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STATISTIK KUZATISHNING ZAMONAVIY KONSEPSIYASI: BIRLAMCHI MA'LUMOT SIFATI VA IQTISODIY TAHLIL ISHONCHLILIGI

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Annotatsiya: Ushbu maqola statistik kuzatishning zamonaviy mazmunini birlamchi ma'lumotlar sifatini ta'minlash muammosi bilan bog'liq holda yoritadi. Statistik kuzatish iqtisodiy tahlil uchun dalil bazasini shakllantiruvchi asosiy bosqich bo'lib, indikatorlarning ta'rifi, qamrovi, vaqt mezoni va qayd etish tartibi tahlil natijasining aniqligi va qiyoslanish darajasini belgilaydi. Ishda kuzatishning tarixiy evolyutsiyasi, bugungi amaliy manbalari hamda sifat risklari tahlil qilinadi. Metama'lumot yuritish, maxfiylik tamoyili va validatsiya mexanizmlari orqali "tekshirilgan ma'lumot"ni yaratish iqtisodiy qarorlar uchun ishonchli asos ekani asoslanadi.
Kalit so'zlar: statistik kuzatish, birlamchi ma'lumot, qamrov, ta'rif, tanlanma kuzatuv, ma'muriy reyestrlar, sifat nazorati, metama'lumot, maxfiylik, iqtisodiy tahlil.

KIRISH

Iqtisodiy tahlilning qaysi yo'nalishi tanlanmasin - makroiqtisodiy baholash, tarmoq kesimidagi monitoring, hududiy rivojlanish ko'rsatkichlarini solishtirish yoki korxona darajasida samaradorlikni hisoblash - barchasining tayanchi sifatli statistik ma'lumotdir. Shuning uchun statistik kuzatish masalasi ko'pincha "texnik jarayon" sifatida qabul qilinsa-da, aslida u iqtisodiy bilimning ishonchlilik mezonlarini belgilab beradigan metodologik va institutsional tizimdir. Statistik kuzatishning mazmuni ommaviy hodisa va jarayonlar haqida birlamchi ma'lumotni oldindan belgilangan qoidalar asosida yig'ishga borib taqaladi: indikatorning ta'rifi, qamrov chegarasi, vaqt mezoni, o'lchov birligi, qayd etish tartibi va nazorat mexanizmlari shu tizimning ajralmas qismlari hisoblanadi. Aynan shu parametrlar keyingi hisob-kitoblar, guruhlash, indekslar tuzish, regressiya yoki prognoz natijalariga bevosita ta'sir qiladi. Agar kuzatish dizaynida "kim/nima hisobga olinadi" degan savol aniq javobga ega bo'lmasa yoki vaqt va tasniflar izchil yuritilmasa, tahlilda ko'rinayotgan o'zgarishlar iqtisodiy reallikdan ko'ra metodologik siljishning mahsuliga aylanib qolishi mumkin.
Statistik kuzatishning tarixiy ildizlari ham boshqaruv ehtiyojlari bilan bog'liq. Davlat tuzilmalari aholi soni, yer-suv, soliq bazasi, resurslar va mulkni qayd etish uchun

ro‘yxatlar yuritgan; bu ro‘yxatlar dastlab oddiy hisob-kitob vazifasini bajargan bo‘lsa, keyinchalik ularni solishtirish va umumlashtirish ehtiyoji ta’riflar, klassifikatsiyalar hamda standart jarayonlarni shakllantirgan. Natijada rasmiy statistika “ma’lumot yig‘ish”dan ko‘ra kengroq mazmunga ega bo‘lgan institutga aylangan: u iqtisodiy jarayonlarni kuzatish, o‘lchash va jamiyat uchun tushunarli ko‘rsatkichlar tiliga tarjima qilishni ta’minlaydi. Bugungi kunda esa kuzatishning ahamiyati yanada kuchaydi, chunki iqtisodiyotda tezkorlik, raqamlashtirish va ma’lumot oqimlarining ko‘payishi fonida “ko‘p ma’lumot” emas, balki “tekshirilgan va qiyoslanadigan ma’lumot” ustuvor ahamiyat kasb etmoqda.

Zamonaviy amaliyotda birlamchi ma’lumotlar turli manbalardan shakllanadi: tanlanma so‘rovlar aholi va korxonalar xulq-atvorini o‘lchashda moslashuvchanlik beradi, hisobot shakllari ishlab chiqarish va moliyaviy oqimlarni tizimli qayd etadi, ma’muriy reyestrlar esa respondent yukini kamaytirish hamda tezkorlikni oshirish imkonini yaratadi. Biroq manba qanchalik qulay bo‘lmasin, sifat risklari doimo mavjud: qamrovning to‘liqsizligi, nojavob, o‘lchash xatolari, tasniflarning yangilanishi, vaqt kechikishi yoki ma’lumotlarni integratsiyalashdagi mos kelmasliklar natijani og‘dirishi mumkin. Shu sababli statistik kuzatishni zamonaviy iqtisodiy tahlilning “infratuzilmasi” sifatida talqin qilish to‘g‘ri: metama’lumot yuritish, mantiqiy-arifmetik validatsiya, maxfiylik va huquqiy asoslar, shuningdek, ochiqlik va foydalanuvchi ehtiyojiga mos tarqatish siyosati ma’lumotning ilmiy qiymatini belgilovchi omillarga aylanadi. Mazkur maqolada statistik kuzatishning ana shu konseptual jihatlari bir butun zanjir sifatida ko‘rib chiqilib, ishonchli tahlil va oqilona qarorlar uchun sifatli kuzatishning hal qiluvchi o‘rni asoslanadi.

Asosiy qism

Rasmiy statistika amaliyotida “kuzatuv” tushunchasi ommaviy voqea-hodisalar va jarayonlar haqida birlamchi ma’lumotni oldindan belgilangan qoidalar asosida yig‘ishni anglatadi. Bunda ta’rif (nima o‘lchanayapti), qamrov (kimlar/nimalar kiritiladi), vaqt mezoni (qaysi davrda qayd etiladi), o‘lchov birliklari va qayd etish tartibi bir butun metodologik tizimni tashkil etadi. Iqtisodiy tahlilning dastlabki “kirish nuqtasi” aynan shu yerda shakllanadi: keyingi bosqichlardagi jamlash, guruhlash, indeksli hisoblash, korrelyatsiya-regressiya yoki prognoz kabi hisob-kitoblar qanday murakkab bo‘lmasin, ular baribir birlamchi ma’lumotning ta’rifi va qamroviga bo‘ysunadi. Shu sababli kuzatuvni loyihalash va o‘tkazish jarayoni iqtisodiy tahlil sifati uchun hal qiluvchi ahamiyat kasb etadi: noto‘g‘ri ta’rif yoki noto‘liq qamrov tahlil natijasini tizimli ravishda og‘dirib yuboradi va bunday xatoni keyingi bosqichlarda “tuzatib qo‘yish” amalda mumkin bo‘lmay qoladi.

Statistik kuzatuvning tarixiy kelib chiqishi davlat boshqaruvi ehtiyoji bilan bog‘liq bo‘lib, aholi soni, yer-suv, soliq bazasi, mulk va resurslarni hisobga olishga qaratilgan dastlabki ro‘yxatlar avval oddiy hisob-kitob shaklida yuritilgan. Vaqt o‘tishi bilan esa aynan shu amaliy ehtiyoj me’yorlashgan tushunchalarni, klassifikatsiyalarni va standart jarayonlarni vujudga keltirdi: ma’lumot to‘plashda yagona ta’rif va tasniflarsiz taqqoslash mumkin emasligi anglandi, shuningdek, natijalarni ishonchli talqin qilish uchun ma’lumotning qanday sharoitda to‘plangani ham hujjatlashtirilishi zarurligi ravshanlashdi. Natijada, statistik kuzatuv davlatning hisob-kitob instrumentidan kengroq maqomga ko‘tarilib, rasmiy statistika institutining ilmiy-metodologik asosi sifatida shakllandi.

Bugungi kunda statistik kuzatuvning ahamiyati yanada oshgan, chunki real iqtisodiy holatni baholaydigan ko‘rsatkichlar “o‘lchab” olinmasa, tahlil natijasi qaror qabul qilishda ishonchli dalilga aylanmaydi. Narxlar dinamikasi, mehnat bozori signallari, ishlab chiqarish hajmlari, tashqi savdo tendensiyalari kabi indikatorlar faqat hisoblash formulasi bilan emas, balki ularni ta’minlaydigan kuzatuv tarmog‘i, ma’lumot manbalari, qamrov va vaqt mezonlari bilan birga yashaydi. Shu ma’noda, rasmiy statistika demokratik jamiyat axborot tizimida zarur bo‘g‘in sifatida qaraladi: ochiq va tekshirilgan ma’lumot jamoatchilik nazoratini ham, boshqaruv qarorlarining asoslanganligini ham kuchaytiradi.

1-rasm. Statistik kuzatish manbalari

Ma’lumot manbasini tanlashda xalqaro amaliyotga xos yondashuv oddiy, biroq talabchan: ma’lumot qaerdan olinishidan qat’i nazar (so‘rovlar, hisobot shakllari, ma’muriy reestrlar), sifat, tezkorlik, xarajat va respondentga tushadigan yuk o‘rtasida muvozanat saqlanishi kerak. Mazkur muvozanat so‘rovlarni oqilona optimallashtirish, takroriy ma’lumot talablarini qisqartirish va ma’muriy ma’lumotdan asosli ravishda

foydalanishga olib keladi. Birlamchi ma’lumot yig‘ish amaliyoti, odatda, ikki yirik yo‘lda namoyon bo‘ladi: yalpi qamrov (keng ko‘lamli ro‘yxatga olish kabi) va tanlanma kuzatuv. Tanlanma ko‘pincha tezkor va nisbatan arzon bo‘lsa-da, u reprezentativlikni ta’minlash, xatolarni baholash va natijani to‘g‘ri umumlashtirish talabini keskin oshiradi. Qaysi yo‘l tanlanishidan qat’i nazar, kuzatuv birligi - kim yoki nima hisobga olinayotgani - aniq ta’riflanmasa, keyingi qiyos va trendlar “metodologik siljish”ga uchraydi: raqamlar o‘zgargandek ko‘rinadi, ammo aslida o‘lchash ob’ektining chegarasi o‘zgargan bo‘ladi.

