zhanyshbekova
Supervisor: Dr Usha Sundar Harris

This research is devoted to the study of communicative ecology among professional women in the Naryn region of Kyrgyzstan. The purpose is to study how professional women in this remote mountainous community use social and mobile platforms to make connections, exchange practical information, and influence their local community. The study reveals women's communication practices is influenced by their professional activities, everyday life and socio-cultural norms.

The theoretical basis of the research is the concept of communicative ecology (Tacchi, 2006), an ethnographic approach which considers technological, social and discursive aspects in the communication space. This theory helps to understand how online and offline communication formats are interconnected in the routine of professional women. In addition, this framework reveals that the media functions not only to support connections but is also an important means for community participation and social support.

The research used qualitative methodology. Open questionnaires and semi-structured in-depth interviews invited responses from different ages and categories of professional women in the Naryn region. The thematic analysis was used to identify important patterns of social media usage, generational and social differences, and the motivations of the participants.

The results of the study reveal that social networks play a key role in the lives of professional women. Facebook Instagram, Facebook, and Telegram are used to share information, maintain professional and personal connections, and participate in the life of the local community. These platforms allow for the exchange of practical information, expand the horizons of work and personal life opportunities. In addition, the study shows that the level of media literacy, infrastructure and the economic situation of the region are important factors in the use of these networks.

The work contributes to the study of communicative ecology within the context of Naryn and other similar communities. The data obtained will be useful for further research in the field of digital communications, social media, and gender differences especially in Kyrgyzstan.

Keywords: *Communicative ecology, professional women, social media, gender, Naryn.*

Balkar Diaspora in Kyrgyzstan: Postmemory of 1944 Stalin's Exiles

Altynai Turgun
Supervisor: Dr Elena Kolesova

This paper explores the postmemory of 1944 Stalin's exile of the Balkar diaspora in Kyrgyzstan. The research deals with my family's experience of deportation and assimilation in Kenbulun and Ivanovka, villages near Bishkek.

Because of "commited treason", accused of collaborating with German troops during World War II, 37000 Balkars were deported from Nalchik in Northern Caucasus to Kyrgyzstan and

Kazakhstan. Children, women, and the elderly were placed in overcrowded freight wagons, without food and water. Because of this harsh condition, many people did not survive the journey.

The deportations left a deep psychological trauma, the effect of which continues to shape lives of subsequent generations. This is autoethnographical research, combining qualitative approaches of in-depth interviews of the 2nd and 3rd generations of Balkar diaspora. Drawing on Marianne Hirsch's concept of postmemory, this study investigates how inherited trauma is preserved and transmitted in the absence of direct family narratives. Embodied practices and everyday rituals become modes of communication through which memory is maintained.

The final outcome of the research project would be presented in photographic collages as visual interpretations of postmemory. Through this approach, the research contributes to scholarship by presenting the memory and history of Balkars' deportation as a living and creative practice.

Keywords: *Balkar deportation, post memory, trauma, diaspora, intergenerational memory, photography*

Commemoration, Representation, and Celebration of the New Year Holiday Across Generations among a Small Community in GBAO, Tajikistan: A Media Study Perspective

Amjad Asalbekov

Supervisors: Dr Amrisho Lashkariev, Dr Chorshanbe Ghoibnazarov

This thesis looks at how the Russian New Year holiday has been remembered, celebrated, and understood across two generations in the Rushani community of Barushan village, located in the Gorno-Badakhshan Autonomous Oblast (GBAO) of Tajikistan. The holiday has been looked at in broader Soviet and post-Soviet contexts before, but how a small minority community with its own cultural identity dealt with this outside tradition across generations, and especially the part media played in all of this, has not received much attention.

This research is qualitative. Twenty in-depth interviews were conducted with eight women and twelve men, half of whom are from the Soviet generation and the other half grew up after Tajikistan became an independent state in 1991. Alongside the interviews, a Soviet-era print media source was analyzed, specifically the December 1975 issue of Mashal magazine. To bring in a comparison with Navruz, recent television programs and videos of Navruz celebrations in GBAO were also analyzed, which helped show how the state used media to promote different holidays at different points in history.

What came out of the research is that the Rushani community did not simply take the Soviet New Year as it was, nor did they reject it. Over time, they made it their own by gradually replacing Soviet symbols with local ones, a notable example is how the Russian Yolochka (Fir Tree) became the Archa (Juniper Tree) through the process of localization. This research contributes to discussions of the role of media in constructing new rituals and practices, cultural memory, and minority identity, and points to the fact that communities do not passively accept traditions brought in and promoted from outside.

Keywords: *Localization, collective memory, invented traditions, media representation, minority identity, intergenerational memory.*

The Language We Forgot to Love: Intergenerational Kyrgyz Identity in Post-Soviet Karakol

Ayana Namazaieva
Supervisor: Dr Elena Kolesova

This study explores how Kyrgyz language influences identity construction across generations of Kyrgyz residents in Karakol, a multiethnic city in eastern Kyrgyzstan. Founded in the nineteenth century as a Russian military settlement and known as Przhevalsk until 1991, Karakol has a complex linguistic environment where Russian remains widely spoken in public sphere and often functions as a lingua franca in this multiethnic setting. After Kyrgyzstan gained its independence in 1991, Kyrgyz was declared the state language, while Russian, which gained the status of an official language, remains widely used, particularly in cities like Bishkek and Karakol. This linguistic reality is not accidental but reflects a deeper colonial legacy in which the Soviet language policy positioned Russian as the language of education, progress, and prestige, a hierarchy which effects persist in urban spaces to this day. Paradoxically, many young people in Karakol grew up speaking Russian as their primary language, often associated Kyrgyz with periphery and backwardness, while feeling a deep emotional and cultural connection to it. This raises the question of how Kyrgyz people construct their cultural identity in the multicultural and multilingual city of Karakol and how they perceive the role of the Kyrgyz language in their identity construction.

The study adopts a qualitative research methodology based on in-depth semi-structured interviews with participants from Soviet and post-Soviet generations of Karakol. It analyzes how intergenerational behaviors and experiences have influenced the linguistic heritage, making Russian more popular and widely used among the Kyrgyz youth of Karakol. Being native to Karakol, I use an autoethnographic approach to reflect on my personal experiences as a Kyrgyz and Russian speaker growing up in this city. The creative outcome, an original song, artistically represents an autoethnographic approach, capturing multigenerational stories, revealing how language and identity are intertwined, and giving voice to the emotional dimensions of linguistic identity. Together, the research contributes to a deeper understanding of how language shapes cultural continuity, identity formation, and the ongoing process of decolonial reclamation in contemporary Kyrgyz society, offering a nuanced portrait of what it means to be Kyrgyz in a multilingual, post-Soviet city today.

Keywords: *Kyrgyz language, Russian language, cultural identity, language shift linguistic diversity, Karakol, Kyrgyzstan, post-Soviet society, colonialism, decoloniality, autoethnography*

Digital Cultural Content and Communication: Challenges, Strategies, and Opportunities in the Ecosystem of Kyrgyz Instagram Influencers

Ayana Supueva
Supervisor: Dr Soheil Ashrafi

The study examines how complex cultural themes can be effectively communicated via short-form social media videos. The contemporary digital landscape brings opportunities for content creators to tell stories and represent cultures, but the common qualities of viral social media content such as simplicity, the fast pace, and the entertainment focus often stop short of the nuanced nature of cultural traditions, histories, and crafts. This raises a challenge for conveying depths in short videos while maintaining the viewer interest. This problem is particularly noticeable in Kyrgyzstan where although a dynamic ecosystem of influencers focused on cultural themes is growing, a lack of consistent audience engagement is still notable. Despite the soaring interest in digital storytelling in Kyrgyzstan, the subject matter still remains widely under-researched.

The study focuses on Instagram as one of the most visited social media platforms in Kyrgyzstan for promotional and experiential content. It employs a qualitative and exploratory research design combining content analysis and semi-structured interviews to gain insight into the efficacy of content creation strategies focused on Kyrgyz culture. To this end, and through purposive sampling, 3 Instagram accounts will be analyzed based on detailed coding schemes and value assignments. To further enrich and complement the emerging results the account owners will be interviewed for their experience of the ebb and flow of audience engagement. Informed by the research results, the study concludes with an experimental series of reels to showcase creative and effective ways in which cultural content can be produced for the current and emerging generations of content creators in Kyrgyzstan.

Keywords: *reels, cultural content, Instagram, influencer ecosystem, Kyrgyzstan*

Revisiting the Notion of Homeland Through Autoethnographic Methods in Mixed Media Filmmaking

Yekaterina Shubina
Supervisor: Anisa Sabiri

This project looks at the notion of "Homeland" as a fluid and subjective concept that is dynamically shaped by a person's memory through personal experience. The research aims to revisit the concept homeland by using autoethnographic methods, such as self-reflection, that will translate through my personal experience into film and position it as a form of knowledge production.

The project draws on Walter Mignolo's theory of Epistemic Disobedience. By challenging conventional hierarchies of knowledge, marginalized and subjective ways of knowing come to the fore.

The methodology of this project is desk-based research and autoethnographic reflection in creative practice. Together, these approaches pave the way for a mixed media film with elements of hand-drawn animation, creating a layered visual narrative. This way, the process of creating a film is an example of how a creative practice can serve as both a research method and a critical inquiry.

By centering the experience of a Slavic minority in Kazakhstan, the project aims to contribute to a broader discussion of identity, belonging, and decolonial approaches to knowledge. It emphasizes the value of personal narratives in reshaping the dominant understanding of place.

Keywords: *homeland, autoethnography, mixed media, decolonial theory, identity, visual storytelling.*

Fragile Belonging: Pamiri Identity Through Cinema

Faridun Karabozov

Supervisors: Nursultan Stanaliev, Anisa Sabiri

This project examines the experience of memory and belonging among Pamiri Ismaili migrants living away from home. Although migration has been extensively researched, there has been little focus on the emotional and sensory aspects of migration - in particular, how small everyday acts of remembrance maintain a connection to a place that is no longer home. This is especially true for Pamiri Ismailis, whose experiences are largely overlooked in research and the media.

The research will explore what film techniques can convey the sense of fragile belonging – not belonging to a place. The main research question is: how to represent memory and belonging of Pamiri Ismaili migrants through film?

This project is important because it is an inside-out look. As a Pamiri Ismaili who lived in Siberia, studied in Kyrgyzstan, and did research in Moscow, I am an autoethnographer, a filmmaker, researcher, and participant. This is not a film about a community from the outside. It is an inside-out portrait – from someone who has lived across cultures, languages and places for most of his life.

Through a practice-based approach, data will be gathered through semi-structured interviews, participant observation, sensory ethnography and performance-based visual techniques. The study also uses recovered archival family video from Pamir, shot in collaboration with my father from afar.

The result will be a 13–15-minute hybrid experimental documentary film, which is personal, non-linear and poetic in structure. It will not explain the experience of displacement but rather convey it. An accompanying written analysis will explore how cinematic techniques like sound, silence, haptic visuality and fragmented narrative express the inexpressible.

Keywords: *migration, memory, in-between, belonging, hybrid documentary, autoethnography, sensory ethnography, haptic visuality, diaspora, displacement*

Representation of Women in Museum Exhibitions in Bishkek: National Museums and Contemporary Feminist Museum

Farzona Mamadrasulova
Supervisor: Dr Elena Kolesova

Museums have a major impact on how societies perceive their histories, cultures and identities. In post-Soviet Central Asia, museums have also become major sites for creating and communicating national narratives. However, in the establishment of these narratives, representations of women are either frequently restricted or largely symbolic and/or absent. As such, this leads to an important question: How are women represented in the current cultural institutions in Kyrgyzstan?

This research examines the representation of women in three museum contexts: the National Historical Museum, Gapar Aitiev National Museum of Fine Arts, and MOFA+ (a digital Museum of Feminist and Queer Art). State museums promote state-sponsored, institutional narratives, while MOFA+ presents an alternative, independent view. The research seeks to compare the two types of institutions in order to learn how different curatorial practices influence the representation, role and agency of women.

The research uses qualitative analysis based on visual and textual examination of artworks and exhibitions. It utilizes a three-layered approach that focuses on three areas: representation, role / experience, and agency / voice. Particular emphasis is placed upon the way that text accompanies visual materials and constructs the meaning.

Findings of the research illustrate that there are distinct differences between the approaches of traditional and feminist artists regarding the portrayal of women. In state-owned museums, women are confined to fixed and/or idealized roles including a cultural icon or an embodiment of tradition removing the individuality of women from the developed works. On the other hand, MOFA+ curates works that depict women more as multidimensional beings with focus on identity, inequality and individual experiences.