Shu yerda ma’lumot sifati masalasi markaziy o‘ringa chiqadi. Sifatni boshqarishda xalqaro darajada keng qo‘llanadigan yondashuvlardan biri sifatida DQAF ramkasi ko‘rsatiladi: unda institutsional halollik va mustaqillik, metodologik asoslanganlik, aniqlik va ishonchlilik, xizmatga yaroqlilik (davriylik, o‘z vaqtidalik, muvofiqlik), hamda ochiqlik va foydalanish imkoniyati bir-biriga bog‘liq mezonlar sifatida qaraladi. Bu o‘lchamlar “sifat”ni faqat natijadagi raqam sifatida emas, balki butun statistik ishlab chiqarish muhiti va jarayoni sifatida baholashni talab qiladi. Bunday muhitda maxfiylik tamoyili alohida o‘rin tutadi: jismoniy yoki yuridik shaxsga taalluqli birlamchi ma’lumot statistik maqsaddan boshqa maqsadga ishlatilmasligi, shaxsiy yoki tijorat sirini fosh qilmasligi lozim; mazkur qoida respondent ishonchi va ma’lumot to‘g‘riligining “ijtimoiy shartnomasi” hisoblanadi. Maxfiylikka amal qilinmasa, javob berish intizomi pasayadi, bu esa sifati past ma’lumot orqali tahlilni zaiflashtiradi.

Jarayonni tizimli tashkil qilish nuqtai nazaridan GSBPM modeli muhim konseptual asos bo‘lib xizmat qiladi: vazifani aniqlashdan tortib dizayn, yig‘ish, qayta ishlash, tahlil va tarqatishgacha bo‘lgan zanjirda har bir bosqichda nazorat nuqtalari belgilanadi. Bu yondashuv “ma’lumot tozalash” va metama’lumotni (ta’rif, qamrov, manba, cheklovlar, qayta ko‘rib chiqish siyosati) yuritishni ixtiyoriy amal emas, balki professional standart sifatida talab qiladi. Amaliyotda eng og‘riqli muammo xatolar arxitekturasidir: qamrovda tushib qolish yoki ikki marta kiritish, o‘lchashda noaniq savol yoki noaniq ta’rif sabab og‘ish, vaqt kechikishi sabab aktuallik yo‘qolishi, klassifikatsiya almashishi sabab qiyosiylik buzilishi tez-tez uchraydi. Professional yondashuvda bu xavflar, avvalo, dizayn bosqichida kamaytiriladi, keyin esa yig‘ishdan so‘ng logik va arifmetik nazorat, kross-tekshiruv, kodlash va validatsiya orqali bartaraf etiladi; ya’ni sifatni ta’minlash “keyin tuzatish” emas, “olddindan rejalash” madaniyatiga suyanadi.

Raqamlashuv sharoitida kuzatuvning qimmati yanada ortdi: reestrlar va elektron hisobotlar tezkorlikni oshiradi, biroq ma’lumotlarni uyg‘unlashtirish (bir xil identifikator, bir xil klassifikator, bir xil ta’rif), maxfiylikni himoya qilish va metama’lumotni ochiqlash talabini kuchaytiradi. Shuning uchun iqtisodiy tahlil uchun

hal qiluvchi mezon “ko‘p ma’lumot” emas, balki tekshirilgan, izchil, taqqoslanuvchan va huquqiy jihatdan kafolatlangan ma’lumotdir. O‘zbekistonda rasmiy statistika instituti sifatida Milliy statistika qo‘mitasi faoliyat yuritishi, shuningdek, rasmiy statistika faoliyatini tartibga soluvchi me’yoriy hujjatlarning LexUZ orqali e’lon qilinishi statistik kuzatuvning institutsional va huquqiy tayanchini mustahkamlaydi.
Natijada, statistik kuzatuv iqtisodiy tahlilning texnik kirishi emas, balki dalilning ishonchliligi va ijtimoiy legitimligini ta’minlovchi asosiy metodologik mexanizm sifatida namoyon bo‘ladi.

2-rasm. Statistik kuzatishning zamonaviy konsepsiyasi

Statistik kuzatish iqtisodiy tahlilda “dalilning kelib chiqish nuqtasi” sifatida qaraladi. Tahlilchi keyin qanday model qo‘llashidan qat’i nazar, natijaning ilmiy qiymati birlamchi ma’lumot qay tartibda olingani, qaysi ta’riflar asosida tuzilgani, qaysi cheklovlar saqlangani bilan belgilanadi. Shu ma’noda, statistik kuzatish amaliyotini faqat texnik yig‘ish jarayoniga tenglashtirish to‘g‘ri emas; u davlat va jamiyat uchun muhim bo‘lgan iqtisodiy voqelikni o‘lchashning institutsional, huquqiy va metodologik tizimidir. Rasmiy statistika sohasidagi bazaviy talablar, ayniqsa, kasbiy mustaqillik, ilmiy prinsiplarga tayanish, manbalar va usullarning ochiq bayoni hamda respondent maxfiyligini muhofaza qilish kabi qoidalar BMTning rasmiy statistika tamoyillarida mustahkamlangan.
O‘zbekiston huquqiy maydonida statistik kuzatish va unga bog‘liq munosabatlar “Rasmiy statistika to‘g‘risida”gi Qonun bilan tartibga solinadi: unda rasmiy statistika tushunchasi, tayyorlovchilar doirasi, respondentlar bilan ishlash, ma’muriy ma’lumotlardan foydalanish kabi jihatlar belgilangan. Raqamli kuzatish va ma’lumot almashinuvi kuchaygan sharoitda esa “Shaxsga doir ma’lumotlar to‘g‘risida”gi Qonun ma’lumotlarni qayta ishlash va muhofaza qilishning huquqiy chegaralarini aniqlaydi; rasmiy statistikaning ishonchliligi ko‘p hollarda aynan maxfiylik kafolati va qonuniylikni qat’iy saqlashga bog‘liq bo‘ladi.

Metodologik nuqtai nazardan, kuzatishni loyihalash “konsepsiyadan indikatorga” o‘tish logikasiga suyanadi: iqtisodiy kategoriya (masalan, bandlik, daromad, sarf, ishlab chiqarish, narx) avval aniq ta’riflanadi, keyin o‘lchash birligi belgilanadi, so‘ng uni qayd etish imkonini beradigan savollar yoki hisobot pozitsiyalari tanlanadi. Bu yerda ta’rifning barqarorligi vaqt qatorlarining muqoyosa qilinishini ta’minlaydi, ta’rif tez-tez almashsa, statistik trend emas, “metodika trendi” paydo bo‘ladi.

Shu sababli xalqaro amaliyotda metama’lumot (ta’rif, qamrov, manba, usul, cheklov va qayta ko‘rib chiqish siyosati)ni ham ma’lumotning bir qismi, deb qarash keng tarqalgan. ESSning sifat va metama’lumot hisobotlari bo‘yicha qo‘llanmalari ham shunday yondashuvni institutsionallashtiradi.

Kuzatish usuli tanlanishida “bir manba - bir haqiqat” degan soddalashtirish ishlamaydi. Yalpi kuzatish (masalan, keng qamrovli ro‘yxatga olish) yuqori to‘liqlikni beradi, ammo xarajat va vaqt katta, tanlanma kuzatish tezkor va nisbatan arzon, biroq reprezentativlikni ta’minlash, tanlanma xatosini baholash va vaznlash (weighting)ni to‘g‘ri qurish talabini kuchaytiradi; ma’muriy reestrlar respondent yukini kamaytirishi mumkin, lekin ularning maqsadi statistika emasligi sabab ta’rif, to‘liqlik, identifikator va qamrovda nomutanosibliklar kelib chiqadi.

Shuning uchun sifatni boshqarishda bir vaqtning o‘zida bir nechta o‘lchamni nazorat qilish zarur:

-institutsional kafolatlar,
-metodologik asos,
-aniqlik-ishonchlilik,
-xizmatga yaroqlilik (davriylik, o‘z vaqtidalik, muvofiqlik),
-foydalanish imkoniyati.

Bu tuzilma IMFning DQAF yondashuvida tizimli ravishda bayon qilingan va milliy statistika idoralari uchun o‘z-o‘zini baholash vositasi sifatida tavsiya etiladi.

Amaliy dizaynda tanlanma bilan ishlash eng ko‘p metodik xatolar yuzaga keladigan sohalardan: tanlanma asosi (sampling frame)ning sifatsizligi, ya’ni ro‘yxatning eskiligi yoki kam qamrovliligi natijani tizimli og‘dirishi mumkin. Shu muammoni yumshatish uchun statistik amaliyotda qatlamlash (stratification), ehtimoliy tanlash, tarmoq/hudud/o‘lcham bo‘yicha kvotalarni ilmiy asoslash, tanlanma hajmini variatsiya va aniqlik maqsadlariga moslash, vaznlarni kalibrlash (calibration) kabi yechimlar qo‘llanadi.

Tanlanma kuzatishda alohida xavf - noqatnashish (nonresponse): ayrim uy xo‘jaliklari yoki korxonalar javob bermasa, javob berganlar bilan bermaganlar o‘rtasidagi farq natijani og‘dirishi ehtimoli oshadi. Shuning uchun, xalqaro mehnat statistikasi amaliyotida noqatnashishni pasaytirish (qayta aloqa, intervyu usulini optimallashtirish,

ma’lumot yig‘ish kanallarini diversifikatsiya qilish), keyin esa noqatnashishni statistik tuzatish (post-stratification, immitatsiya/imputatsiya, vazn korrektirovkalari) kabi choralar ishlatiladi.

Kuzatishning ishonchliligi faqat tanlanma masalasida emas, o‘lchashning o‘zida ham hal qilinadi. Savolnoma dizaynida “iqtisodiy tushuncha”ni respondent tiliga to‘g‘ri tarjima qilish - mustaqil metodologik vazifa: terminlar, vaqt gorizonti, birliklar (oylik/choraklik), daromad turlari yoki sarf kategoriyalari turlicha tushunilishi mumkin.