Therefore, this study argues that contemporary feminist practices in museums can create new narratives that will challenge and redefine the traditional representation of women in museums. This will be achieved through the emphasis on the evolution of representation of women from static and symbolic roles to more dynamic, experience-based and self-authored. As such, this study contributes to the ongoing discourse regarding the construction and representation of women's identities in post-Soviet contexts, as well as providing a framework for thinking about museums' construction and communication of women's identities.

Keywords: *women representation, museums, Kyrgyzstan, feminist art, agency, visual culture, post-Soviet studies*

The Role of Instagram Marketing in Customer Conversion: A Case Study of Small Food Businesses in Khorog

Inessa Baidulloeva
Supervisor: Dr Soheil Ashrafi

This study examines the role of Instagram marketing in customer conversion among small food businesses in Khorog, Tajikistan. In the context of the growth of digital marketing, Instagram is widely used by small food businesses to increase their visibility online. However, its impact on customer purchasing remains insufficiently understood. Using a case study approach, the study analyzed three cafés in Khorog through content analysis and semi-structured interviews. Results indicate that while Instagram is effective in increasing the visibility of the cafés, it has no direct impact on the conversion of customers to those cafes. High engagement doesn't necessarily lead to customer action, highlighting the visibility-conversion gap. The study emphasizes the importance of aligning content with customer intent to improve conversion outcomes.

Keywords: *Instagram Marketing, Social Media Marketing, Visibility-Conversion gap, AIDA, Khorog*

Women's Agency in Kyrgyz Traditional Crafts

Nurkamal Zhetigenova
Supervisors: Dr Elena Kolesova, Anisa Sabiri

Kyrgyz traditional crafts, including shyrdak, kurak (patchwork), and embroidery, are praised as symbols of the national heritage. Nonetheless, existing research often overlooks the craftswomen who sustain them, ignoring their agency and cultural expertise. To address this gap, this study investigates how craftswomen in rural regions of northern Kyrgyzstan exercise agency through traditional craft practices. The research reinterprets craft not as passive cultural heritage but as a living space where women actively assert creativity, economic independence, social and cultural leadership and authority, within a decolonial framework. The study uses qualitative methods built upon semi-structured interviews and visual documentation. The final output of the research is a multimedia website that presents craftswomen's stories through written narratives, photographs, and audio recordings. The main argument of this research is that Kyrgyz traditional craft is not a remnant of the past but a living practice, actively shaped by the women who drive it into the future.

Keywords: *traditional crafts, cultural heritage, women's agency, decolonial perspective, cultural identity.*

A Lost Story of Home: A Study of Mnemonic Space Through Poetic Documentary

Sharora Ismoilshoeva
Supervisors: Anisa Sabiri, Nursultan Stanaliev

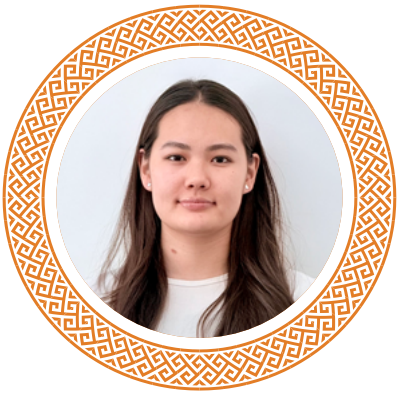
Home is often understood as a physical place to which one can always return. However, with the rise of migration, this concept becomes increasingly blurred. This project explores home as a mnemonic space through poetic filmmaking techniques that resist fixed definitions.

A Lost Story of Home, the film produced as part of this research, employs non-linear storytelling, symbolic imagery, and haptic visuality to reconstruct home not as a fixed location, but as an emotional and memory-based landscape. The project presents home as a fluid and shifting experience as one that exists not in a single place, but in the tension between what is remembered, lived, and imagined.

Keywords: *home, poetic documentary, memory, autoethnography, feminist visual theory*

Computer Science

Designing an Empirically Validated RAG Architecture for Multilingual Companies in Kyrgyzstan



Aizirek Iskenderova
Supervisor: Dr Muhammad Fayaz

The growing adoption of artificial intelligence for organizational knowledge access and automation has led to rapid development of Retrieval-Augmented Generation (RAG) systems. However, most existing approaches are designed and optimized for high-resource languages, particularly English, and remain insufficiently adapted to multilingual corporate environments where several languages may appear simultaneously within the same query, document, or workflow. This challenge is especially significant in the context of Kyrgyzstan, where Russian and Kyrgyz are often used together, while Kyrgyz remains a low-resource language with limited empirical evaluation in embedding, retrieval, and answer generation tasks. This research addresses the lack of a scientifically grounded RAG architecture for low-resource multilingual corporate settings based on Russian and Kyrgyz data. Rather than focusing on a single domain-specific application, the study investigates how organizations can design multilingual RAG pipelines. The case study is based on one of the leading mobile and banking companies in Kyrgyzstan and combines publicly available and private corporate datasets to reflect realistic enterprise conditions. The proposed work aims to identify practical and scientifically justified design principles for building a multilingual RAG system. In particular, the study examines the role of structured document organization, dataset preparation standards, multilingual embedding selection, chunking strategies and retrieval methods in improving answer relevance, factual grounding, and operational reliability. The expected outcomes include an empirically supported recommendations for structuring enterprise knowledge bases, and a practical reference architecture for multilingual RAG deployment in corporate environments. The findings are intended to support more scalable, inclusive, and trustworthy AI adoption in Kyrgyzstan.

Keywords: *Retrieval-Augmented Generation (RAG), multilingual corporate knowledge systems, low-resource languages, Kyrgyz language, code-switching, multilingual embeddings, hybrid retrieval, chunking strategies.*

DyikanAI: A Smart Greenhouse System for Mountainous Regions: ML-Based Frost Detection and AI Farmer Assistance

Alfiia Zholdosheva
Supervisor: Dr Muhammad Fayaz,
Co-Supervisor: Dr Dmytro Zubov

Farming in Kyrgyzstan, a country located in the mountains, is always confronted by issues like fast temperature fluctuations, irregular access to water, and increased instances of frost. Greenhouse farms operate through small-scale farmers that monitor the environment manually with limited capacity to predict future change as they are based on simple thresholds and pre-defined rules. In this regard, this paper introduces the data science module of DyikanAI, a joint project between multiple research institutions that has been established under the aegis of the COMMON Project – University of Central Asia Research and Development initiative. The author's contributions include data preprocessing, feature engineering based on physical properties of the greenhouse environment, comparing different classification algorithms used for frost prediction, building a predictive and threshold-based hybrid actuator control framework, as well as creating a chat bot-like recommendation tool for farmers. The sensors used in the experiment record air temperature, relative humidity, soil moisture content, and light intensity within the greenhouse. This process occurs once every 30 seconds in an Internet of Things (IoT) sensor box. In total, there are 35,545 training samples, including 505 samples from real greenhouse environments and 35,040 artificially created samples modeled based on the physical characteristics of Naryn's continental climate. Five algorithms were chosen for frost detection purposes: XGBoost, LightGBM, Random Forest, Gradient Boosting, and a Multi-Layer Perceptron (MLP). The highest recall (0.9747), and F1-score (0.9765) with AUC = 0.9950 was obtained by XGBoost. As a result, the XGBoost algorithm was deployed to perform frost prediction while a separate LightGBM algorithm predicted soil moisture levels ($R^2 \approx 0.97$, MAE ≈ 5 units). Hybrid control led to 20% reduced water use and 18% reduced energy use in comparison with threshold-based approaches. On average, the model inferrence time did not exceed 50 milliseconds per prediction period.

Keywords: *S greenhouse, IoT, XGBoost, LightGBM, frost detection, time-series forecasting, predictive control, precision agriculture, Kyrgyzstan.*

A Multilingual Intelligent Assistant for Education Content Retrieval and Voice Interaction – "Lumi"

Ali Davlatshoev
Supervisor: Dr Sam Goundar

In multilingual learning environments, the content of teaching is often shared in a haphazard and fragmented fashion on lingual, format, and platform levels, thus hindering effective and equal access by both students and teachers. This is notably acute in Central Asia where the students regularly listen to pedagogical material in the Tajik, Russian, and English languages. The present generation of AI based educational assistants is heavily biased towards English language content and uses cloud-based solutions, thus limiting their usability in settings where language resources are scarce, or where strong privacy policies are enforced. The current project proposes Lumi, a multilingual smart assistant designed to find and explain the academic material through the textual and spoken formats. It is based on a Retrieval-Augmented Generation (RAG) architecture that combines semantic document retrieval with the reasoning of large language models to provide source-based answers that give contextual awareness. Multilingual embeddings are used to process input documents and indexed with FAISS to do a similarity search quickly, and a locally hosted language model produces responses. Automatic speech recognition and text-to-speech make voice capabilities possible. The expected deliverables would include: a workable prototype that can be used to show the multilingual document retrieval, voice interaction and local deployment. The initiative aims to support the development of inclusive and privacy-friendly educational technologies by supporting the low-resource languages and higher access to the structured learning resources.

Keywords: *Multilingual AI assistant, Retrieval-Augmented Generation (RAG), Cross-lingual information retrieval, Low-resource languages, Local language models, Speech-based interaction (ASR/TTS), Privacy-preserving AI, Educational technology*

Decentralized Crowdfunding Platform For Kyrgyz Startups

Alisher Isaev
Supervisor: Dr Sam Goundar

One can state the key disadvantages of traditional crowdfunding websites such as Kickstarter and Indiegogo: expensive service fees (5-10%), geographic restrictions, early money withdrawals, and centralized design. Taking into consideration that there are no local platforms available for use in Kyrgyzstan, foreigners cannot use foreign platforms easily, and Kyrgyz people generally mistrust banks, decentralized crowdfunding solutions can become quite effective.

The suggested platform tackles these issues in several ways: with the help of Ethereum smart contracts based on the EIP-1167 Minimal Proxy (or clone factory) model, which allows to reduce costs of deploying campaigns' code by 71.2% compared to simple contracts creation. Projects will be launched on the Polygon platform, but the platform itself will work using KGST – the Kyrgyz government stablecoin on BNB Smart Chain, thus being aligned with the newly introduced Kyrgyz Digital Asset Regulation Act. The governance system will include blockchain-based DAO.

The development process was completed according to Agile approach with Test-Driven Development throughout three sprints: smart contract designing, back-end API implementation, and front-end building. The smart contracts code was written using the OpenZeppelin library in the Solidity programming language. As for the technologies used in back-end: Go and the Gin framework, as well as PostgreSQL database. The front-end was created using React along with ethers.js library for blockchain integration. The passwordless authentication will use crypto wallets signatures.

Security remains an important objective. Measures have been taken to protect against reentrancy exploits, impose stringent access restrictions, introduce rate limits, and conduct input validations. Fifty test cases have passed with a score of 100%.

The results demonstrate that the cost of deploying contracts has decreased from around 2.1 million gas to 600,000 gas per cloned contract and transactions costing less than one US cent per transaction on the Polygon network. The process of validating all the operations was conducted on a public test network. Next steps involve smart contract auditing, mainnet deployment, connecting mBank payment portal, and scalability considerations.

Keywords: *Blockchain, Crowdfunding, Smart Contracts, Decentralized Finance, Web3, Polygon, BNB Smart Chain, Kyrgyzstan, DAO, Governance, Solidity, Fintech, Startup Ecosystem*

Sport Management System for the University of Central Asia

Anis Partovov

Supervisor: Dr Dmytro Zubov

Currently, sports tournaments at the University of Central Asia are managed manually, which can lead to scheduling conflicts, delays in updating results, and limited access to tournament information. This project proposes the development of a web-based Sports Management Platform to address these challenges by providing a centralized system for organizing and managing sports events. The main objective of this project is to design and implement a system that simplifies key processes such as team and player registration, match scheduling, score tracking, and result presentation. By digitizing these activities, the platform aims to improve efficiency, transparency, and accessibility for all users.

The project follows a system implementation methodology, including requirements analysis, system design, backend and frontend development, database management, testing, and deployment. The backend is developed using Django and Django REST Framework, while PostgreSQL is used as the database system. The frontend is designed to be user-friendly and accessible to users with varying levels of technical expertise.

Although the system is still under development, the goal is to deliver a fully functional platform that streamlines administrative tasks, reduces human error, and provides real-time access to tournament data. Ultimately, this project aims to significantly improve the organization and management of sports events at the University of Central Asia.