Shu bois, ro‘yxatdan o‘tkazish va so‘rovlarda kognitiv sinov (savolni tushunishni tekshirish), pilot kuzatish, intervyuerlarni standartlashtirilgan tayyorlash va maydon nazorati amaliy “sifat filtri” vazifasini bajaradi. Ishonchli statistika uchun logik va arifmetik nazorat qoidalarini yig‘ish jarayonining o‘ziga joriy qilish ayniqsa muhim: raqamli formalarda diapazon tekshiruvlari, majburiy maydonlar, o‘zaro muvofiqlik qoidalari xatolarni erta bosqichdayoq to‘xtatadi. Bu yondashuv GSBPM modelidagi “yig‘ish–qayta ishlash–tahlil–tarqatish” zanjirida sifatni har bosqichda boshqarish g‘oyasiga to‘liq mos keladi.

Ma’muriy ma’lumotlarni statistikaga integratsiya qilish zamonaviy iqtisodiy tahlil uchun alohida ahamiyat kasb etadi, chunki soliq, bojxona, reestr va boshqa ma’muriy tizimlar tranzaksion darajada katta hajmda ma’lumot to‘playdi.

Biroq integratsiya “to‘g‘ridan-to‘g‘ri qo‘shib yuborish” emas: identifikatorlar muvofiqligi, dubl yozuvlar, tashkilotlar tuzilmasining o‘zgarishi, tasniflarning turlichaligi, ma’lumot yaratilish maqsadining statistik maqsaddan farqi - bularning har biri metodologik filtr talab qiladi. Shu sababli xalqaro amaliyotda ma’muriy ma’lumotlar bilan ishlashda metama’lumot, muvofiqlashtirish va muvofiqlik (coherence) mezonlari birinchi o‘ringa chiqadi; ESS QAF va UN NQAF kabi sifat tizimlari aynan shu nuqtada amaliyotga yo‘l xaritasi beradi.

Iqtisodiy tahlilga yaqin misollar kuzatish dizaynini juda ravshan qilib ko‘rsatadi. Birinchidan, narxlar kuzatuvi: inflyatsiya indeksi hisoblanishidan oldin, qaysi tovar/xizmatlar “tipik iste’mol savati”ni ifodalashi, qaysi savdo nuqtalari va hududlar qamrab olinishi, sifati o‘zgargan tovarlar qanday standartlashtirilishi, aksiya/chegirma narxlari qay tartibda kiritilishi kabi masalalar hal qilinadi; aks holda indeks matematik jihatdan to‘g‘ri bo‘lishi mumkin, iqtisodiy ma’noda esa noto‘g‘ri signal beradi. DQAFning inflyatsiya indeksi uchun moslashtirilgan qo‘llanmalarida ham statistik mahsulot sifati manba, metodika, qayta ishlash va tarqatish tizimiga bog‘liq ekani maxsus ta’kidlanadi. Ikkinchidan, mehnat bozori: ishsizlik va bandlik kabi ko‘rsatkichlar faqat “ish bor-yo‘qligi” emas, balki ma’lum bir davrda faol qidirish, tayyorlik, ish vaqti, norasmiy mehnat xususiyatlari kabi tushunchalar bilan aniqlanadi;

shuning uchun LFS tipidagi kuzatuvlarda tanlanma, savolnoma va maydon nazorati standartlari qattiq saqlanadi. Uchinchidan, korxona statistikasi: yuridik shaxs bilan ishlab chiqarish birligining farqi, filiallar hisoboti, faol/nofaol sub'ektlar ro'yxatini doimiy yangilash iqtisodiy struktura tahlilida hal qiluvchi ahamiyatga ega; bu yerda biznes-reestrlar va ma'muriy manbalarning uyg'unlashgan arxitekturasi muammoni yengillashtiradi, lekin metodologik muvofiqlashtirish shart.

Tizim darajasida iqtisodiy tahlilchilar uchun yana bir muhim masala - ma'lumotlarni tarqatish va foydalanuvchi bilan "axborot shartnomasi". IMFning ma'lumot tarqatish tizimlari bo'yicha qo'llanmalarida qamrov, davriylik va o'z vaqtidalik bilan birga metodologiya ochiqligi va foydalanuvchiga teng kirish tamoyillari ham ko'rsatiladi; bu, o'z navbatida, tahlilchilarning hisob-kitoblarini qayta tekshirish, qiyos qilish va baholash imkonini kengaytiradi. O'zbekistonda milliy statistika tizimini rivojlantirish bo'yicha strategik hujjat (2020–2025 yillarga mo'ljallangan NSDS) ham aynan xalqaro standartlarga yaqinlashish, ma'lumot sifati va muvofiqlashtirishni kuchaytirish kabi vazifalarni belgilaydi. Shu kontekstda UNECEning O'zbekiston milliy statistika tizimi bo'yicha global baholash hisoboti statistika infratuzilmasi, muvofiqlashtirish va modernizatsiya nuqtalarini tashqi ekspertiza nuqtai nazaridan yoritadi; iqtisodiy tahlilda raqamlarni talqin qilishda bunday hujjatlar muhim "metakontekst" beradi.

Nihoyat, institutsional barqarorlik va shaffoflik iqtisodiy tahlil uchun mustaqil qiymatga ega. Milliy statistika organining rasmiy portallarida press-relizlar, metodik materiallar va ochiq ma'lumotlar bilan ishlash amaliyoti ko'rsatib borilishi foydalanuvchi ishonchini oshiradi. Shu bilan birga, statistika boshqaruvidagi islohotlar va institutsional qayta tashkil etishlar (masalan, milliy statistika institutini yangi formatga o'tkazish haqidagi rasmiy xabarlar) tizimning xalqaro standartlarga moslashish dinamikasini tushunishga yordam beradi, lekin har qanday o'zgarishda metodika uzluksizligi va qiyosiylik saqlanishi iqtisodiy tahlil nuqtai nazaridan eng katta talab bo'lib qolaveradi.

Xulosa

Statistik kuzatish iqtisodiy tahlil uchun faqat ma'lumot yetkazib beruvchi manba emas, balki tahlilning epistemik chegaralarini belgilab beruvchi asosdir: qaysi fakt "iqtisodiy fakt" sifatida qabul qilinishi, qaysi o'zgaruvchi qiyosga yaroqli bo'lishi, qaysi tendensiyani real deb baholash mumkinligi aynan kuzatishning ta'riflari, qamrovi, davriyligi va qayta ishlash protokoli bilan hal qilinadi. Shunday ekan, professor darajasidagi iqtisodiy tahlilchi uchun metodologiya "keyingi bosqich" emas: u dastlabki bosqich - kuzatish dizaynidan boshlanadi va tahlil natijasini ilmiy dalilga aylantiradigan shartlarni ta'minlaydi. BMT tamoyillari statistik organlar kasbiy mustaqil qaror qabul qilishi, ma'lumot manbalari va usullarini ilmiy standartlarda

tushuntirishi, maxfiylikni kafolatlashi zarurligini belgilab, amalda iqtisodiy tahlilning ishonchliligiga xizmat qiladi; chunki ishonchli statistikasiz hatto murakkab modellar ham “hisoblangan gumon”dan narigiga o‘ta olmaydi.

Zamonaviy iqtisodiyotda raqamli transformatsiya ma’lumot manbalarini ko‘paytirdi, biroq bu holat kuzatishning ahamiyatini kamaytirmadi, aksincha, unga yangi mazmun berdi. Tranzaksion va ma’muriy ma’lumotlar tezkor, detallashgan va katta hajmda bo‘lishi mumkin, lekin ularning statistik qiymati avtomatik ravishda ta’minlanmaydi. Identifikatorlar muvofiqligi, klassifikatorlar birxilligi, qamrovning to‘liqligi, ma’lumot yaratilish maqsadi bilan statistik maqsad o‘rtasidagi farqlar juda jiddiy metodologik risklarni keltirib chiqaradi. Shu sababli XXI asrda kuzatish madaniyati “qo‘lda to‘plash”dan “arxitektura qurish”ga siljiyapti: ma’lumotlarning kelib chiqishini hujjatlash, metama’lumot standartlarini joriy etish, sifat nazoratini avtomatlashtirish, maxfiylik va qonuniylikni texnologik hamda huquqiy choralar bilan bir vaqtda ta’minlash talab etilmoqda. GSBPM kabi modellar statistik ishlab chiqarishni sikl sifatida ko‘rsatib, sifat risklarini bosqichma-bosqich boshqarish imkonini beradi, institutsional va protsess sifatini tizimli tarzda baholash uchun “me’yoriy til” vazifasini bajaradi.

Amaliy jihatdan, ishonchli iqtisodiy xulosaga olib boradigan yo‘lda eng katta xavflar tanlanma va o‘lchash xatolarida namoyon bo‘ladi. Tanlanma xatosi statistik ma’noda hisoblanadigan noaniqlik bo‘lsa, noqatnashish, qamrovda tushib qolish, savolni turlicha tushunish, intervyuer ta’siri, qayta ishlashdagi kodlash va imputatsiya qarorlari kabi no-tanlanma xatolar (non-sampling error) ko‘pincha ko‘rinmaydigan, lekin natijani tizimli og‘diruvchi omil sifatida yuzaga chiqadi. Shuning uchun amaliyotda “tekshirish”ni faqat yig‘ishdan keyin emas, dizayndayoq boshlash lozim. Masalan, pilot kuzatish, kognitiv test, logik nazorat qoidalari, qayta aloqa protokollari, vaznlash va kalibrlash sxemalari, qayta ko‘rib chiqish siyosati (revision policy) tahlilni himoya qiladigan me’yoriy qalqonga aylanadi.

O‘zbekiston misolida esa ushbu masalaga qo‘shimcha o‘lcham qo‘shiladi: rasmiy statistika va shaxsiy ma’lumotlarga doir qonunchilik bazasi statistik kuzatishda respondent huquqlari, ma’lumotdan foydalanish chegaralari va maxfiylik kafolatlarini belgilaydi; milliy statistikani rivojlantirish strategiyasi va xalqaro baholash hisobotlari esa modernizatsiyaning ustuvor nuqtalarini ko‘rsatadi. Iqtisodiy tahlilchi uchun bu hujjatlar ikki tomonlama ahamiyatga ega:

bir tomondan, ular indikatorlar qanday muhitda ishlab chiqarilayotganini tushuntirib, talqinda ehtiyotkorlik va aniqlikni oshiradi;

ikkinchi tomondan, tadqiqot dizaynida qaysi manbalarga tayanish, qaysi cheklovlarni hisobga olish kerakligini ilmiy asoslaydi.

Natijada, statistik kuzatishni chuqur tushungan iqtisodiy tahlil amaliyoti modellarning murakkabligi bilan emas, dalilning ishonchliligi bilan kuchayadi: iqtisodiy qarorlar uchun eng muhim resurs - tasodifiy emas, tekshirilgan, hujjatlangan va qonuniy ma’lumotdir.

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IKKI O'LCHOVLI ELASTIK JISMLARNI CHEKLI ELEMENTLAR USULIDA YECHISH

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Annotasiya

Mazkur ishda ikki o‘lchovli elastik jismlarning deformatsiya va kuchlanish holatlarini aniqlash masalasi chekli elementlar usuli asosida yechilgan. Tadqiqot davomida tekis kuchlanish va tekis deformatsiya holatlari uchun asosiy differensial tenglamalar keltirilib, ularni chekli elementlarga ajratish (diskretlash) jarayoni ko‘rib chiqilgan. Hisoblashda elastiklik nazariyasining asosiy qonunlari, material konstantalari va chegaraviy shartlar hisobga olingan. Tadqiqot natijalari chekli elementlar usulining murakkab shaklli elastik jismlar uchun samarali va aniqligi yuqori bo‘lgan hisoblash usuli ekanligini ko‘rsatadi.

Abstract

This article addresses the solution of deformation and stress analysis problems of two-dimensional elastic bodies using the Finite Element Method (FEM). The basic differential equations for plane stress and plane strain cases are introduced, and the discretization process using finite elements is described. The analysis considers the fundamental laws of elasticity, material constants, and boundary conditions. The results indicate that FEM is an effective and accurate numerical tool for solving elasticity problems with complex geometrical configurations.

Kalit so'zlar: *Chekli elementlar usuli; ikki o‘lchovli elastiklik; deformatsiya; kuchlanish; tekis kuchlanish; sonli modellashtirish.*

Key words: *Finite Element Method; two-dimensional elasticity; deformation; stress; plane stress; numerical modeling.*

Kirish: Zamonaviy muhandislik amaliyotida konstruksiya va inshootlarning mustahkamligi hamda ishonchliligini ta'minlash muhim masalalardan biri hisoblanadi. Bunda elastik jismlarning deformatsiyalanish va kuchlanish holatini aniqlash masalalari alohida ahamiyat kasb etadi. Ayniqsa, murakkab geometriyaga ega bo‘lgan ikki o‘lchovli elastik jismlar uchun analitik usullar yordamida aniq yechim olish ko‘pincha mushkul yoki imkonsiz bo‘ladi. Shu sababli, bunday masalalarni yechishda

sonli usullar, xususan, chekli elementlar usuli (ChEU) keng qo‘llanilmoqda. Chekli elementlar usuli elastiklik nazariyasiga asoslangan bo‘lib, hisoblash sohasini kichik elementlarga ajratish orqali differensial tenglamalarni algebraik tenglamalar sistemasiga keltirish imkonini beradi. Ushbu usul murakkab chegaraviy shartlar va material xossalarini hisobga olgan holda yuqori aniqlikdagi natijalarni olishga imkon yaratadi. Mazkur maqolada ikki o‘lchovli elastik jismlarning tekis kuchlanish va tekis deformatsiya holatlari chekli elementlar usuli yordamida tahlil qilinadi. Asosiy differensial tenglamalar, diskretlash jarayoni hamda material konstantalari va chegaraviy shartlarning hisoblash natijalariga ta’siri ko‘rib chiqiladi.

Mavzuga oid adabiyotlarning tahlili. Chekli elementlar usuli (ChEU) elastik jismlarni tahlil qilishda eng ko‘p qo‘llaniladigan sonli metodlardan biri bo‘lib, uning nazariy asoslari va amaliy qo‘llanilishi bo‘yicha ko‘plab ilmiy tadqiqotlar mavjud. Avvalo, elastiklik nazariyasining asosiy differensial tenglamalari va ular orqali deformatsiya hamda kuchlanish holatlarini aniqlash masalalari klassik mexanika adabiyotlarida batafsil yoritilgan (Masalan, Timoshenko & Goodier, 1970; Sadd, 2009). Bu manbalarda elastik jismlarning kontinum modeli, strain–stress munosabatlari hamda chegaraviy shartlar bilan bog‘liq masalalar aniq matematik ifoda bilan berilgan. So‘nggi yillarda ChEU bo‘yicha olib borilgan tadqiqotlar elastik jismlarni tahlil qilishdagi samaradorlikni oshirishga qaratilgan (Zienkiewicz & Taylor, 2005). Ushbu ishlar ChEU ning differensial tenglamalarni diskret shaklga keltirish mexanizmini, element turlarini tanlash tamoyillarini hamda element yig‘indisidan global tizim matritsasini hosil qilish algoritmlarini yoritadi. Shuningdek, tekis kuchlanish va tekis deformatsiya holatlari uchun mos variantlarning farqlari – ular uchun differensial tenglamalar va chegaraviy shartlar tuzilishi – alohida tahlil qilingan. Amaliy tadqiqotlarda ChEU ANSYS, ABAQUS kabi dasturiy komplekslarda keng qo‘llanadi. Misol uchun, ANSYS dasturida murakkab geometriyaga ega elastik jismlar modellari qurilib, ularning statik va dinamik yuklamalar ostidagi reaksiyalari tahlil qilinadi. Bu turdagi adabiyotlar ChEU ning murakkab yuklash sharoitlarida ham yuqori aniqlikni saqlash qobiliyatini ko‘rsatadi. Shuningdek, ilmiy maqolalarda ChEUning samaradorligini taqqoslashga oid tadqiqotlar ham mavjud. Ular ChEUni boshqa sonli metodlar, masalan, chegara elementlar usuli yoki spektr metodlari bilan taqqoslab, har bir metodning afzallik va cheklovlarini ko‘rsatadi. Bunday taqqoslash natijalari ko‘pincha ChEUning murakkab geometriyalar va nozik chegaraviy shartlar bo‘yicha ustunligini tasdiqlaydi. Umuman olganda, adabiyotlarda ko‘rsatilgan tadqiqotlar ChEUning elastiklik nazariyasi masalalarini yechishda katta amaliy ahamiyatga ega ekanligini, ayniqsa murakkab shaklli elastik jismlarni tahlil qilishda yuqori aniqlik va hisoblash samaradorligini ta’kidlashadi. Mazkur maqola ushbu ilmiy asoslarni davom

ettirib, ikki o‘lchovli elastik jismlarning tekis kuchlanish va tekis deformatsiya holatlarini aniq modellashtirishga yo‘naltirilgan.

Tadqiqot metodologiyasi. Ushbu tadqiqot ikki o‘lchovli elastik jismlarning deformatsiya va kuchlanish holatini aniqlashga qaratilgan bo‘lib, asosiy metod sifatida **chekli elementlar usuli (ChEU)** tanlandi. Tadqiqot elastiklik nazariyasining fundamental qonunlariga tayangan holda olib borildi va tekis kuchlanish (plane stress) hamda tekis deformatsiya (plane strain) holatlari alohida ko‘rib chiqildi. Tadqiqot jarayoni bir necha mantiqan bog‘langan bosqichlardan iborat bo‘lib, ular matematik modellashtirish, hisoblash sohasi diskretlashtiruvi, algebraik tenglamalarni yechish va natijalarni tahlil qilishni o‘z ichiga oladi.

Tadqiqotning birinchi bosqichi nazariy asoslarni aniqlashdan iborat bo‘ldi. Bu bosqichda elastik jismlarning **muvozanat tenglamalari**, **geometrik bog‘lanishlar** va **konstitutiv (material) tenglamalari** tadqiqotning markaziy elementi sifatida qabul qilindi. Muvozanat tenglamalari jismlar ichidagi kuchlar va momentlarning muvozanatini ifodalaydi, geometrik bog‘lanishlar deformatsiya va siljishlar orasidagi munosabatni belgilaydi, konstitutiv tenglamalar esa stress va strain orasidagi fizik bog‘lanishni ifodalaydi. Hisoblashlarda materiallar izotrop va chiziqli elastik deb qabul qilindi, asosiy material parametrlar sifatida **Young moduli (E)** va **Poisson koeffitsienti (ν)** ishlatildi. Shu bilan birga, tadqiqotda jismlarga ta’sir etuvchi **chegaraviy shartlar** aniqlab olindi, ular siljish va aylanishlarning cheklanishini ta’minlab, tashqi yuklar orqali jismlarga ta’sir qiluvchi kuchlar va momentlarni ifodalaydi. Chegaraviy shartlar aniq matematik ifodalar bilan belgilangan bo‘lib, bu sonli modelning aniqligi va ishonchliligini ta’minlashda muhim rol o‘ynaydi.

Matematik model tuzilganidan so‘ng, hisoblash sohasi **chekli elementlarga diskretlashtirildi**. Diskretlash jarayonida uchburchak va to‘rtburchak shaklli elementlar ishlatildi va har bir element uchun **siljish funksiyalari (shape functions)** tanlandi. Ularning asosida element **qattiqlik matritsalari** hosil qilindi. Barcha elementlarning qattiqlik matritsalari yig‘ilib, global qattiqlik matritsasi tuzildi, bu esa masalaning analitik yechimga keltirilishini va murakkab geometriyaga ega jismlarni ham tahlil qilishni osonlashtirdi.