Keywords: *Sports Management System, Web-Based Platform, Tournament Management, Scheduling System, Django, Django REST Framework, PostgreSQL, Sports Analytics, Information System, University Sports Management.*

DyikanAI: Multi-Sensor Monitoring System For Smart Greenhouse

Aruuke Sanzharbekova
Supervisor: Dr Dmytro Zubov
Co-Supervisor: Dr Muhammad Fayaz

This thesis addresses the absence of data-quality-aware IoT monitoring infrastructure for small-scale greenhouse agriculture in Central Asia. An edge layer was designed and implemented for the DyikanAI smart greenhouse system, integrating sensor calibration, Kalman filtering, time-series storage, a REST API, and MQTT-based communication security into a pipeline of independent, fault-tolerant services running on an Arduino Mega 2560 and Raspberry Pi 400. The system was evaluated through continuous operation, reboot testing, and targeted security verification. Results show 0% MQTT message loss across 45,035 messages, 37ms mean actuator command latency, and full autonomous service recovery within 46 seconds of power failure. Per-channel Kalman filtering reduced soil moisture and humidity noise by 71.5% and 65.8% respectively. Gravimetric calibration revealed that the capacitive soil moisture sensor saturates at 60% volumetric moisture content in peat substrate — a finding not reported for this sensor model in the literature that changes the correct calibration model qualitatively. This work contributes a calibrated, filtered, and authenticated data foundation for the fuzzy logic control and machine learning layers of DyikanAI, and a reproducible template for principled IoT edge layer development in resource-constrained agricultural contexts.

Keywords: *Internet of Things; Smart Greenhouse; Sensor Calibration; Kalman Filter; MQTT; Edge Computing; InfluxDB; IoT Security; Precision Agriculture*

MyCity: Smart City Digital Bureaucracy Platform

Bahrom Saidashurov
Supervisor: Dr Sam Goundar

The high rates of urbanisation and population are pushing more and more pressure on the municipal governments to provide efficient, transparent and people-centred services. The administrative procedures that ensure permits, licences and maintenance requests are also based in most areas in paper forms and mysterious bureaucracies. There is a tendency of the citizens to have problems when it comes to reporting the infrastructure problems, the progress of their request and receiving the official documents. MyNaryn is a digital city bureaucracy framework created as a Final Year Project to provide solutions to these issues in the setting of Naryn, Kyrgyzstan. The site provides residents with a user friendly web interface to report neighbourhood issues, take out permits and communicate with the municipal departments. It encompasses map based visualisation, real time status information and an administrative dashboard that are useful towards informed decision making. The proposed project uses an agile approach and is developed with a modern technology stack that consists of React, Node.js, PostgreSQL, Leaflet and geospatial services. This is a report about the conceptualization, design, execution and analysis of MyNaryn platform. It provides a summary of the digital government and smart city projects literature, explains the system plan and user experience, evaluates the project results of the implementation and evaluates the sustainability and ethical aspects. The MyNaryn platform helps to enhance transparency and involvement levels of citizens by digitising bureaucratic work thereby making Naryn a more responsive and comfortable city to live in. The MyNaryn platform is currently not a publicly launched project; it is currently deployed on the web as a local application and a mobile application on Flutter. The prototypes for mobile devices are deployed on local machines and servers and have not been made available to external users as the project is yet to be given into a governmental use. This report is therefore an analysis of a local prototype but not a production deployment.

Keywords: *smart city; digital bureaucracy; e-government; civic engagement; geographic information system; Naryn*

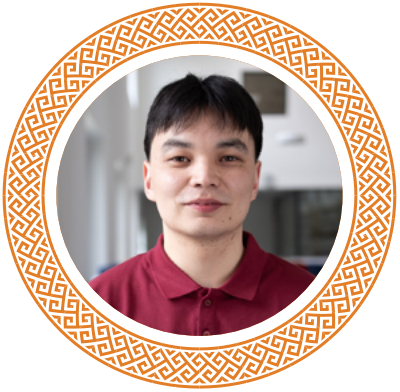
JAILOO.KG: Digital Livestock Market Platform for Kyrgyzstan

Cholpon Ishenbekova
Supervisor: Dr Muhammad Fayaz

This research outlines the design and development of the JAILOO marketplace platform, a digital marketplace that allows transactions involving livestock to overcome geographical and economic limitations faced by livestock farmers and traders in Kyrgyzstan. JAILOO is developed using the Progressive Web App framework, thus providing functionality like a native app without developing an iOS or Android version. JAILOO features support for multiple languages, including Kyrgyz and Russian; support for media-rich listings; direct buyer-seller communication; and logistics management for delivery services. A unique interface for delivery drivers and web dashboards for logistics and administrators completes the application's offerings. The JAILOO platform aims to increase market access, minimize risks associated with travel, and foster digital inclusivity among rural populations. The effectiveness of the platform is gauged through its performance and user testing.

Keywords: *Online marketplace, livestock trade, Kyrgyzstan, Progressive Web App (PWA), AI chatbot, rural economic development, logistics integration*

OkuORT: Leveraging Gamification and AI-Driven Tutoring to Enhance Habitual Engagement in High-Stakes Exam Readiness



Dastan Akatov
Supervisor: Dr Sam Goundar

In the Kyrgyz Republic, the National Scholarship Test (ORT/JRT), is the primary determinant of access to subsidised higher education. Despite its high stakes, a significant performance gap exists between urban centers and rural regions, largely driven by the scarcity of high-quality, structured preparation resources for Kyrgyz-language students. This paper presents the design and implementation of OkuORT, a web-based platform engineered to bridge this divide through a combination of high-fidelity exam simulation, retrieval-augmented intelligence, and behavioural design. This system is implemented based on the client-server architecture where the backend is written in Go and supports concurrency to accommodate simultaneous examination periods; the frontend developed by Next.js 16 provides a fast and type-safe UI experience. Engineering difficulties related to the domain have been solved in many ways. First of all, in order to manage data of different types and formats that are used in standardized examinations, including math-style problems and reading comprehension tests, there is a polymorphic schema with the use of PostgreSQL JSONB field. Second of all, in order to turn the passive tests into an active learning tool, OkuORT incorporates an artificial intelligence based on the Retrieval Augmented Generation principle which uses Google Gemini File Search API. After providing an incorrect answer, the system finds out contextually appropriate passages and produces a logically coherent explanation based on the actual curriculum. Finally, in order to facilitate information memorization, a Spaced Repetition System and gamification are used. The resulting platform shows how production-ready web engineering techniques, used with an understanding of the local educational context, can provide accessible and effective learning infrastructure even where the usual institutional resources are not available.

Keywords: *ORT (ЖКРТ), Standardized Test Preparation, Web Engineering, Golang, Next.js, Retrieval-Augmented Generation (RAG), AI Tutoring, Spaced Repetition System (SRS), Gamification, Scalable Architecture*

Traffic Light Control Application Based on Computer Vision

Erkinbek Diushekeev
Supervisor: Dr Muhammad Fayaz

Traffic management in urban areas is one of the most important problems in modern urban planning. One of the major problems is static traffic control, which relies on time-based algorithms that are not adapted to real-time changes in the number of vehicles. This project offers an "AI-Adaptive Traffic Management System", a software solution to increase traffic efficiency at intersections using computer vision and state management algorithms. This solution uses the YOLOv8 object detection algorithm to recognize and count vehicles in video feed from overhead cameras or drone footage. The technical architecture consists of a Python backend that implements machine learning and API logic, and a Next.js frontend used to create an interface for operators. The application allows using one of three modes of operation: Manual mode, Timer mode, and AI-Adaptive mode. The main emphasis during development was on software-hardware integration and optimization of deep learning models. To minimize inference time, hardware acceleration with an NVIDIA RTX 3060 GPU was implemented. In addition, this solution contains deterministic safety mechanisms, such as All-Red phases to avoid conflicting traffic lights.

Keywords: *Computer Vision, Machine Learning, Car Recognition, Traffic Control, Software Development*

IrisAuth

Firuz Azizbekov
Supervisor: Dr Dmytro Zubov

Biometric authentication has emerged as a reliable alternative to traditional credential-based access control, offering higher security and reduced risk of unauthorized access through the use of unique physiological traits (Daugman, 2004). Iris recognition, in particular, is considered one of the most accurate biometric modalities due to the high entropy and long-term stability of the iris pattern. Despite these advantages, biometric access systems in university settings remain largely proprietary, expensive, or poorly integrated with institution-level student management workflows. This thesis addresses that gap by documenting the design and implementation of a web-based iris recognition system tailored to the University of Central Asia's access control context. The system enables authorized personnel to enroll students via an iris scan and subsequently authenticate them in under two seconds, with all events recorded and viewable through a live security dashboard. The backend was developed using Python and the FastAPI framework, with Motor providing asynchronous access to a MongoDB database for persistent storage of student records and access events. Redis serves as an in-memory cache for enrolled iris codes, enabling fast candidate retrieval during matching. A Java bridge service mediates communication with the IriShield MK 2120U USB iris scanner, abstracting low-level hardware interaction from the Python application layer. Iris code extraction and matching are performed using the open-iris pipeline (Worldcoin, 2023), applying normalized Hamming distance over binary iris codes and masks. The React and Vite frontend provides a real-time security feed driven by WebSocket events, along with pages for student enrollment, access history, and system health monitoring.

Keywords: *Iris Recognition, Biometric Authentication, FastAPI, open-iris, MongoDB, Redis, WebSocket, Java Bridge, IriShield, Reac*

Artificial Intelligence-Based Fire Detection System

Marzia Taban Jafari
Supervisor: Dr Muhammad Fayaz

Throughout history, fire has caused significant damage to people, the environment, infrastructure, and animals. Traditional fire detection methods that depend on heat and smoke sensors often respond slowly. Fire detects when the heat or smoke physically reaches the sensor. Additionally, these systems can trigger false alarms from normal daily activities like ironing and cooking. This can lower trust in alarm systems during genuine emergencies. With advancements in surveillance systems and the rise of artificial intelligence, fire detection using computer vision has become a viable alternative. This project develops deep learning object detection models, YOLOv8, for quick and accurate differentiation between fire and non-fire situations. Convolutional neural networks are used to train the model after datasets of fire and non-fire images are gathered and labeled. Live video feeds are processed using OpenCV, system communication is supported by a FastAPI backend, and real-time results and alerts are shown on a web-based dashboard. Temporal filtering is used to improve reliability by confirming fire only after it has been consistently detected over several frames. Hard negative mining is also used to reduce false positives. brought on by reflections, bright lighting, and other recognizable visual patterns. To. Monitor and analyze recognized events, the system also logs them. In comparison to conventional techniques, experimental results show that the system can effectively detect fire in real time with increased accuracy. and. fewer false alarms. Therefore, this system is suitable. in environments where early fire detection is crucial, like residential buildings, university campuses, and industrial environments

Keywords: *Artificial Intelligence, Fire Detection, Computer Vision, YOLOv8, Real-Time Monitoring, Deep Learning, False Alarm Reduction, Temporal Filtering.*

Mobile Event Management Platform for UCA

Muzaffar Nazarkhudoev
Supervisor: Dr Muhammad Fayaz

Universities are constantly involved in various activities like academic, cultural, and community events, yet the information regarding these activities is spread out across different sources such as emails, social media posts, and paper posters. This scattering gives rise to a situation where events receive little visibility, registration processes become inefficient, and organizers get limited feedback. The idea behind this project is to come up with a mobile-first UCA Event Management Platform that will consist of a Flutter mobile application and a Django REST backend. This is going to be a centralized platform where students, staff, organizers, and admins can discover, register, and obtain digital tickets as well as report analytics in one place. The envisioned platform is going to provide a range of features such as user-role access, QR-code ticketing and check, notification in real-time through WebSockets and Firebase Cloud Messaging, and dashboards with engagement analytics. The agile software development methodology is followed, which combines iterative backend and mobile development with regular testing and user-centered design. The project includes the analysis of requirements, design of systems, backend infrastructure, and the creation of basic features such as authentication and events management together with an integrated mobile interface for users. Advanced features have been implemented in the app such as analytics, notification flows, and usability assessment from the user's point of view. The outcome of the final assessment will be known later; however, the project is the implementation of a secure, scalable, and UCA-oriented event management platform that will streamline communication, eliminate manual tasks, and make data-driven decisions.

Keywords: *Event Management System; University Events; Mobile Application; Django REST Framework; Flutter; QR Code Ticketing; Role-Based Access Control; Push Notifications; Analytics Dashboard; Centralized Communication; Higher Education Technology; System Design.*

LLM Security Tester: Web-Based Benchmarking of LLM Safety Against Adversarial Prompts

Ramzi Abdulalishoev
Supervisor: Dr Sam Goundar

Large Language Models are becoming more common in workflows that use user prompts alongside search results, system prompts and tool invocations. This presents vulnerabilities such as prompt injection, jailbreaks, system prompt leakage, and Unicode/emoji encoding. Such risks are difficult to test on a regular basis, especially since most tools are command-line based that cannot be easily incorporated into the engineering workflow. This project addresses this issue by creating LLM Security Tester, an application-layer adversarial scanning tool for large language models. The tool includes Quick Scan mode with preassembled packs of attack prompts, and Research Scan mode, which uses garak to perform probe-based scanning. The app uses a worker queue and an asynchronous backend API to scan, and records results with configuration information and offers a clear PASS/WARN/FAIL summary. Additional features are user authenticated scans, model management (local and cloud), scan history, dashboard analytics, heatmap visuals and report exports. The evaluation is done on twelve Quick Scan executions, four models with three repeated scans. The results show that the system can generate structured logs of model behavior under adversarial attacks and compare local and cloud models. Finally, the project demonstrates the possibility to design the process of security testing of LLM in a more structured, traceable, and available form rather than an ad hoc and manual process.