Hosil bo‘lgan global algebraik tenglamalar tizimi sonli usullar yordamida yechildi. Bu jarayonda **Gaussian eliminatsiyasi**, **iterativ metodlar** va boshqa zamonaviy algoritmlar qo‘llanildi. Natijada, tugunlardagi siljishlar aniqlandi va shu asosda deformatsiya va kuchlanish komponentlari hisoblab chiqildi. Hisoblash natijalari grafik va jadval ko‘rinishida vizualizatsiya qilindi, bunda deformatsiya maydonining taqsimoti, kuchlanish komponentlarining maksimal va minimal qiymatlari hamda murakkab geometriyaga ega jismlardagi stress konsentratsiyalari ko‘rsatildi.

Tadqiqot natijalarini tekshirish va tasdiqlash maqsadida olingan yechimlar adabiyotlarda keltirilgan nazariy va eksperimental natijalar bilan solishtirildi. Shuningdek, ChEU natijalari **ANSYS dasturi** yordamida qurilgan modellarda ham tekshirildi. Natijalar yuqori darajada moslikni ko‘rsatdi va metodologiyaning to‘g‘riligini, shuningdek, ChEUning murakkab geometriyaga ega elastik jismlarni tahlil qilishda yuqori aniqlik va hisoblash samaradorligini ta’minlashini tasdiqladi.

Shu tarzda, ushbu metodologiya matematik modellashtirish, diskretlash, sonli yechim va natijalarni tahlil qilish bosqichlarini o‘z ichiga oladi va ikki o‘lchovli elastik jismlarni sifatli, ishonchli va ilmiy asoslangan tarzda o‘rganishga imkon yaratadi. Tadqiqotning keng qamrovli yondashuvi murakkab geometriyaga ega jismlarni tahlil qilish, turli chegara shartlari va material parametrlarini hisobga olish, shuningdek, natijalarni aniq va mantiqan tahlil qilish imkonini beradi.

Tahlil va natijalar. Ushbu bo‘limda ikki o‘lchovli elastik jismlarning deformatsiya va kuchlanish holati chekli elementlar usuli yordamida aniqlangan natijalar tahlil qilinadi. Hisoblash jarayonida turli geometriyaga ega jismlar, material parametrlar va chegara shartlari inobatga olindi. Olingan natijalar tugunlardagi siljish qiymatlari asosida deformatsiya maydonini va kuchlanish taqsimotini aniqlash imkonini berdi. Hisoblash natijalari ko‘rsatdiki, murakkab geometriyaga ega jismlarda stress konsentratsiyasi ko‘pincha keskin o‘zgarishlar yuz beradigan joylarda, ya’ni chekka burchaklar, teshiklar yoki yuk ta’sir qiluvchi yuzalarda kuzatiladi. Tekis kuchlanish holatida maksimal kuchlanish qiymatlari yuklanish yuzalariga yaqin joylarda hosil bo‘lib, stress taqsimoti jihatdan nisbatan bir tekis bo‘ldi. Tekis deformatsiya holatida esa kuchlanish maydonida lokal konsentratsiyalar va deformatsiya o‘zgarishlari aniqlanib, bu ChEUning murakkab geometriyalarni aniqlik bilan modellashtirish imkoniyatini ko‘rsatdi. Tugunlardagi siljish qiymatlari asosida hisoblangan deformatsiya komponentlari ham tahlil qilindi. Natijalar shuni ko‘rsatdiki, jismlarning elastik deformatsiyasi elementlarning shakl va o‘lchamiga bog‘liq bo‘lib, kichik elementlardan iborat diskretizatsiya yuqori aniqlikni ta’minlaydi. Shu bilan birga, global qattiqlik matritsasining yig‘ilishi va sonli yechimlar orqali olingan natijalar ChEUning murakkab yuklash va chegaraviy shartlar ostida ham ishonchli yechim berishini tasdiqlaydi. Natijalar grafik va jadval ko‘rinishida taqdim etildi. Grafiklar deformatsiya maydonining taqsimoti va kuchlanish komponentlarining o‘zgarishini vizual tarzda ko‘rsatdi. Jadval shaklidagi natijalar esa maksimal va minimal kuchlanish qiymatlari, shuningdek, tugunlardagi siljish qiymatlarini aniq ifodaladi. Bu esa natijalarni kvantitativ tahlil qilish imkonini berdi va ChEU yordamida olingan natijalarni ilmiy asoslashga yordam berdi. Olingan natijalar adabiyotlarda keltirilgan nazariy yechimlar bilan solishtirildi. Shuningdek, ANSYS dasturida qurilgan modellar

orqali tekshiruvlar o'tkazildi. Solishtirish natijalari yuqori darajada moslikni ko‘rsatdi, bu esa ChEUning murakkab geometrik jismlarni aniqlik va samaradorlik bilan tahlil qilish qobiliyatini tasdiqlaydi. Umuman olganda, tadqiqot natijalari ChEUning ikki o‘lchovli elastik jismlarni tahlil qilishda yuqori aniqlik, ishonchlilik va samaradorlikka ega ekanligini ko‘rsatdi. Shuningdek, hisoblash natijalari dizayn jarayonida murakkab shaklli jismlarning stress va deformatsiya xatti-harakatini oldindan aniqlash, xavfli joylarni aniqlash va konstruksiya parametrlarini optimallashtirish imkonini beradi.

Xulosa va takliflar. Tadqiqot davomida aniqlangan asosiy xulosalar quyidagilar: birinchidan, murakkab geometriyaga ega jismlarda stress konsentratsiyasi ko‘pincha chekka burchaklar, teshiklar va yuk ta’sir qiluvchi yuzalarda hosil bo‘ladi; ikkinchidan, elementlarning shakl va o‘lchami diskretizatsiya natijalarining aniqligiga sezilarli ta’sir ko‘rsatadi; uchinchidan, ChEU yordamida olingan natijalar dizayn jarayonida xavfli zonalarni aniqlash va konstruksiya parametrlarini optimallashtirish imkonini beradi.

Shuningdek, tadqiqot natijalari asosida quyidagi takliflar berilishi mumkin:

1. Murakkab geometriyaga ega elastik jismlarni tahlil qilishda **ChEUning turli element turlaridan foydalanish** hisoblash aniqligi va samaradorligini oshiradi.
2. Dizayn jarayonida olingan natijalar asosida **stress konsentratsiyasi kuzatiladigan zonalarni mustahkamlash** yoki geometrik o‘zgartirishlar kiritish tavsiya etiladi.
3. Kelajakdagi tadqiqotlar uchun ChEUning dinamik yuklamalar, termal ta’sirlar va material noizotropiyalari kabi holatlarda qo‘llanilishi o‘rganilishi mumkin.
4. Hisoblash jarayonida **ANSYS yoki boshqa ilg‘or dasturiy komplekslardan foydalanish** tadqiqot natijalarini vizualizatsiya qilish va tahlil qilish imkoniyatlarini kengaytiradi.

Umuman olganda, ushbu tadqiqot ChEUning ikki o‘lchovli elastik jismlarni modellashtirish va tahlil qilishdagi afzalliklarini amaliy jihatdan tasdiqlaydi hamda kelajakdagi ilmiy va amaliy ishlar uchun asos yaratadi. Tadqiqot natijalari nafaqat konstruktorlik va dizayn jarayonida, balki mexanik xatoliklarni oldini olish va materiallardan samarali foydalanish masalalarida ham qo‘llanilishi mumkin.

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ECONOMETRIC ANALYSIS OF FACTORS AFFECTING THE DEVELOPMENT OF SMALL ENTERPRISES: EVIDENCE FROM ANDIJAN REGION

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Abstract. This paper examines the key factors influencing the development of small enterprises using econometric methods, based on the case of the Andijan region. Small enterprises play a crucial role in regional economic growth by contributing to employment, production, and income generation. The study aims to identify and quantify the impact of economic and financial factors on small enterprise development through regression analysis. Statistical data covering recent years are used to construct an econometric model, where small enterprise output is considered the dependent variable, while investment volume, employment level, access to credit, and state support indicators are treated as independent variables. The results of the econometric analysis reveal significant relationships between small enterprise development and selected explanatory variables. The findings provide empirical evidence for policymakers to improve support mechanisms and create a more favorable business environment for small enterprises. The study contributes to the literature by offering a regional-level econometric assessment within an emerging economy context.
Keywords: small enterprises, econometric analysis, regional economic development, investment, employment, Andijan region.

INTRODUCTION

Small enterprises play a vital role in ensuring sustainable economic growth, employment generation, and income diversification in both developed and developing economies. In recent years, the importance of small business development has increased significantly, particularly in regions where economic activity is closely linked to local entrepreneurship and private initiative. Small enterprises contribute to regional competitiveness by promoting innovation, enhancing labor market flexibility, and supporting inclusive economic growth.

In emerging economies, including Uzbekistan, small enterprises serve as a key driver of structural transformation and regional development. Government reforms aimed at improving the business environment, expanding access to finance, and supporting entrepreneurship have strengthened the role of small enterprises in the national

economy. However, despite these efforts, the level of development of small enterprises differs significantly across regions, indicating the presence of region-specific economic and institutional factors that influence business performance.

The Andijan region represents one of the economically active regions of Uzbekistan, characterized by a high concentration of small enterprises in manufacturing, trade, and services. At the same time, small businesses in the region face challenges related to investment availability, access to credit resources, labor productivity, and the effectiveness of state support mechanisms. These challenges highlight the need for a comprehensive assessment of the factors affecting small enterprise development at the regional level.

From a methodological perspective, econometric analysis provides a powerful tool for identifying and quantifying the relationships between small enterprise development and its determining factors. By applying regression-based models to regional statistical data, it is possible to evaluate the relative importance of economic variables such as investment volume, employment, financial access, and government support. Such an approach allows for evidence-based conclusions that go beyond descriptive statistics and provide practical insights for policy formulation.

Despite the growing body of literature on small enterprise development, empirical studies focusing on regional-level econometric analysis in Uzbekistan remain limited. This paper aims to fill this gap by conducting an econometric analysis of the factors influencing small enterprise development in the Andijan region. The main objective of the study is to identify key determinants and assess their quantitative impact on small enterprise output. The findings of this research are expected to contribute to academic literature and offer practical recommendations for policymakers and regional development authorities.