Keywords: *cybersecurity, software engineering, large language models, LLM security, OWASP Top 10 for LLM Applications, adversarial prompting, prompt injection, jailbreak attacks, system prompt leakage, security benchmarking, PASS/WARN/FAIL scoring, garak*

Automated Cryptocurrency Trading System

Ramzi Shodmonbekov
Supervisor: Dr Sam Goundar

This thesis introduces the design and execution of a TradingView to Bybit Automation Platform that links trading alerts based on charts to exchange execution via a regulated software layer. The project fills a functional gap in actual trading processes: users tend to create explicit signals in TradingView and do so manually on exchange platforms, which brings about delays, imprecision, and unnecessary operational errors. To counter this, the research creates a full-stack solution featuring an authentication backend API, webhook ingestion API, validation API, state-based policy checks API, exchange connection handling API, and conditional order routing API, backed by a user management frontend, bot management frontend, settings frontend, and monitoring frontend. The methodology is an engineering artifact plus assessment method, where the testing is done by scenarios and an interpretation of the evidence is evidence-based. It is found that the system implemented can impose consistent decision behavior in that it can accept valid and qualified signals and reject unauthorized, malformed or policy-ineligible requests. This shows the importance of conditional automation as compared to direct signal forwarding. The technical implementation is finished, and optimization is currently in a ten-cycle plan, two complete cycles and one partial cycle is finished at reporting time. Interim analysis is supported by supplementary cycle artifacts of real historical candle data but not as end-of-the-line profitability evidence. The project adds a more practical, governance-based pattern of integration of safer alert-to-execution automation.

Keywords: *Algorithmic Trading, TradingView Webhooks, Bybit API, Alert-to-Execution Automation, Risk-Controlled Execution, Full-Stack Web Application*

Campus Network Security Monitoring

Raul Shodmonbekov
Supervisor: Dr Dmytro Zubov

In an era of increasing frequency and sophistication of cyber threats, maintaining the integrity of institutional network infrastructures has become a critical challenge for modern universities. At the University of Central Asia (UCA), aging network hardware and the lack of centralized visibility often result in undetected anomalies and delayed incident response. This project addresses these vulnerabilities through the development of a professional-grade Campus Network Security Monitoring System, designed to provide real-time visibility, automated threat detection, and advanced data visualization. The system's architecture is built on a robust data pipeline that integrates open-source security sensors with a scalable distributed processing stack. Network traffic is captured and analyzed using Zeek for behavioral logging and Suricata for signature-based Intrusion Detection (IDS). These logs are streamed through Apache Kafka as a message broker and normalized via Logstash before being indexed in Elasticsearch for high-speed retrieval. The backend is developed using the Python-based Django framework, incorporating the Django REST Framework for API management and Django Channels for real-time WebSocket-based alert streaming. The frontend provides a high-end, "Cyber-Dark" glassmorphism dashboard built with React and Shadcn/UI, utilizing Framer Motion for professional animations and Recharts for security analytics. Key features include automated alerting through integrated case management, threat intelligence correlation via external APIs, and a multilingual interface supporting English, Russian, Kyrgyz, Tajik, and Kazakh. This project delivers a comprehensive, Dockerized solution that significantly enhances the university's cybersecurity posture while serving as a hands-on research tool for computer science students.

Keywords: *Network Security Monitoring, Intrusion Detection System (IDS), ELK Stack, Apache Kafka, Django REST Framework, WebSockets (Django Channels), Real-time Security Analytics, Threat Intelligence Correlation, Role-based Access Control (RBAC), Cybersecurity Automation, Dockerized Infrastructure.*

DyikanAI: Weather-Driven Intelligent Control System For Smart Greenhouse

Saadat Orozova

Supervisor: Dr Dmytro Zubov,
Co-Supervisor: Dr Muhammad Fayaz

Climate change, water scarcity, and frosting are placing increased stress on small-scale farmers in cold continental mountain environments such as in Naryn, Kyrgyzstan. While greenhouses are among the most straightforward solutions to this challenge, neither the commercial controller for industrial-grade farms, which assumes cloud connectivity, nor the threshold-based controller, common to inexpensive IoT installations, can be used in an unreliable internet connection setting. This paper presents the design and implementation of a subsystem of a control system for a greenhouse in a cold continental environment that features an intelligent fuzzy inference engine based on Mamdani fuzzy inference system. The controller takes in six input values (indoor air temperature, humidity, soil moisture, soil temperature, light), including a boolean frost risk value, and controls three actuators (the heater/fan, water pump, and grow light) through three rule bases totaling 83 rules. All membership function break points are informed by FAO recommendations and empirical statistics from site sensor data. The system operates in a standalone configuration using the Raspberry Pi 4 as an edge computer and an Arduino Mega with an attached Ethernet Shield. There are two operational modes: automated fuzzy rule base operation every ten seconds and manual mode with direct web dashboard-driven actuator control. Evaluation includes property testing, sensitivity analysis, control surface evaluation, rule base verification, and head-to-head comparison against a threshold-based control system. The purpose of this work is to develop a reproducible, low-cost reference implementation of a climate-aware intelligent greenhouse control system for use in small agricultural operations in cold continental environments.

Keywords: *Smart greenhouse, Mamdani fuzzy inference, intelligent control, weather-driven irrigation, frost protection, Internet of Things, edge computing, explainable AI, climate-smart agriculture*

Intelligent Business Analytics and Forecasting System for E-Commerce

Sawera Mushtaq
Supervisor: Dr Muhammad Fayaz

In today's world, businesses possess a large amount of data about their customers, markets, and operations. They are facing problems in taking insights from this data that could give them the capability of making strategic decisions. To address this challenge, this project has developed an end-to-end Business Analytics System that will help organizations make decisions based on predictions and insights derived from their data. The system has four main components, including prediction tools, customer churn analysis, automated reporting, and an AI-assistant. The architecture of the system has FastAPI in the backend along with an automated machine learning pipeline. It functions dynamically by finding the best models for the predictions, such as Random Forest, Gradient Boosting, and Ridge Regression, depending on the dataset's specifics. In addition, ARIMA and Holt-Winters models are incorporated for capturing trends and seasonality in the data. This integrated intelligent system will assist organizations in forecasting sales and analyzing customer behavior using interactive visualizations. Moreover, the system is deployed for users to use from any device. For more interpretability, the system is further enhanced by Google Gemini AI assistance feature, allowing its users to communicate and have a better sense of the analytics. As a result, users will be able to make scenarios for analyzing various business optimizations. Overall, this project has provided a viable solution for improving companies' performance and enhancing decision-making processes.

Keywords: *Machine Learning, Generative AI (Gemini), ARIMA, Customer Churn, Random Forest, Gradient Boosting, FastAPI, E-commerce Analytics, Data-Driven Decisions.*

A Cloud-Based Educational Technology Solution for the Pamir Region

Sayed Zamonuddin Adeem
Supervisor: Dr Muhammad Fayaz

Pamir Academy is an educational technology platform to support the full learning journey of Pamiri high school students in remote and under-resourced contexts. The project tackles a common problem faced by small educational initiatives where the process of registration, placement, group organization, course delivery and communication with students is often done through a series of disconnected tools that diminish efficiency and weaken the learner experience. To address this challenge, the project develops an integrated web platform that brings together these functionalities in a single system for students, teachers and administrators. The platform lets you register in more than one step, verify your email, take a placement test, get assigned to a level, make study plans for groups and individuals, take live online lessons, manage your courses and tests, send announcements, and talk to people directly. One of the most important things about the system is that it focuses on making education more affordable by allowing students to study in groups, which lowers the cost for each student. The platform also gives students more chances in the future by letting administrators post blogs and links to universities, summer camps, and other academic programs. Also, being able to access study materials offline helps students keep studying even when the internet isn't working well in the Pamir region. The project gives students with very limited resources the opportunity to enhance their knowledge and prepare for better opportunities posted on the platform.

Keywords: *online education, learning management system, educational technology, low-connectivity learning, offline synchronization, WebRTC, Django, React, role-based access control, student placement, Pamir Academy, Pamir region.*

Tour Booking Website for Pacific Partners Tokyo

Suhrob Umarov
Supervisor: Dr Muhammad Fayaz

The project focuses on creating a web-based tour booking system which will be used by Pacific Partners Tokyo, a travel agency that specializes in Japanese tourism. The project needs to be developed because current travel platforms provide standard content which lacks proper regional customization and fails to meet the unique operational needs of travel agency. The existing system limitations directly impact international users because they decrease system usability and make tour service operations more difficult to manage. To solve these problems, I created a complete web application that uses Django as its development framework. The system implements the Model–View–Template architectural design and uses a structured database system to handle tour operations and booking requests and user interactions. The main features of the application include a tour catalog that users can search and filter through and a complete booking system and a user dashboard that shows their activity and a dedicated admin interface that staff members use for their tasks. The platform enables users to access content in three languages which include English and Russian and Japanese to reach a wider range of people. The project implements automatic translation capabilities together with standard web security measures that protect against common threats through their authentication systems. The implemented system demonstrates how a specialized platform can improve both user experience and operational efficiency compared to general travel applications. Overall, the project provides a practical solution for digital tourism management while it demonstrates how usability and localization and system design need to be developed in present-day travel platforms.

Keywords: *Tour booking systems, web-based information systems, Django framework, multilingual applications, user experience design, tourism management systems*

AI Teacher

Sultan Toktomambetov
Supervisor: Dr Muhammad Fayaz

This project is about helping students in Bishkek who have big classes. Sometimes classes exceed 40 to 50 kids in one room. Because there are so many students, teachers can't give everyone the one-on-one help they might need. My idea is to make talking AI-tutor that students can call from home or during breaks, just like having private teacher. The AI tutor will speak both English and Russian, and it will use the exact same textbooks and lesson plans as the real teacher, so it won't teach anything wrong or different. I built full stack web site which handles planning classes and lessons for teachers and fully implemented online calls with AI teacher agent for students. Since gRPC and WebSocket streaming protocols were used to handle real time interaction, intelligent conversational agent was developed. An agent tries to transcribe audio to text, thinks of an answer using OpenAI models with Retrieval-Augmented Generation (RAG) support, and then talks back using voice models PocketTTS and Silero. As a result, AI teacher application guarantees high quality speech and maximum 5 seconds latency.

Keywords: *Speech-to-Speech, AI Tutoring, Retrieval-Augmented Generation, Automatic Speech Recognition, Text-to-Speech, Educational Technology, Kyrgyzstan, FastAPI, Vosk, Silero VAD*

AI-Powered Apprenticeship Matchmaker: Connecting Refugee Youth to Career Opportunities Using Machine Learning

Wasim Jafar
Supervisor: Dr Muhammad Fayaz

This report presents ProMatchAI, a mobile-first employability platform designed to address fragmentation in refugee job and apprenticeship access by integrating opportunity discovery, skill development, application tracking, and employer workflows into a single system. Fragmented digital services often limit visibility for job seekers and increase coordination costs for employers; this project responds by proposing a unified, pathway-oriented platform. The study follows design science and artifact-evaluation methodology, combining system design, implementation, and empirical analysis of the resulting prototype. Evaluation methods include static codebase inspection, functional workflow tracing, recommendation logic analysis, and production build validation. The system is implemented using a React and Vite frontend, Supabase Edge Functions backend, hybrid persistence (local storage and key-value store), and an explainable, feature-based recommendation engine. Results show that ProMatchAI is a substantial and functional prototype, comprising over 20,000 lines of code, 27 backend endpoints, and fully implemented workflows for onboarding, profiling, learning, job matching, applications, and administrative coordination. The recommendation engine provides transparent, reciprocal matching with user-facing explanations, while hybrid persistence supports resilience in low-connectivity environments. However, limitations include prototype-level authentication, synchronization complexity, large frontend bundles, and the absence of formal fairness auditing or user-based evaluation.

The findings suggest that ProMatchAI effectively demonstrates how inclusive, explainable, and mobile-first employability systems can be designed as coherent socio-technical platforms. Its implications extend to software engineering practice and refugee support systems, highlighting the importance of integration, transparency, and progression-oriented design for real-world impact.

Keywords: *Refugee; apprenticeship matching; micro-learning; micro-credentials; AI-driven; recommended systems; artificial intelligence; skills-based; employment transition; sustainable computing; low-resource AI; mobile-first platforms; humanitarian technology*

Earth & Environmental Sciences

Spatiotemporal Dynamics and Hazard Susceptibility of Glacial Lakes in Upper Ghizer, Hindu Kush Pakistan: The 2025 Talidas Outburst Case

Anara Zainab
Supervisor: Dr Kanayim Teshebaeva
Co-Supervisor: Dr Mukesh Boori

Climate-driven changes in the Hindu Kush Himalaya are leading to the rapid formation and expansion of glacial lakes, increasing the risk of outburst floods for communities living downstream. Gilgit-Baltistan, Pakistan, contains more than 13,000 glaciers, the largest concentration outside the polar regions, and around 3,000 glacial lakes. About 1.5 million people live in areas that may be affected by changes in these glacier-fed systems. Despite this risk, the Upper Ghizer Basin and its 130 downstream villages had no manually verified glacial lake inventory or hazard susceptibility assessment. This gap became especially clear on 22 August 2025, when the Talidas glacial lake burst at 02:30 local time and damaged 180 houses across four villages. This thesis examines changes in glacial lakes in the Upper Ghizer Basin, reconstructs the Talidas outburst event, and develops a hazard susceptibility model for confirmed lakes. Manually verified inventories were prepared for 2020 and 2025 using Sentinel-2 imagery. Lake boundaries were extracted using a Modified Normalised Difference Water Index threshold of 0.25, followed by four-band visual verification and comparison with five reference datasets. The Talidas outburst was reconstructed using PlanetScope lake-area time series, post-event Normalised Difference Turbidity Index mapping, TerraClimate reanalysis data, and a structured survey of 30 Talidas residents. A deterministic six-factor hazard susceptibility model was then applied to all confirmed glacial lakes. The results show that the basin had 736 lakes covering 30.01 square kilometres in

2020. By 2025, this had increased to 859 lakes covering 30.64 square kilometres, representing a 16.7 percent rise in lake number at about twelve times the long-term baseline rate. Talidas expanded by 1,287 percent within twelve months, alongside a June temperature anomaly of +7.1 degrees Celsius and an August precipitation deficit of 18.1 millimetres. The model classified 53 lakes as Very High and 180 as High susceptibility. Importantly, 31 lakes scored higher than Talidas, suggesting that several lakes which have not yet failed may pose equal or greater outburst risk. Overall, this study provides the first manually verified glacial lake inventory and hazard assessment for the Upper Ghizer Basin and offers practical guidance for monitoring and reducing climate-related risks in high-mountain communities.

Keywords: *glacial lake outburst flood; Hindu Kush Himalaya; hazard susceptibility; remote sensing; Gilgit-Baltistan; climate change*

Analysis and Forecasting of PM2.5 Concentrations in Dushanbe, Tajikistan

Dilnoza Mamadrizobekova
Supervisor: Dina Kaskina
Co-Supervisor: Ibrohim Rahimjonov

Air pollution is an important environmental and public health concern in urban areas, and fine particulate matter (PM2.5) is one of the most harmful air pollutants due to its ability to penetrate deep into the respiratory system. This thesis examines PM2.5 pollution in Dushanbe, Tajikistan, with a focus on its temporal variation, relationship with meteorological conditions, and short-term forecasting performance for 1-day, 3-day, and 7-day horizons. The study compares Linear Regression, Random Forest, and XGBoost models using PM2.5 and meteorological data from two monitoring locations in Dushanbe. The dataset includes hourly PM2.5 concentrations and meteorological variables from 2019 to 2026. The results show that PM2.5 concentrations in Dushanbe are high and strongly seasonal, with the highest levels observed during winter and the lowest during spring. Meteorological conditions were found to influence PM2.5 concentrations, especially during the cold season. Higher PM2.5 levels were generally associated with lower temperature, lower wind speed, and higher atmospheric pressure, indicating the role of stable and poorly ventilated conditions in pollution accumulation. Forecasting results show that PM2.5 can be predicted more effectively for short horizons, especially one day ahead, with accuracy decreasing for longer horizons. Overall, this study provides local evidence on PM2.5 behavior in Dushanbe and highlights the importance of improved monitoring and forecasting for future air quality management.

Keywords: *PM2.5, health, meteorology, correlation, forecasting, machine learning*

Formation of Gem-Quality Clinohumite at Kuh-i Lal, Southwestern Pamir in Relation to the Petrogenesis of Metamorphic Rocks

Farishtamoh Elnazarova
Supervisors: Dr Mohssen Moazzen
Co-Supervisors: Sangin Elnazarov, Dr Nalan Lom

Clinohumite is a rare mineral of the humite group of magnesium-rich silicates which is one of the scientifically and gemologically important minerals of the Kuh-i Lal deposit in the Southwestern part of the Pamir Mountains in Tajikistan. Historically Kuh-i lal is known for its gem-quality spinel, but the area is rich in gem-quality clinohumite as well. This study focuses on the occurrence, formation, and geological context of clinohumite at Kuh-i Lal. The Kuhi Lal deposit occurs in the Goran series of high-grade metamorphic rocks consisting of magnesite and dolomite marbles and alternating with Shakhdara gneisses and migmatites. The study reveals that clinohumite is mainly concentrated in marbles where it is associated with tremolite, diopside, forsterite, spinel, enstatite and phlogopite in a magnesian skarn assemblage. Considering the mineral assemblages in the marbles, the main mineralogical reactions for clinohumite formation were tremolite+dolomite+H_2O = clinohumite+calcite+CO2 and tremolite+calcite = clinohumite+diopside+fluid. Clinohumite crystallized primarily during the post-skarn phase, at the temperature of 680-600°C and was reached through metasomatic modification of the earlier forsterite by chloride-rich, CO2-bearing fluids. Based on phase equilibria, using temperature and XCO2 relation, the maximum mole fraction of CO2 for clinohumite crystallization was XCO2 = 0.06. Clinohumite is present in productive skarns at 20-30% and the transparent yellow to orange types are gemstones. The study concludes that at Kuh-i Lal, clinohumite was formed by interaction of magnesium rich carbonate rocks with fluorine-rich metamorphic fluids under high grade metamorphic conditions typical of Southwestern Pamir.

Keywords: *Southwestern Pamir, Kuh-i Lal, clinohumite, metamorphic rocks, skarn, high-grade metamorphism, gemstone, fluid-rock interaction.*

Influence of Light Absorbing Particles (LAPs) on Snow Melt Dynamics in the Pamir Mountains

Fasih Uddin
Supervisor: Dr Arnaud Caiserman
Co-Supervisor: Khizer Zakir

Light absorbing particles (LAPs) play a major role in changing the surface albedo and snowmelt of the Pamir Mountains, which are a major water resource for the Amu Darya basin, but have not been directly measured to quantify their effects on the surface albedo and melt of this snowpack. This thesis consists of the first sample-based evaluation of LAP present in the surface snow of the Pamir region, which is based on multi-decadal satellite data analysis and field sampling. In February 2026, 14 surface snow samples were taken in the Gunt and Shokhdara valleys of Gorno-Badakhshan, Tajikistan. Meltwater was filtered with 0.45 µm membrane filters and the recovered particulate matter was analyzed gravimetrically and optically in different mineralogical classes. The microscopic images of each sample were then analyzed using DeepLIIF software to find the percentage of each mineral class. The field data were merged with MODIS MCD43A3 white-sky albedo data (2000–2025) and the MERRA-2 dust extinction (DUEXTTAU) data and a Normalized Difference Snow Index comparison (2000–2025). Ordinary least squares regression was used to test the correlation between dust loading and albedo. A negative spatial gradient was found in the Gunt valley, where the concentration is decreasing from the regional capital Khorog, and $R^2 = 0.65$, $n = 5$. Using the Painter–Skiles–Naple radiative forcing framework, a first order estimate of dust-induced melt was calculated for the most LAP loaded stations, which was about 70% of the typical spring melt day, or 200–260 mm of additional meltwater over a 90-day ablation season. Lastly, long term trends in NDSI and white sky albedo over December, January, and February for the period 2000 to 2025 were assessed using the non-parametric Mann–Kendall test. The results show that the LAP induced snowmelt enhancement in the Pamir is measurable and needs to be explicitly considered in water resource assessments of Amu Darya basin.

Keywords: *Snow albedo, mineral dust, black carbon, snowmelt, Pamir Mountains; Central Asia, MODIS, MCD43A3, MERRA-NDSI, gravimetric analysis, optical microscopy, Mann–Kendall trend test, remote sensing.*

Spatio-Temporal Inventory and Characterization of Glacial Lakes in the Gunt Basin, Tajikistan

Ghulomhusein Marodbekov

Supervisors: Ibrohim Rahimjonov, Dr Aslam Qadamov

The Glaciers in the Tajik Pamir are quickly receding, and the associated glacial lakes are undergoing rapid changes, with significant consequences for water resources and the hazard of Glacial Lake Outburst Floods (GLOF). Based on the 10 m Sentinel-2 imagery, the glacial lakes of the Gunt Basin were mapped and analyzed for the period 2016 to 2025. The NDWI detection, supervised Random Forest classification and manual refinement in ArcGIS Pro was combined to generate high resolution inventories and to measure changes in lake number, surface area, elevation, size class, and lake type. The results identified 300 glacial lakes covering 35.75 ± 1.04 km² in 2016 and 367 lakes covering 36.82 ± 1.21 km² in 2025. Lake number grew by 22.3%, in the area by 3.0%, which indicates that the recent change was primarily due to the creation of numerous small lakes but not to the significant expansion of the larger lakes. The most significant alteration was between 4,500 and 5,000 m altitude particularly in proglacial and supraglacial environments. Supervised Random Forest classification had an F1-score of 99.70% which attested to the robustness of the mapping workflow.

Keywords: *glacial lake inventory, Gunt Basin, Sentinel-2, glacial retreat, Random Forest Classification*

Influence of Lithology on Aggregate Performance and Concrete Strength: A Case Study from the Pamir Region, Tajikistan

Karomatullo Jafarkhonov
Supervisor: Dr Denis Samyn
Co-Supervisor: Dr Mohssen Moazzen

Although in the Gorno-Badakhshan Autonomous Region (GBAO) of Tajikistan infrastructure is being built at a fast pace, the engineering suitability of the available rock resources for use as coarse concrete aggregate in the area has not been characterised in the international scientific literature and made available to the public. This study provides the first systematic engineering geological characterization of three lithologic types of the Pamir rocks, namely biotite granite (KJR01/KJA01), granodiorite (KJR02/KJA02), and granite gneiss (KJR03/KJA03). These three lithologies were sampled in Shohdara Valley (Sajethkhoy), Khorog (Dasht), and Shohdara Valley (Langar), respectively. An integrated methodology was used, which included X-ray fluorescence (XRF) geochemistry, X-ray diffraction (XRD) mineralogy, thin-section petrographic analysis, rock mechanical testing, aggregate characterisation, concrete compressive strength testing at 7 and 28 days, chemical analysis (chloride, sulphate, pH), and life cycle assessment (LCA). All testing was conducted according to Russian GOST construction standards cross referenced with ASTM and ISRM (American Society for Testing and Materials: material testing standards body; International Society for Rock Mechanics: rock mechanics standards body) equivalents. To isolate the influence of the aggregate lithology on the concrete performance, the same standardised concrete mix design (cement 370 kg/m3; w/c = 0.49) was used across this study. The results show that the granodiorite sample (KJA02) is consistently better than the two other lithologies, with a low ACV (7.20 %; Grade M1200), a low LAAV (24.92 %; Grade И1) and the highest 28-day concrete compressive strength (55.7 MPa). Despite having the highest SiO□ content (72.41 wt. %), the biotite granite sample (KJA01) shows the lowest aggregate performance (ACV = 14.21%; LAAV = 33.42%). The presence of strongly altered clay minerals observed in this sample through thin section petrology, resulting from pervasive alteration of plagioclase in the structure of biotite granite, can explain the reduced strength of this aggregate. The granite gneiss sample (KJA03), obtained from alluvial deposits, has the lowest ACV (6.29%) and the lowest LAAV (24.22%), therefore indicating superior resistance to crushing and abrasion, but has the lowest concrete strength after 28 days (45.8 MPa) due to the strong presence of rounded particles (67.7%) that reduces mechanical interlock at the aggregate-cement paste interfacial transition zone (ITZ). In terms of concrete compressive strength, the three lithologies meet the Russian Class B27.5 design criteria, rendering them suitable for construction purposes in Tajikistan. However, according to ionic test result, the KJR03 sample is not compliant with the GOST

8269.1-97/8267-93 chloride limit for reinforced concrete (0.0781%/0.05%), making it unsuitable for construction purpose in Tajikistan. LCA calculations show that using local aggregates reduces transport CO_2 emissions by 96–99% compared to importing aggregates from limitrophe or farther countries.