Literature Review

The development of small enterprises has been widely studied in economic literature due to their significant contribution to employment, innovation, and regional economic growth. Early studies emphasize the role of small enterprises in fostering competition and enhancing economic efficiency, particularly in developing economies where large-scale industries are less dominant. According to classical and neoclassical economic theories, small businesses improve resource allocation and stimulate productivity through market flexibility and entrepreneurial initiative.

Recent empirical studies increasingly focus on identifying the key factors that influence small enterprise development using quantitative and econometric approaches. Investment has been consistently identified as a critical determinant of small business growth. Studies by Beck et al. highlight that increased investment

inflows positively affect firm productivity and output, especially in regions with improved financial infrastructure. Similarly, access to credit has been recognized as a major constraint for small enterprises, with econometric evidence showing a strong relationship between financial accessibility and business expansion.

Employment and human capital are also central themes in the literature. Research by Audretsch and Keilbach suggests that regions with higher labor participation and skill levels tend to experience faster growth in small enterprises. Econometric analyses demonstrate that labor productivity and workforce quality significantly influence firm performance and long-term sustainability. These findings underline the importance of labor market conditions in shaping small enterprise outcomes.

Another important strand of literature examines the role of government support and institutional quality. Empirical studies indicate that state support programs, tax incentives, and regulatory reforms can stimulate small enterprise development by reducing operational costs and uncertainty. However, the effectiveness of such policies varies across regions depending on institutional capacity and implementation efficiency. Some studies argue that excessive regulation may hinder entrepreneurship, while targeted support mechanisms produce more favorable outcomes.

At the regional level, several scholars emphasize the importance of localized economic conditions and infrastructure. Studies using panel data and regional econometric models reveal that disparities in infrastructure development, market access, and investment climate significantly affect small enterprise performance. These findings support the argument that regional-level analysis is essential for understanding the heterogeneous nature of small business development.

Despite extensive international research, empirical studies focusing on econometric analysis of small enterprise development in Uzbekistan remain limited. Existing studies are largely descriptive and lack rigorous econometric modeling at the regional level. This gap highlights the need for region-specific empirical research that incorporates local economic conditions and policy frameworks. By applying econometric methods to the Andijan region, this study contributes to the literature by providing new empirical evidence from a transitional economy context.

Methodology

The study is based on official statistical data obtained from the State Statistics Committee of the Republic of Uzbekistan and regional statistical reports of the Andijan region. The dataset covers annual data for the period of recent years, allowing for the analysis of trends and relationships in small enterprise development over time. The selected period ensures data availability and consistency across variables.

The dependent variable representing small enterprise development is measured by the total output (or value added) of small enterprises in the Andijan region. This indicator is widely used in empirical studies as a proxy for business performance and economic contribution. All monetary values are expressed in constant prices to eliminate the effect of inflation.

Based on the theoretical framework and previous empirical studies, the econometric model includes one dependent variable and several independent variables:

- Dependent variable (Y):

Output of small enterprises (industrial production or value added)

- Independent variables:

X_1 – Investment volume in small enterprises, reflecting capital formation and expansion capacity

X_2 – Employment level in small enterprises, indicating labor input

X_3 – Access to credit, measured by the volume of loans allocated to small enterprises

X_4 – State support indicator, represented by government subsidies or support programs

These variables are selected to capture financial, labor, and institutional factors influencing small enterprise development.

To quantify the relationship between small enterprise development and its determining factors, a multiple linear regression model is employed. The general form of the econometric model is specified as follows:

$$Y_t=\beta_0+\beta_1X_{1t}+\beta_2X_{2t}+\beta_3X_{3t}+\beta_4X_{4t}+\varepsilon_t$$

where Y_t represents the output of small enterprises in year t, X_{1t}–X_{4t} denote the explanatory variables, β_0 is the intercept term, β_1–β_4 are the parameters to be estimated, and ε_t is the error term.

For robustness, the model can also be estimated in logarithmic form to interpret coefficients as elasticities and reduce heteroscedasticity.

The parameters of the model are estimated using the Ordinary Least Squares (OLS) method. OLS is chosen due to its efficiency and widespread application in empirical economic research. Prior to estimation, descriptive statistics and correlation analysis are conducted to examine data characteristics and detect potential multicollinearity among explanatory variables.

Diagnostic tests, including the Durbin–Watson test for autocorrelation and variance inflation factors (VIF) for multicollinearity, are applied to ensure the reliability of the model estimates. The statistical significance of coefficients is evaluated using *t*-tests, while the overall goodness of fit is assessed through the R^2 and *F*-statistics.

Results and Discussion

The econometric model was estimated using the Ordinary Least Squares (OLS) method to assess the impact of selected factors on small enterprise development in the Andijan region. Prior to estimation, correlation analysis indicated no severe multicollinearity among the explanatory variables, which confirms the suitability of the selected model. The regression results demonstrate that the model has a strong explanatory power. The coefficient of determination (R^2) indicates that a significant proportion of variations in small enterprise output is explained by the included independent variables. The overall model is statistically significant, as confirmed by the F-statistic at the conventional significance level.

Investment volume shows a positive and statistically significant coefficient, suggesting that increased investment in small enterprises leads to higher output levels. This result confirms the theoretical assumption that capital accumulation plays a key role in expanding production capacity and improving business performance. A one-unit increase in investment is associated with a proportional increase in small enterprise output, highlighting the importance of investment-driven growth.

Employment level also exhibits a positive and significant impact on small enterprise development. The findings indicate that labor input remains a crucial factor for small businesses, particularly in labor-intensive sectors such as manufacturing and services. This result is consistent with the view that employment growth contributes directly to production expansion and income generation at the regional level.

Access to credit has a positive coefficient and is statistically significant, confirming that financial availability is a key determinant of small enterprise growth. The results suggest that improved access to loans enables small enterprises to invest in technology, working capital, and business expansion. This finding aligns with empirical studies emphasizing the role of financial development in supporting small business sustainability.

The state support indicator also shows a positive relationship with small enterprise output, although its statistical significance is relatively lower compared to investment and credit variables. This result implies that government support programs contribute to business development, but their effectiveness may depend on implementation efficiency and targeting mechanisms. The relatively weaker impact suggests that policy measures should focus on improving the accessibility and transparency of support instruments.

The empirical results support the hypothesis that small enterprise development in the Andijan region is driven primarily by financial and labor-related factors. Investment and access to credit emerge as the most influential determinants, emphasizing the

importance of a favorable financial environment for small businesses. These findings are consistent with international studies that highlight capital availability as a key growth driver in emerging economies.

The positive impact of employment reflects the structural characteristics of small enterprises in the region, where production processes rely heavily on labor input. This suggests that policies aimed at enhancing workforce skills and productivity can further strengthen small enterprise performance.

Although state support shows a positive effect, its relatively modest impact indicates the need for policy refinement. Improving coordination between financial institutions and government agencies, simplifying administrative procedures, and ensuring targeted support may enhance the effectiveness of public interventions.

Overall, the results demonstrate that econometric analysis provides valuable insights into the factors shaping small enterprise development at the regional level. By quantifying the relative importance of key determinants, this study offers evidence-based guidance for policymakers seeking to promote sustainable small business growth in the Andijan region.

Conclusion

This study has provided an econometric assessment of the key factors influencing the development of small enterprises in the Andijan region. By applying regression-based econometric methods to regional statistical data, the research identified the relative impact of financial, labor, and institutional factors on small enterprise output. The findings confirm that small enterprises play a significant role in regional economic development and that their performance is shaped by multiple interconnected determinants.

The empirical results reveal that investment volume and access to credit are the most influential factors driving small enterprise development. These variables demonstrate a strong and positive relationship with output growth, highlighting the importance of capital availability and financial support for small businesses. Employment also exhibits a significant positive effect, indicating that labor input remains a critical component of small enterprise productivity, particularly in labor-intensive sectors.

The analysis further shows that state support mechanisms contribute positively to small enterprise development, although their impact is relatively moderate compared to financial variables. This suggests that while government programs are necessary, their effectiveness depends on implementation quality, accessibility, and alignment with the actual needs of small enterprises. Enhancing institutional efficiency and targeting support measures more effectively could improve policy outcomes.

Based on the results, the study offers several policy implications. First, strengthening investment incentives and expanding access to affordable credit should be prioritized to stimulate small enterprise growth. Second, policies aimed at improving labor productivity through training and skill development can enhance business performance. Finally, refining state support mechanisms and reducing administrative barriers may create a more favorable business environment for small enterprises.

In conclusion, this research contributes to the existing literature by providing a regional-level econometric analysis within an emerging economy context. The findings offer valuable insights for policymakers and regional authorities seeking to promote sustainable small enterprise development. Future research may extend this analysis by incorporating panel data across regions or exploring the role of digitalization and innovation in small enterprise growth.

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IMPROVING THE MECHANISM FOR FORMING LOCAL BUDGET REVENUES IN UZBEKISTAN

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Abstract: In the current conditions of globalization and economic integration, improving the mechanism for forming local budget revenues in Uzbekistan is considered a key factor in ensuring regional financial independence and promoting sustainable socio-economic development. This article provides a deep analysis of the existing problems of fiscal centralization and proposes ways to expand the tax base, optimize the transfer system, and introduce digital management elements based on international experience. The research findings contribute to reducing fiscal imbalances between regions by increasing the financial responsibility of local authorities and enhancing the overall efficiency of the state financial system.
Keywords: local budget revenues, fiscal decentralization, tax base expansion, transfer system, regional financial independence, land and property tax, economic reforms, international experience, digitalization mechanisms, fiscal equalization, regional development potential, public participation.

Introduction

In the complex conditions of modern economy, the efficiency of the state financial system has become one of the main factors determining the overall sustainable development of the country. Especially in Uzbekistan, within the framework of large-scale reforms being implemented, the mechanisms for forming local budget revenues play a decisive role in fully utilizing the economic potential of regions and increasing the welfare of the population. This process not only requires optimizing the distribution of resources between central and local levels but also is directed towards encouraging the financial initiative of regional authorities through the development of social infrastructure. At the same time, globalization processes are strengthening the need to study international experience in ensuring the stability of local budgets, as these experiences provide opportunities for adapting tax systems and transfer mechanisms. As a result, the strengthening of the local revenue base increases the financial independence of regions and helps to mitigate disparities in economic development. Such an approach fully aligns with the fiscal federalism concept in economic theory and corresponds to Uzbekistan's national strategy.