Keywords: *coarse aggregates, concrete mis design, lithological controls, granodiorite, biotite granite, gneiss, aggregate crushing value, Los Angeles abrasion value, concrete compressive strength, interfacial transition zone, Pamir, Tajikistan*

Air Quality Assessment in the Sughd Region, Tajikistan

Saddam Khudobakhshov
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Co-Supervisors: Dr Iraj Rahmani, Saidmuqbil Hojiev

Air pollution poses one of the most significant threats to public health globally, yet systematic air quality assessments remain scarce in Central Asia, particularly in Tajikistan. This study presents the first multi-season statistical characterization of particulate matter concentrations and their associations with air pollutants and meteorological variables in the Sughd region of Tajikistan. Data were collected at 30 fixed monitoring sites across the urban areas of Guliston - Qayroqum, and Buston over August 2024 to April 2026, using portable instruments deployed once per season. Concentrations of PM2.5 and PM10 in particles per liter were analyzed alongside air pollutants, molecular hydrogen, ammonia, and carbon dioxide in parts per million, and meteorological variables including temperature, wind speed, humidity, atmospheric pressure, and solar radiation. Pearson and Spearman correlation analyses were applied to 12 monthly observations. The most robust finding was a significant positive association between PM10 and H_2, confirmed by both Pearson ($r = 0.696$, $p = 0.012$) and Spearman ($\rho = 0.701$, $p = 0.011$), implicating incomplete combustion as a primary driver of coarse particle concentrations. PM2.5 was significantly associated with H_2 ($r = 0.604$, $p = 0.037$) and NH_2 ($r = 0.688$, $p = 0.013$) by Pearson correlation; the NH_2 association is mechanistically explained by gas-phase reactions with sulphuric and nitric acids that produce secondary inorganic aerosols constituting a major fraction of fine particulate matter. A strong non-linear negative association between PM10 and wind speed (Spearman $\rho = -0.811$, $p = 0.001$) indicated that wind-driven mechanical dispersion is a key modulator of coarse particle accumulation. No significant correlations were identified between PM2.5 and meteorological variables at monthly temporal resolution, consistent with emission-dominated settings in which source variability exceeds meteorological dispersion effects. Pronounced seasonal variation was observed, with peak PM2.5 concentrations of 2839 n/L recorded in December 2024, consistent with temperature inversions and maximum residential heating demand. These findings provide the first empirical foundation for targeted air quality management in the Sughd region and underscore the urgent need for continuous high-frequency monitoring infrastructure in Tajikistan.

Keywords: *particulate matter; PM2.5; PM10; air quality; Sughd region; Tajikistan; combustion emissions; secondary aerosol formation; seasonal variation; temperature inversion; monitoring sites*

Predictive Assessment of Rockfall Hazard Susceptibility Using GIS and Machine Learning in Khorog, Tajikistan

Shahnoza Fazlonshoeva
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Co-Supervisors: Dr Mohssen Moazzen, Ibrohim Rahimjonov

Rockfall and shallow slope failures are persistent hazards in Khorog, Tajikistan, where steep mountain terrain, active tectonics, fractured bedrock, and limited urban space place settlements, infrastructure, and the main regional transit corridor close to unstable slopes. Despite this exposure, local-scale rockfall susceptibility has remained insufficiently assessed. This study evaluates rockfall susceptibility in Khorog by integrating GIS-based terrain analysis, field observations, geological interpretation, and machine-learning modelling. Terrain variables such as slope, aspect, elevation, curvature, drainage conditions, and lithology were analyzed together with field evidence from stable and unstable slope sites. Field observations focused on fracture openness, rock mass condition, weathering, talus accumulation, and signs of recent instability. Machine-learning models, including Logistic Regression, Random Forest, and XGBoost, were used to compare stable and unstable slope conditions, while feature-importance and SHAP analysis helped interpret the main controls on instability. The results indicate that unstable zones are mainly associated with steep slopes, south- and southwest-facing aspects, convex slope forms, fractured and weathered rock masses, and drainage-related weakening or undercutting. The findings show that rockfall susceptibility in Khorog is controlled by the combined influence of terrain, lithology, structural discontinuities, and weathering processes rather than by a single factor. This study provides a local-scale, evidence-based susceptibility framework that can support hazard awareness, field monitoring, and safer land-use planning in high-relief mountain urban areas.

Keywords: *rockfall susceptibility; GIS; machine learning; Random Forest; XGBoost; SHAP; Khorog; Western Pamirs; Tajikistan*

Geology and Gemstones of the Gorno-Badakhshan Autonomous Oblast, Tajikistan

Shohmansur Rahmatshoev
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Co-Supervisor: Dr Nalan Lom

The Gorno-Badakhshan Autonomous Oblast (GBAO) is one of the most significant regions in Central Asia for precious and semi-precious gemstones. This study seeks to provide an understanding of the formation and distribution of gemstones in GBAO. It is based on a review of the geological settings of various gemstones, existing studies on gemstones from the Pamir, examinations of hand specimens, and consultations with artisans engaged in gem cutting and jewelry making in Khorog. Geologically, gemstones of the Pamir Mountains are associated with three genetically distinct lithological systems: marble-hosted metamorphic assemblages, evolved granitic pegmatites, and skarn-metasomatic zones. The principal gems formed in marble-hosted metamorphic rocks include spinel, ruby, clinohumite, and lapis lazuli. Pegmatites yield aquamarine, tourmaline, and amazonite, while skarn-metasomatic zones produce scapolite and garnet. In addition, large semi-gem-quality garnets occur in regional metamorphic rocks. The gemstones of the Pamir are distributed across nine localities, with the Kukurt area of Murghab, as well as the Kui Lal and Ishkashim pegmatites, being the most important. These gemstones hold considerable potential for small-scale lapidary and jewelry enterprises. They may also serve as a pathway to sustainable economic development in some of the most remote regions of Central Asia, supporting artisanal mining, geotourism, and improved livelihoods.

Keywords: *Gemstone, Pamir, Marble-hosted, Skarn, Granite Pegmatite, Ruby, Tourmaline, Spinel, Clinohumite*

First Assessment of Microplastics in Pamir Snow

Sidra Alam

Supervisors: Dr Denis Samyn

Microplastic contamination is now found in some of the most remote environments on Earth. This thesis presents the first quantitative assessment of microplastic contamination in the snow of Javshongoz Valley, Shokhdara, western Pamir Mountains, Tajikistan. Snow samples were collected on 22 February 2026 from five stations along an 8 km transect (3,415–3,383 m a.s.l.) in this remote high-mountain valley, with concentrations ranging from 2.3 MPs L^{-1} (±0.51) at Station 1 to 12.8 MPs L^{-1} (±1.66) at Station 5 ($R^2 = 0.81$, $p < 0.001$, $n = 25$). It is interesting to note that, although inter-study comparison requires methodological caution, Station 5 concentrations are in the top concentration range compared with published means from several remote alpine environments. Of 23 characterised particles, 74% were fibres and 52% provisionally identified as polyester by visual characteristics only, pending spectroscopic confirmation. HYSPLIT backtracking trajectory analysis suggested air masses potentially originated from South Asia, the Middle East, Central Asia, and on two occasions Eastern Europe, with transport distances possibly reaching 4,000–5,000 km. SNICAR-ADv3 radiative modelling indicated that black carbon and mineral dust reduced broadband albedo from 0.781 to 0.688 (RF = +22.32 W m^{-2}; ~5.77 mm day^{-1} estimated additional melt), with microplastics contributing a provisional further +0.031–0.168 W m^{-2}. These preliminary findings suggest that geographic isolation may not reliably prevent atmospheric plastic deposition, with potential implications for water security across the Amu Darya basin. Our study suggests that even geographically remote mountain environments are not sheltered from microplastic contamination, and that atmospheric circulation patterns and long-range transport mechanisms can potentially deliver plastic particles across regional and continental distances. Contrary to common belief, elevation and remoteness therefore do not necessarily act as reliable barriers to anthropogenic particle deposition, undermining the idea that the upstream water sources in the Amu Darya basin remain pristine. Despite further work is needed before firm conclusions can be drawn, such evidence can inform regional water security strategies and watershed management policies in this part of Central Asia.

Keywords: *Microplastics; Pamir Mountains; HYSPLIT; SNICAR-ADv3; air-mass backtracking; radiative forcing; snow albedo*

Global Economics

Digital Attention as a Leading Signal of Domain-Specific Innovation: Evidence from AI and Renewable Energy Patents (2010-2022)

Dovud Asadulloev
Supervisor: Sedbegim Mirzosaidova
Co-supervisor: Dr Anwar Naseem

Patent-based indicators of innovation are inherently backward-looking, while digital search behavior offers a real-time window into where research and investment interest is heading. This thesis investigates whether domain-specific digital attention, measured through Google Trends indices, can serve as a leading signal of patent activity in artificial intelligence and renewable energy technologies. The analysis covered 27 countries over the period 2010 to 2022, using dynamic two-way fixed-effects panel models with system generalized method of moments robustness checks, a reverse causality test, and an expanding-window standardization check that addressed look-ahead bias. For renewable energy, attention at a two-year lag positively predicted patent intensity, with a coefficient of 0.048 in the main specification, 0.051 in the generalized method of moments check, 0.059 in first differences, and 0.056 under expanding-window standardization. The result survived outlier exclusion and all nine control combinations. For artificial intelligence, the picture was more complex and methodologically sensitive. Under full-sample standardization, attention did not predict patents at any forward lag, while past patent intensity predicted current attention at a three-year lag with a coefficient of 0.073. Under expanding-window standardization, the forward channel emerged at a one-year lag with a coefficient of 0.073, and the reverse channel disappeared, suggesting that the two findings reflect a bidirectional relationship whose specific identification depends on how the attention signal is constructed. The thesis provides the first cross-domain panel test of digital attention as a leading innovation indicator and identifies a boundary condition for search-based indicators: in distributed, policy-sensitive innovation systems, digital attention functions as a forward-looking signal robust to multiple methodological corrections; in concentrated, institutionally driven systems, the relationship is bidirectional and empirically sensitive to standardization choices.

Keywords: *digital attention, Google Trends, patent intensity, leading indicators, panel data*

Optimizing the Cost of Therapeutic Diets for Non-Communicable Diseases in Khorog, Tajikistan: An Application of Linear Programming

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Co-Supervisor: Dr Kholiknazar Kuchakshoev

Chronic diet-related diseases impose a significant economic burden on households, particularly in low-income and geographically isolated regions where food access is limited and incomes are constrained. This study addresses a critical gap in the economic literature on food affordability in Tajikistan by estimating the minimum daily cost of nutritionally adequate, disease-specific food baskets for patients with cardiovascular disease (CVD), Type 2 diabetes mellitus, and chronic gastritis in Khorog, Gorno-Badakhshan Autonomous Oblast (GBAO). Using linear programming (LP) — a cost minimization technique from operations research widely applied in food economics — three optimization models were constructed based on locally collected market prices in Tajik Somoni and nutritional data from the USDA FoodData Central database. Each model minimizes total daily food expenditure subject to three constraint layers: disease-specific nutritional requirements derived from international clinical guidelines, food group diversity constraints following established LP diet methodology, and a locally calibrated cooking oil range reflecting Khorog household consumption patterns.

All three models yielded optimal solutions. The minimum daily food cost was 13.53 TJS for CVD, 18.42 TJS for Type 2 diabetes, and 22.55 TJS for chronic gastritis, corresponding to monthly expenditures of 405.90, 552.6, and 676.5 TJS respectively. Benchmarked against the national minimum wage of 800 TJS per month, these costs represent 50.7%, 69.1%, and 84.6% of monthly income — revealing that even the mathematically cheapest possible therapeutic diet is unaffordable for minimum wage earners in GBAO without external support. The LP-optimized diets were 33–49% cheaper than the Cost of Recommended Diet (CoRD) previously estimated for Khorog, confirming the economic efficiency of optimization-based approaches over fixed-basket methods. This study provides the first LP-based economic analysis of therapeutic diet costs in Tajikistan, offering quantitative benchmarks for hospital dietary planning, food assistance program design, and health-nutrition policy in the GBAO region.

Keywords: *linear programming, diet optimization, therapeutic diets, non-communicable diseases, food cost, Tajikistan, Khorog, GBAO, affordability.*

How Do Water and Energy Insecurity Affect Household Food Insecurity? Evidence from Rural Tajikistan

Gulnisso Bunedbekova
Supervisor: Dr Anwar Naseem

Rural Tajikistan struggles with persistent food insecurity. Although water and energy access are often discussed as contributing factors, little is known about how they relate at the household level. This study examined how water and energy insecurity are independently and jointly associated with household food insecurity in rural Tajikistan, and whether their combined association is additive or synergistic. The analysis was based on the cross-sectional survey of 3195 rural households conducted during January and February 2025 in 48 districts of three regions of Tajikistan as part of the Tajikistan Rural Household Survey 2025. Food insecurity was assessed with the Household Food Insecurity Access Scale; water insecurity with a 6-item version of the Individual Water Insecurity Experiences scale; and energy insecurity with an 8-item experience-based index constructed from the energy module of the survey. The primary estimation method was ordinary least squares regression with district fixed effects, complemented by ordered probit, interaction modelling, and seemingly unrelated regression. Energy insecurity was the strongest correlate of food insecurity. A one-unit increase in the energy insecurity index was associated with a 3.3 point increase in the food insecurity score, and with a 32.5 percentage point lower probability of being food secure in the ordered probit. Water insecurity showed a smaller but statistically significant association when food insecurity was modelled as an ordered categorical outcome. The interaction term was not statistically significant, indicating that the effects of water and energy insecurity on food security are independent and additive rather than multiplicative. Seemingly unrelated regression revealed that all three insecurities share common unobserved determinants, pointing to shared structural roots. The results highlight that rural energy infrastructure is a key determinant of food security outcomes, and that the three forms of insecurity share common structural drivers, which may extend beyond the scope of sector-specific interventions.

Keywords: *food insecurity, water insecurity, energy insecurity, water-energy-food nexus, rural Tajikistan*

Structural Transformation and Labor Productivity Growth in Uzbekistan, 2000–2024

Hayratsho Shoniyozov
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Co-Supervisor: Dr Anwar Naseem

The concept of structural transformation is a key element in long-term economic development particularly in the transition of labour to industry and services from low to high productivity. In this thesis, the contribution of structural transformation to the growth of labour productivity in Uzbekistan in 2000-2024 is analyzed. The study uses an empirical approach that involves two parts because of the absence of consistent data in terms of gross value added for each sector at constant prices for the entire period. The analysis of period 2000-2009 was made descriptive, based on general sectoral employment and sectoral output trends; the analysis of the main quantitative indicator 2010-2024 was based on data of "Stat.uz" (sectoral gross value added at constant 2010 prices) and (sectoral employment). The thesis estimates sectoral labour productivity and then employs the McMillan–Rodrik three-way decomposition to decompose the aggregate labour productivity growth into the within-sector productivity improvement, static reallocation and dynamic reallocation effects. The decomposition is performed for the whole period 2010-2024, as well as for two subperiods-2010-2016 and 2017-2024-which correspond to two different political eras-late Karimov and Mirziyoyev reform. The labor productivity of aggregates has increased from 5.69 to 12.83 million soums per worker at constant 2010 prices, which is 2.25 times more. This growth was almost entirely due to within-sector productivity increase, accounting for 98.9 per cent of total productivity increase. The overall results for static reallocation were negative and for dynamic reallocation were positive, but small. At the sector level, the productivity increase was the highest in the industry sector, and the lowest in agriculture. The productivity growth was stronger during the post-2017 period than during 2010-2016, which is in line with the timing of the unification of the exchange rates, the liberalization of trade and the other economic reforms that took place, but not necessarily causal. The overall results indicate that growth of labour productivity in Uzbekistan in 2010-2024 was primarily due to the modernization and intensification of sectors and it was not very sensitive to the reallocation of labour across the sectors. The study adds to the literature by offering a country specific decomposition of the structural transformation of Uzbekistan and by contrasting the productivity patterns over the two different policy periods.

Keywords: *structural transformation, labor productivity, Uzbekistan, McMillan–Rodrik decomposition, within-sector effect, labor reallocation, economic reforms, constant prices.*

Women's Economic Empowerment and Agricultural Productivity: Evidence from Rural Tajikistan (2025)

Maria Kousar

Supervisor: Dr Anwar Naseem

Agriculture is a central part of rural livelihoods in Tajikistan, yet large-scale male out-migration has transferred farming workload to women without necessarily increasing their control over land, credit, or productive resources. This study examines whether women's economic empowerment within households influences agricultural productivity in rural Tajikistan. The analysis uses data from the 2025 Tajikistan Rural Household Survey, conducted by the International Food Policy Research Institute and the Tajik Academy of Agricultural Sciences across 2,002 rural households in Khatlon, Sughd, and the Districts of Republican Subordination. The main estimation approach was Ordinary Least Squares regression with regional fixed effects and district-clustered standard errors, supplemented by quantile regression, alternative empowerment indices, and subsample analyses across market participation status and household roles. Women's empowerment was measured through a household financial decision-making index capturing involvement in daily expenditures, major purchases, and credit decisions. Across all specifications, the empowerment coefficient was small and statistically insignificant: the baseline estimate was 0.011 log points with a standard error of 0.052, and results were robust across all specifications. Land area was the dominant predictor of crop value, with a coefficient of approximately 2.35 across models, followed by household size and education. These null results suggest that in post-Soviet agrarian settings where women face constraints on land rights and resource access, household-level decision-making authority alone is insufficient to raise agricultural productivity, and that meaningful gains require structural reforms to land tenure, credit access, and extension services.

Keywords: *women's empowerment, agricultural productivity, Tajikistan, rural households, feminization of agriculture, null results*

Macroeconomic Determinants of Remittance Inflows to Pakistan: A Corridor Specific Panel ARDL Analysis of GCC and Western Source Countries

Mutahar Hussain
Supervisor: Dr Mirzobobo Yormirzoev
Co-supervisors: Dr Iraj Rahmani, Dr Anwar Naseem

Remittances are one of Pakistan's largest sources of foreign exchange, rising from approximately one billion US dollars in 2000 to over thirty billion US dollars by 2024, yet most existing studies treat them as a single national flow and overlook the very different migration systems that generate them. This study asked whether the macroeconomic determinants of remittance inflows to Pakistan differ between Gulf Cooperation Council (GCC) corridors and Western corridors, and whether post 2019 institutional changes distorted measured relationships. The analysis used annual panel data from thirteen major source countries, six GCC economies and seven Western economies, over the period 2000 to 2024, producing a balanced panel of 325 country-year observations. Static panel models and dynamic Panel Autoregressive Distributed Lag models were estimated using Pooled Mean Group and Mean Group estimators, with a post-2019 dummy variable included to capture composite institutional and reporting changes affecting Pakistan's remittance data. Pakistan's own gross domestic product emerged as the most consistent long-run determinant of remittances, with a baseline long-run elasticity of 1.18, though this weakened to statistical insignificance once additional macroeconomic controls were introduced. Oil prices and host-country output were statistically insignificant in the GCC corridor, in line with the contract-based nature of Gulf migration. In the Western corridor, the post-2019 period coincided with a sharp jump in measured inflows, and a large negative host-country effect disappeared once smaller European corridors most affected by post-2019 reporting changes were excluded. The findings imply that pooled estimates mask substantial cross-corridor heterogeneity, and that corridor-specific estimation, combined with explicit control for institutional changes, is necessary for credible analysis of Pakistan's remittance behaviour.

Keywords: *remittances, Pakistan, migration corridors, Panel ARDL, structural break, macroeconomic determinants*

An Empirical Analysis of the Structural Decoupling of Gold Prices and U.S. Real Yields Before and After Early 2022

Muzafar Ali
Supervisor: Dr Anwar Naseem
Co-supervisor: Dr Azmat Hussain

This thesis investigates the structural weakening of the historically strong inverse relationship between U.S. real interest rates and gold prices early 2022. For more than a decade, U.S. 10-Year Treasury Inflation-Protected Securities yields acted as the dominant driver of gold prices through the opportunity cost mechanism. However, despite sharply rising real yields during the Federal Reserve's tightening cycle after 2022, gold prices continued to rise to record highs, suggesting the emergence of a new pricing regime influenced by geopolitical and reserve-management factors. The study examines whether a structural break occurred in the gold–real yield relationship and identifies the new macro-financial drivers of gold prices in the post-break period. Monthly data covering 2010–2026 are analysed using a multi-stage econometric framework. The QLR test identifies a statistically significant structural break in January 2022, one month before the formal sanctions on Russian sovereign reserves, consistent with forward-looking pricing of geopolitical reserve risk. The empirical results show that the sensitivity of gold returns to real yields declined by nearly 70% in multivariate OLS regressions after the break. A 36-month rolling regression confirms this decline visually, with the gold-yield beta converging toward zero in the post-break period and its 95% confidence interval crossing zero. Geopolitical risk became a statistically significant positive determinant of gold returns in the post-2022 regime ($\beta = 0.029$, $p = 0.007$), whereas it was insignificant before 2022. In addition, the influence of the U.S. Dollar Index strengthened substantially, with the DXY coefficient increasing in magnitude from -0.629 before 2022 to -1.118 after the structural break. The ARDL bounds test further reveals that a long-run cointegrating relationship emerged only in the post-break period, and is dominated by central bank gold holdings, although the estimated magnitude should be interpreted cautiously given the small post-break sample.

Keywords: *Gold prices, real interest rates, TIPS yields, structural break, geopolitical risk, DXY index*

Between Home and Hotel: Accommodation Entrepreneurship in the Gorno-Badakhshan Autonomous Region, Tajikistan

Navruz Qurbonmamadov
Supervisor: Dr Bernard Musyck
Co-supervisor: Sitora Mirzoeva

Tourism is becoming more significant in the Gorno-Badakhshan Autonomous Region of Tajikistan, but little is known about the accommodation industry, which accounts for most of that growth. Despite the different environments, value, and customer base, the policy considers both village homestays in remote valleys and registered hotels in Khorog as comparable businesses. This thesis asks how accommodation entrepreneurship is organized across rural and urban areas of the region, and what this reveals about tourism value, household livelihood, and policy design. It was based on 25 semi-structured interviews that were carried out with owners and managers of homestays, hotels, and sanatorium-type facilities in Rushan, Shugnan, and Khorog. Site visits to the facilities with overnight stay in homestays, and discussions with the regional tourism authorities in January and February 2026 were also carried out. Four themes have been identified through a hybrid inductive–deductive thematic analysis: place-based value, remoteness and seasonality, co-mingling of home and business, and guest typologies. Of 25 providers, 16 (64 per cent) were fully registered, five were unregistered but locally accepted, and four were unregistered outright; 14 (56 per cent) operated in a season of three to four months, and all 11 year-round operators were in Khorog or along the main road. Hotels in Khorog sell urban reliability and hub function. Village homestays offer a place, host contact, and services far more than just accommodation. Remoteness does not reduce tourism value but transforms its basis, and the informal operation of many rural providers is better read as adaptation to short seasons, fragile supply chains, and household labor than as a failure of formalization. The thesis provides a comparative description of a relatively little-known mountain economy and proposes that an accommodation policy should not be uniform but should differentiate between the functions of village homestays and Khorog hotels.

Keywords: *accommodation entrepreneurship, homestays, hotels, Gorno-Badakhshan, rural tourism, authenticity, informality, moral economy, asset specificity, tourism policy.*

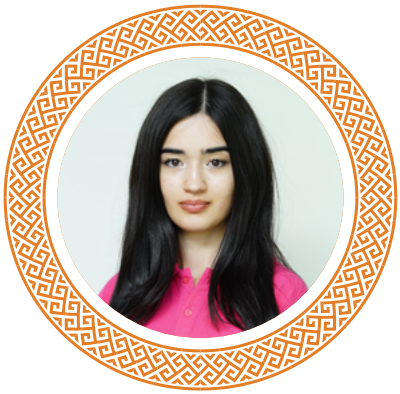
Health Shocks And Catastrophic Health Expenditure: Evidence from Household Survey Data in Tajikistan

Navruzmamad Davlatmamadov
Supervisor: Dr Anwar Naseem

The healthcare financing system in Tajikistan is still very reliant on direct payments for health services, and many rural households are not insured or protected from the financial impact of direct health expenditures. This means that health shocks are a critical financial source of vulnerability, particularly in areas with low-income levels and unequal access to healthcare services. This study examines the link between health shocks and catastrophic health expenditure (CHE) in rural households in Tajikistan. The study estimates the likelihood that direct payments for health care services are more than 10 percent of total household expenditure for 3,265 rural households in Tajikistan using logistic regression. Health shocks are defined as serious illness, accident, or death of a household member, whereas control variables are household size, presence of elderly household members aged 60 and over, income of households, international remittances, and region. The results indicate that the impact of health shocks on the likelihood of CHE is 11.9 percentage points, indicating that health shocks are the strongest indicator in the model. Household size is also a significant contributor to CHE risk and households in Khatlon are more likely to be in catastrophic spending than households in DRS. The effects of income and remittances are negative but statistically insignificant. The study brings new evidence to Tajikistan, from TRHS 2025, that unexpected health events, rather than income alone, are key determinants of rural household financial vulnerability.