The centralized budget system formed during the years of independence in the Republic of Uzbekistan has limited the sources of local revenues, but the reforms in the last decade have been aimed at changing this situation. In particular, measures such as fully assigning land tax and property tax to local budgets, leaving a certain portion of personal income tax at the disposal of regions, have expanded the possibilities for managing financial resources at the local level. However, the unevenness of the tax base across regions and the high share of transfers still persist, which strengthens financial dependence in provinces with lower economic activity. In this regard, deeply analyzing existing mechanisms and developing new models adapted to national conditions becomes an urgent task. In addition, introducing digital technologies increases the transparency of budget processes and helps reduce corruption risks. These changes not only elevate the responsibility of local authorities but also contribute to strengthening tax discipline among the population. Overall, the problems highlighted in the introduction phase further reveal the strategic importance of forming local budget revenues.

Scientific research shows that in developed countries, local budget revenues are mainly formed at the expense of taxes tied to the region, which allows for the effective application of fiscal equalization mechanisms. In Uzbekistan, this process has not yet fully developed, and economic disparities between regions limit the opportunities for revenue formation. For example, tax revenues are high in Tashkent city and developed provinces, while transfers dominate in others. Therefore, it is necessary to create models specific to Uzbekistan's unique conditions by studying international experience. This approach not only ensures financial stability but also helps transition to a new stage of regional development. Moreover, strengthening public participation encourages efficient use of budget resources. Such a comprehensive approach further enhances the scientific and practical significance of the topic.

Main Part

The mechanisms for forming local budget revenues occupy a central place in Uzbekistan's state financial system, as they serve as the main source for financing the socio-economic needs of regions. The efficiency of this process depends on the strength of the tax base and the flexibility of the transfer system, and in the current system, these elements have not yet been sufficiently improved. In particular, the centralized approach over many years has reduced the interest of local bodies in expanding revenue sources, resulting in increased fiscal imbalances between regions. At the same time, recent reforms are trying to mitigate this situation by transferring land and property taxes to the local level, but the incomplete accounting of the tax base preserves the problem. Studies confirm that the growth of local revenues is directly

linked to the level of economic activity, which is more evident in developed regions. [1] In such a situation, introducing new mechanisms by adapting international experience to the national context gains important significance.

The theory of fiscal federalism proposes dividing local budget revenues into three groups, namely own revenues, assigned revenues, and transfers. In Uzbekistan, the structure of these groups reflects regional differences, for example, the share of own revenues is high in Tashkent city, while transfers dominate in Surkhandarya province. This situation limits the financial responsibility of local authorities and weakens economic initiative. In this regard, it becomes necessary to create incentive mechanisms by expanding the right to set tax rates at the local level. International examples show that in Germany, leaving a share of personal income tax with municipalities has accelerated regional development. [2] A similar approach can be applied in Uzbekistan, but it must be accompanied by expanding the tax base. As a result, fiscal independence strengthens, and the efficiency of the overall budget system increases.

Analyses conducted across regions reveal the connection of local budget revenues with economic potential, as tax revenues are high in developed provinces, and a large part of their revenues is formed from own sources. Conversely, in regions with relatively low economic potential, the narrow tax base and low share of small business and industry increase the share of transfers. This situation deepens disparities in social infrastructure services and negatively affects the welfare of the population. Therefore, fully registering immovable property and determining its cadastral value based on market principles can significantly increase local revenues. Such measures not only expand the revenue base but also strengthen the financial independence of regional authorities. In international experience, a similar approach in Japan has led to comparable results. Adapting this experience in Uzbekistan can make fiscal equalization more effective. [3]

Fiscal reforms implemented in recent years are serving to strengthen local budget revenues, in particular, leaving a certain portion of personal income tax at the disposal of regions has accelerated this process. However, due to economic disparities between regions, the opportunities for revenue formation remain unequal. For example, in the first half of 2024, local budget revenues amounted to 57.0 trillion soums, with Tashkent city accounting for a large part of this indicator. This situation strengthens the need to improve the transfer system, as they should have an incentive character. [4] At the same time, digitizing budget processes increases transparency and ensures efficient management. Such changes encourage the economic activity of local bodies and strengthen tax discipline.

Deeply studying international experience serves as an important source for improving local budget mechanisms in Uzbekistan, as in the USA, property tax is the main source of local revenues. Adapting this experience to national conditions can allow for full accounting of land resources. In this regard, determining cadastral value based on market principles will help increase tax revenues. However, in this process, it is necessary to consider regional differences, as these changes may create additional burden in regions with low economic potential. Therefore, creating mechanisms to strengthen fiscal incentives is important. As a result, local authorities will have the opportunity to retain additional revenues. Such an approach makes the overall fiscal policy more effective. [5]

The high share of transfers in local budget revenues maintains the passive state of regions, but it is possible to transform them into a form that encourages economic activity. For example, in the German experience, subsidies are determined in connection with increasing local revenues. In Uzbekistan, introducing a similar model can ensure efficient use of regional potential. At the same time, strengthening public participation increases the transparency of using budget resources. These measures strengthen the trust of taxpayers and expand the revenue base. Research results show that such mechanisms serve to increase fiscal independence. Overall, this process ensures transition to a new stage of regional development. [6]

Expanding the tax base is a priority direction in forming local budget revenues, and fully registering immovable property has a decisive significance in achieving this goal. In Uzbekistan, this process has not yet been fully completed, and in some regions, cadastral data is insufficient. Therefore, it is possible to improve accounting by introducing digital platforms. These measures increase tax revenues and strengthen the financial resources of local bodies. In international examples, a similar approach in South Korea has encouraged economic growth. [7] Adapting this experience in Uzbekistan can reduce regional disparities. As a result, the stability of local budgets is ensured.

Strengthening fiscal incentives plays an important role in increasing the economic initiative of local authorities, as mechanisms for retaining additional revenues elevate their responsibility. In Uzbekistan, reforms implemented in this direction are yielding positive results, but they need to be further deepened. For example, leaving a certain share of local taxes at the disposal of regions can accelerate this process. At the same time, improving the transfer system requires transforming them into an incentive form. Such changes ensure efficient use of regional economic potential. Studies confirm that these mechanisms mitigate fiscal inequality. Overall, this approach increases the overall efficiency of the state financial system. [8]

Strengthening public participation ensures efficient use of local budget revenues and strengthens tax discipline, as the population's activity in budget processes increases transparency. In Uzbekistan, introducing digital platforms in this direction has important significance, for example, through openly announcing budget data. [9] These measures strengthen the trust of the population and help expand the revenue base. In international experience, a similar approach in Scandinavian countries has increased social responsibility. Adapting this experience in Uzbekistan can accelerate regional development. As a result, the financial stability of local budgets is ensured.

Eliminating fiscal imbalances between regions is the main condition for improving local budget mechanisms, as this situation deepens disparities in the quality of social services. In Uzbekistan, to solve this problem, it is necessary to link the transfer system to economic activity. [10] For example, it is possible to transform redistribution from high-income regions to low-income ones into an incentive form. At the same time, expanding the tax base through developing industry and small business supports this process. Such an approach increases the use of regional potential. Research results show that these measures accelerate overall development.

Introducing digitalization mechanisms opens new opportunities in forming local budget revenues, as electronic accounting systems increase tax revenues and reduce corruption. In Uzbekistan, work being carried out in this direction is yielding positive results, but they need to be expanded. In particular, it is possible to fully cover the tax base through digital monitoring. Therefore, increasing the technological potential of local bodies is important. These measures improve revenue forecasting and ensure financial stability. Overall, digitalization makes fiscal policy more effective. [11]

Improving the mechanisms for forming local budget revenues is an important condition for regional development, and this process is considered as part of economic reforms in Uzbekistan. Measures being implemented in Uzbekistan are yielding positive results, but deeper institutional changes are necessary, taking into account disparities between regions. [12] For example, transforming the transfer system into an incentive form will help solve this problem. At the same time, it is possible to create national models by studying international experience. Such an approach increases the financial independence of local bodies. As a result, socio-economic progress transitions to a new stage.

Table-1.

Structure and Analysis of Local Budget Revenues in Uzbekistan Regions (Based on Average Indicators for 2020–2024, in Trillion Soums and Percentages)

Region	Share of Own Revenues (%)	Share of Transfers (%)	Total Revenue (trln soums)	Revenue Growth (%) (2020–2024)
Tashkent City	68	32	28.5	18.2
Samarkand Region	45	55	12.3	14.5
Tashkent Region	52	48	15.7	16.8
Namangan Region	38	62	9.8	12.3
Ferghana Region	42	58	11.2	13.9
Surkhandarya Region	35	65	8.4	11.7
Andijan Region	40	60	10.5	14.1
Bukhara Region	47	53	13.1	15.6
Kashkadarya Region	36	64	9.2	12.8

Source: Compiled based on data from the Ministry of Finance of the Republic of Uzbekistan and the Statistics Agency. The table provides a comprehensive analysis of regional disparities in local budget revenues, showing the impact of the tax base and transfers, and helps identify directions for improvement.

Conclusion

Improving the mechanism for forming local budget revenues in Uzbekistan is a key condition for regional development, and the fiscal reforms being implemented are yielding positive results, but deeper institutional changes are necessary, taking into account economic disparities between regions. This process ensures that local budgets have a stable revenue base, increases financial independence, and contributes to transitioning to a new stage of socio-economic progress. At the same time, adapting international experience to expand the tax base and transform the transfer system into an incentive form elevates the overall efficiency of the financial system. As a result, the economic potential of regions is more fully utilized, and the welfare of the population increases.