Keywords: *catastrophic health expenditure, health shocks, direct payments for healthcare, rural households, financial vulnerability, Tajikistan*

The Association Between Remittances and Household Budget Shares in Rural Tajikistan



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Tajikistan is one of the most remittance dependent countries in the world, and remittances are important factor in supporting household welfare, particularly in rural areas. Less is known, however, about the budget shares of remittance-receiving households devoted to the various non-food categories, and whether remittance-receiving households differ by the gender of the head in their budget shares. This study explored whether remittance-receiving households in rural Tajikistan use their budgets differently from non-remittance households and whether the impact of remittance receipts differs between female-headed and male-headed households. The study relied on the 2025 Tajikistan Rural Household Survey (TRHS), which encompassed a sample of 3,267 rural households across three provinces: Sughd, Khatlon and Districts of Republican Subordination, including 1,503 remittance-receiving rural households and 1,764 non-remittance households. The ordinary least squares regressions with robust standard errors were estimated separately for each of the twelve expenditure categories. The results revealed that remittances had positive association with higher household spending shares on clothing by 1.0 percentage points, appliances by 0.3 percentage points, electronic devices by 0.2 percentage points, utilities by 0.4 percentage points, ceremonies by 1.0 percentage points and home repair by 1.3 percentage points among male-headed households. Education was negatively correlated with remittances (-0.5 percentage point), vehicle repair (-0.5 percentage point), and vacation (-0.4 percentage point). Gender differences in remittance use were only significant for appliances, home repair, and vacation, indicating that remittance use is not very different by gender in this sample. Overall, the results indicate that the influence of remittances on household budget allocation was the main effect, not general gender differences, as remittance-receiving households devoted higher proportions of their spending to ceremonies, durable goods, and housing costs.

Keywords: *remittances, budget shares, rural Tajikistan, household expenditure, household head gender*

Financial Evaluation of Ground-Mounted Photovoltaic Pilot Systems: Evidence from University of Central Asia Campuses in Khorog, Tajikistan and Naryn, Kyrgyzstan

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In Central Asia, solar photovoltaic systems are becoming commonplace at institutional campuses in remote high-altitude locations, but there is limited robust empirical evidence of the technical performance and financial results of such installations in these locations. The study evaluated two pilot systems at the University of Central Asia, Khorog (Gorno-Badakhshan Autonomous Oblast, Tajikistan) and Naryn (Kyrgyzstan) with a capacity of 96 kilowatt-peak and 89 kilowatt-peak respectively. The analysis was based on the data of 2025 monitoring portals, cost, electricity billing data and monthly exchange-rate data provided by the National Bank of Tajikistan and limited to the phases that were in operation for the entire 2025 calendar year. Khorog achieved a specific yield of 1,695 kilowatt-hours per kilowatt-peak and Naryn 1,602 kilowatt-hours per kilowatt-peak; the 5.8 per cent Khorog advantage may partly reflect higher irradiance at greater altitude, though orientation, shading, and microclimate differences cannot be excluded. In 2025, the monitoring portal reported savings in Tajikistani somoni (TJS) in Khorog at 6.9 per cent lower than the real savings recorded, as it used a fixed late-2025 exchange rate instead of the monthly exchange rates. Both systems showed positive annual avoided costs (USD 8,397 for Khorog and USD 6,356 for Naryn), but negative net present values (USD −73,993 for Khorog and USD −67,193 for Naryn) at an 8 per cent discount rate. The cost-only levelized cost of electricity (Khorog: USD 0.035 per kilowatt-hour; Naryn: USD 0.033 per kilowatt-hour) fell below the applicable tariff at each campus, while the full discounted levelized cost (Khorog: USD 0.096; Naryn: USD 0.091 per kilowatt-hour) exceeded it, consistent with the negative net present value result. These results indicate that both systems are technically sound but financially constrained by the unusually low frozen electricity tariff, and that a modest increase in the tariff would significantly enhance the financial viability of future solar investments at both campuses.

Keywords: *solar photovoltaic, levelized cost of electricity, avoided cost, net present value, Central Asia*

Debt Service Burden, the Crowding-Out of Investment, and Economic Growth: Panel Evidence from 31 Heavily Indebted Economies (1990–2024)

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Many developing countries devote a large share of their export earnings to servicing external debt, leaving fewer resources available for the productive investment that drives long-run growth — yet most empirical research measures this burden using total debt stocks rather than the annual repayment flows that actually constrain government budgets and foreign exchange reserves. This study examined whether higher external debt service obligations crowd out investment and, through that channel, reduce economic growth in heavily indebted developing economies. Using an unbalanced panel of 31 developing economies across South Asia, Sub-Saharan Africa, the Middle East and North Africa, and Latin America over 1990–2024, the analysis employed Two-Way Fixed Effects with Driscoll-Kraay standard errors and System Generalized Method of Moments to address reverse causality between debt service and macroeconomic outcomes and the strong persistence of investment behaviour. A one percentage-point increase in external debt service as a share of exports reduced gross capital formation by 0.052 percentage points and per capita GDP growth by 0.037 percentage points in the preferred dynamic specification. Mediation analysis showed that investment partially transmits the growth effect, but debt service also constrained growth directly through fiscal compression and foreign exchange shortages. Nonlinearity tests found no evidence of a threshold above which the burden intensifies — debt service appears to operate as a broad structural constraint rather than one confined to crisis episodes or high-debt regimes. A Pakistan case study documented this mechanism concretely: interest payments on government debt nearly doubled from 3.8 to 7.7 percent of GDP between 2017 and 2024, while the public development budget contracted from 4.8 to 2.0 percent. These findings imply that debt sustainability frameworks should prioritise annual debt service flows over stock-based indicators, and that protecting productive investment during fiscal adjustment is essential for long-run growth.

Keywords: *external debt service; crowding-out; investment; economic growth; panel data; debt sustainability.*

Fiscal Sustainability of the Tajik Pension System, 2024–2035: A Deterministic Projection with a Retirement-Age Reform Scenario

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The pay-as-you-go (PAYG) pension benefits in Tajikistan are low: the average monthly benefit is 370 somoni, which is less than the statutory minimum wage, and the system has a positive accounting surplus, which raises the question as to whether the system is sustainable, adequate or both. The aim of this thesis was to determine whether demographic and pension trends observed since 2000 suggest that there is a fiscal sustainability issue on the 2024-2035 horizon, and what the consequences would be of a gradual increase in the legal retirement age to 65. A deterministic accounting projection was built from seven identities that connect population, labour force participation, formal employment, contribution revenue and pension expenditure and with a 2024 baseline as reported by the State Social Insurance and Pensions Agency.

Descriptive analysis showed a nominal increase in the mean pension by 105 times from 2000 to 2024 and a decrease in pension spending from 3.67 to 2.40 per cent of GDP since 2014. With business as usual, the ratio of contributors to beneficiaries increased from 1.83 in 2024 to 2.33 in 2035, and the system balance slightly improved from 3.71 to 4.35 per cent of GDP. By 2035, the system balance had been improved by around 0.77 percentage points of the gross domestic product (GDP) and the contributor-to-beneficiary ratio moved from 2.66 to 3.55. However, this is not a medium-term sustainability problem driven by the demographic; rather, it is an issue of shrinking pensions, relative to wages, that a retirement-age reform doesn't tackle. Instead of focusing on retirement age, Policy attention should now focus on indexation and coverage.

Keywords: *Tajikistan; pension system; pay-as-you-go (PAYG); fiscal sustainability; retirement age reform; demographic dividend.*

Digital Access and the Gender Gap in Financial Inclusion in Tajikistan: Evidence from the Global Findex 2024

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Although there has been significant financial inclusion progress globally, Tajikistan shows an unusual trend, with the gender gap in formal account ownership almost closing in 2021 being 0.82 percentage points, but increasing sharply to 15.66 percentage points by 2024, with 62.56% of men having a formal account compared to 46.90% of women. This study examines whether access to digital tools such as mobile phone ownership and the use of the internet were associated with higher likelihood of formal account ownership more for women than for men, and whether gender differences in financial confidence among the unbanked compounded women's exclusion. The study is based on the World Bank Global Findex Database, a nationally representative sample of 1,000 adults in Tajikistan for the 2024 wave of the data. To test the differential effects of digital tools by gender, weighted logit models with gender-digital access interaction terms were used, separate logit model examined financial self-efficacy among the 304 unbanked respondents who provided valid responses, and a Fairlie nonlinear decomposition quantified how much of the gender gap was attributable to observable characteristics. Mobile phone ownership and internet use both positively correlated with having an account, with the odds of having an account being approximately 2.4 times higher for a mobile phone owner and 2.1 times higher for an internet user, respectively, but the differences in these odds between men and women were not significant. Among unbanked respondents, women were 29.1 percentage points less likely than men to report that they could use a financial account without assistance. The Fairlie decomposition confirmed that the gender gap is mainly driven by observable characteristics as being out of the workforce (34.6%), mobile phone ownership (25.0%), age (21.8%) and tertiary education (14.8%) which explained 82.9% of the gender gap, while the remaining 17.4% of the gender gap is explained by variables related to digital access. The results suggest that the gender gap in financial inclusion in Tajikistan is predominantly linked to structural socioeconomic disadvantages and financial confidence as factors impacting on financial inclusion than to differential returns to digital access interventions, highlighting the importance of policies targeting labor force participation and financial capability of women, rather than digital access alone.

Keywords: *gender gap, financial inclusion, digital access, financial self-efficacy, account ownership, Tajikistan*

Structural Transformation and Labor Productivity Growth in Tajikistan, 2000-2023: A Comparative Shift-Share Analysis with China as a Frontier Economy

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Structural transformation is central to long-term economic development, but its productivity impacts depend on whether workers move into sectors that produce higher output per worker. This thesis aimed to analyze structural change and labour productivity growth in Tajikistan between 2000-2023, comparing this period with China as a frontier comparison economy. The primary goal was to see if the country's productivity growth had been led by changes in the allocation of labour between the agriculture, industry, and services sectors, or by productivity improvements within existing sectors. The study employed the sectoral employment shares, sectoral value added, gross domestic product in constant 2015 United States dollars, population, and employment indicators from the annual World Bank World Development Indicators data for Tajikistan and China for the period 2000 to 2023. Labour productivity was measured in terms of sectoral value added per worker and a three-term shift-share decomposition was performed for the entire period and for the following three subperiods: 2000-2008, 2008-2016, 2016-2023. The findings indicated that Tajikistan's productivity growth was dominated by improvements within its sectors (90 percent of all productivity growth was attributable to within-sector changes), with less productivity growth attributable to changes in structure (about 10 percent). In contrast, the share of structural change in China's productivity growth was around 29 per cent, driven by increased reallocation of labour from agriculture to activities with higher productivity levels in industry and services. In Tajikistan the dynamic reallocation term became negative in 2008-2016, indicating a shift towards sectors with weaker productivity growth in the same time period that saw a decline in remittances and external shocks. The results suggest that Tajikistan experienced noticeable employment shifts, but not a strong productivity-enhancing structural transformation, mainly because labour moved into services rather than a dynamic manufacturing sector.

Keywords: *structural transformation, labour productivity, shift-share decomposition, Tajikistan, China, sectoral reallocation.*

Economic Growth and Productivity Performance Across 14 Post-Soviet Economies, 2000–2023

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The 14 post-Soviet economies have taken very different trajectories in growth over the past 30 years and most empirical research papers analyzing the patterns of growth in these countries focus on a small proportion of them and cover short periods. Using harmonized Penn World Tables 10.1 data for the 14 post-Soviet countries for 2000-2023, this thesis aims to examine the origins of economic growth and the factors driving cross-country income differentials across all of the post-Soviet economies. The growth accounting framework of standard Solow-type growth accounting is used to decompose output increase into contributions from physical capital accumulation, labor input and total factor productivity (TFP). The cross-country income gaps relative to the Russian frontier are decomposed into the physical capital intensity, the human capital and the residual TFP Results show that there is significant inter-regional variability in the four sub-groups - grouped into the Baltic states (Estonia, Latvia, Lithuania), the South Caucasus (Armenia, Azerbaijan, Georgia), the Slavic economies and Moldova (Belarus, Moldova, Russia, Ukraine), and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan). In almost all economies, the most salient source of the post-Soviet growth has proven to be TFP, with an average annual increase of 2.83 percent in the Baltic states, 5.74 percent in the South Caucasus, 4.67 percent in the Slavic group and Moldova and 4.59 percent in Central Asia. The exception is Uzbekistan, where the growth of output is mainly due to capital accumulation and not to productivity. The results of development accounting suggest that the main reason why income gaps persist is that their TFP gaps are high relative to Russia, especially in Central Asia and Moldova, where residual productivity ratios fall below 0.60. The human-capital-augmented decomposition indicates that the physical and human-capital components of the differences between the post-Soviet countries are limited in magnitude when compared with the productivity component, reflecting the fact that the Soviet educational system was very similar across the countries. The COVID-19 shock has generated a temporary but pronounced decline in TFP in all areas, with the Baltic and Slavic sub-group facing the slowest recovery.

Keywords: *Growth Accounting, Development Accounting, Total Factor Productivity, Post-Soviet Economies, Penn World Tables, Solow Residual.*

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