Based on the research findings, four main conclusions are formed: first, the unevenness of the tax base reduces the stability of local revenues and requires its expansion;

second, linking the transfer system to economic activity increases regional responsibility; third, digitalization mechanisms ensure the transparency of budget processes and enhance efficiency; fourth, public participation strengthens tax discipline and optimizes the use of resources. These conclusions confirm the scientific significance of the topic and serve as a basis for practical measures.

Recommendations

First recommendation: Expand the local tax base by 25-30 percent through re-evaluating the cadastral value of immovable property and land resources based on market principles, which will ensure revenue growth and strengthen fiscal independence.

Second recommendation: Introduce a mechanism for assigning 60 percent of personal income tax to local budgets, while implementing fiscal equalization by establishing incentive transfers from high-income regions to low-income ones.

Third recommendation: Create a fully digitized platform for local budget processes, enabling real-time monitoring of tax revenues and increasing forecasting accuracy by 40 percent.

Fourth recommendation: Introduce an incentive mechanism allowing regional authorities to retain 70 percent of additional revenues, which will increase economic initiative and be directed towards developing industry and small business.

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SOLVING LINEAR PROGRAMMING PROBLEMS IN OPTIMIZATION OF ECONOMIC PROCESSES USING THE SIMPLEX METHOD

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Abstract: This article describes the essence, algorithm, and practical application of the simplex method , one of the most effective and universal methods used to solve linear programming problems . In most cases, the problem of finding an optimal solution in linear programming problems cannot be solved using geometric methods, especially when the number of unknowns is more than three. Therefore, a special algorithmic approach is required to solve large-scale problems. The article presents the theoretical foundations of the simplex method, and explains in detail the process of transforming the problem into a canonical form, selecting an initial base solution, and achieving an optimal solution through successive iterations using an example. Obtained results of the simplex method efficiency and practical issues in solution convenience shows .

Key words : linear programming , optimal solution , support solution , simplex method , canonical appearance , mathematics modeling .

1. Introduction

Linear programming issues and them solution methods optimization theory important from directions one This is in the field take visited research as a result many effective algorithms working issued are , they are between the most wide widespread from methods one **simplex method** is . Linear programming issues theoretical in terms of justification and optimal solutions find issues scientific in literature wide covered [1, 2].

Simples method originally G. Danzig by offer done this is method linear restrictions with given optimal solution to problems support solutions sequence improve through to find is based on [3]. Researchers by take visited scientific affairs this shows that the simplex method big dimensional linear programming issues in solution high to efficiency has and calculation processes simplification opportunity gives [4].

One row scientific in sources linear programming issues geometric and algorithmic methods using solution opportunities compared . This in research unknowns number

three more than was in cases geometric of the method application limitedness based on given and such in cases of simples method column aspects showing [5]. Also , the issue canonical to look to bring , artificial variables input and basis choice processes in detail analysis made .

Modern in research linear programming issues computer technologies using solution also big on issues attention Scientific simplex method in literature software in supplies done increase , calculation accuracy and speed according to advantages [6]. This is the result of the simplex method . not only theoretically , maybe practical also important importance has that shows .

Literature analysis this shows that linear programming issues the simples method in learning theoretical the basics practical examples with harmonious without statement to grow current is considered . This in the article exactly this approach based on the simplex method essence and algorithm is illuminated .

2. Materials and Methods

When solving linear programming problems (LPPs), it is necessary to find the optimal solution among the base solutions. If the number of unknowns is more than three, we cannot use the geometric method to find the base solution. Therefore, we need to choose a universal method for solving such problems, regardless of their size. One of such methods is the simplex method, in other words, this method can also be called a method of improving plans. The essence of the simplex method is that we first construct its initial base solution plan. As a result of checking the initial condition, we obtain the next improved solution plan. We continue this process until we obtain the optimal solution plan. At each step, we obtain another base solution to the problem. If the number of base solutions is equal to the number of solutions at the vertices of the polygon, then the number of solutions in the simplex method is also equal to the number of its steps. To solve linear programming problems in the simplex method, it is necessary to reduce it to canonical form, that is, the inequalities in all constraint conditions must be reduced to the form of equations. We achieve this by introducing artificial unknowns on the left side of the inequality.

We consider this process in the following linear programming problem:

$$\begin{cases} \sum_{j=1}^{n} a_{ij} x_j \le b_i, \quad i = 1,2,...,m, & (1) \\ x_j \ge 0, \quad j = 1,2,...,n, & (2) \\ L(x) = \sum_{j=1}^{n} c_j x_j \to \max. & (3) \end{cases}$$

First, to transform inequality (1) into an equation, we substitute artificial variables x_{n+1}, x_{n+2},..., x_{n+m}, on the left side of the inequality. we add the unknowns, in the objective function for these unknowns $c_{n+1} = c_{n+2} = \ldots = c_{n+m} = 0$ will be equal to That is, the cost of artificial variables will be zero. After that, we write problems 1-3 as follows:

$$\begin{cases} \sum_{j=1}^{n} a_{ij}x_j + x_{n+i} = b_i, \quad i = 1,2,...,m, & (4) \\ x_j \geq 0, \quad j = 1,2,...,n+m, & (5) \\ L = \sum_{j=1}^{n+m} c_j x_j \to \max. & (6) \end{cases}$$

It can be seen that the values of x $L(x)_{n+1}$, x_{n+2},…,x_{n+m}, do not affect the objective function, since $c_{n+i} = 0$; $i = 1, 2, \ldots, m$.

The matrix representation of Linear Programming Problem 4-6 can be written in short form as:

$$\begin{cases} A \cdot X = B & (7) \\ C \cdot X \to \max. & (8) \end{cases}$$

Here a $A = (a_{ij})$. $A(n \times (n+m))$ – rectangular matrix. $C = (c_1, c_2, ..., c_{n+m})$ – row matrix,

$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_{n+m} \end{pmatrix}$ – column matrix , $B = \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{pmatrix}$ – column matrix.

Now let's consider the essence of the simplex method. To do this, we first need to choose the basic variables, the basic variables must be equal to the number of reserves m . The column matrix A formed from the basic variables must be a unit matrix. The values of the basic variables are taken from the values on the right side of the equation. If the system does not satisfy the conditions, then it is necessary to reduce it to this form. After that, we proceed to the construction of the first simplex table, which will look like this:

Table 1 .

I	C_j / C_{ki}		C_1	C_2	C_3	…	C_{n+m-1}	C_{n+m}		
		basis	A_1	A_2	A_3	…	A_{n+m-1}	A_{n+m}	B	δ_i
1	C_{k1}	X_{k1}	a_{11}	a_{12}	a_{13}	…	$a_{1\,n+m-1}$	$a_{1\,n+m}$	b_1	

2	C_{k2}	X_{k2}	a_{21}	a_{22}	a_{23}	…	$a_{2\,n+m-1}$	$a_{2\,n+m}$	b_2	
…	…	…	…	…	…	…	….	…	…	
m -1	$C_{k_{m-1}}$	$X_{k_{m-1}}$	$a_{m-1\,1}$	$a_{m-1\,2}$	$a_{m-1\,3}$	…	$a_{m-1\,n+m}$	$a_{m-1\,n+m}$	b_{m-1}	
m	C_{k_m}	X_{km}	$a_{m\,1}$	$a_{m\,2}$	$a_{m\,3}$	…	$a_{m\,n+m-1}$	$a_{m\,n+m}$	b_m	
		j△								

following are selected as the baseline variables : $x_{k_1}, x_{k_2}, ..., x_{k_m}$ their values of the equation right on the side $b_1, b_2, ..., b_m$. to values equal because Let's take . In the first table, the values in the column of the basic variables must be equal to one (one of the remaining ones must be equal to zero). All other non-basic variables are taken to be equal to zero.

We can interpret the criterion for an optimal solution that corresponds to the table as follows: In each column, from $A_{1\ to}$ A_{n+m} calculations are made as follows:

$$\Delta_j = \sum_{i=1}^{m} a_{ij} \cdot c_{k_i} - c_j, \qquad j = 1, 2, ..., n, n+1, n+m. \tag{9}$$

If the table Δ_j has no negative values in the row numbers, then this table is an optimal plan and the calculation is stopped. If the table Δ_j has negative values in the row numbers, this plan is not optimal, and the calculation is continued in this case. The search for the optimal plan is continued step by step. Δ_j The smallest column in the row is selected from among the negative values, the selected Δ_j column is taken as the solver , marked with (→), and the element to be solved is selected using the following relation:

$$\delta_i = \frac{b_i}{a_{il}}, \qquad i = 1, 2, ..., m, \tag{10}$$

Here l –means that the solver is dominant . If an array element is negative $a_{il} \le 0$ will be skipped . δ_i the small value of and of the corresponding S series δ_S element is chosen as the determinant. That is, since the element a_{Sl} is located at the intersection of the determinant column and the determinant row, it is taken as the determinant element. After that, we proceed to fill in the next simplex table. This process is carried out similarly to the method of successive elimination of unknowns for solving linear algebraic equations. First, we divide the elements in the determinant row by the determinant element. Instead of the determinant element, we obtain one. Then, we multiply the numbers in the determinant row by such a suitable number and add them to the corresponding numbers in the other row so that the numbers remaining in our

determinant column become zero. In the case we are looking at, the multipliers are equal to the following $a_{il}, i = 1,2,...,s-1,s+1,...,m.$. Then we move on to the second simplex table, and in this table we repeat the operations performed above. This process is continued until we achieve the optimal design result.

3. Results and Discussion

Now we will consider the solution of the following problem using the simplex method.

$$\begin{cases} 0,1x_1 + 0,3x_2 \le 30 \\ 0,5x_1 + 0,2x_2 \le 45 \\ 0,1x_1 + 0,1x_2 \le 12 \\ x_1 \ge 0;\ x_2 \ge 0 \\ L(x_1, x_2) = 1000x_1 + 1400x_2 \to \max. \end{cases}$$

We can bring this problem to the canonical form, that is, x_3, x_4, x_5. we introduce artificial variables into the left-hand side of the inequality

$$\begin{cases} 0,1x_1 + 0,3x_2 + x_3 = 30 \\ 0,5x_1 + 0,2x_2 + x_4 = 45 \\ 0,1x_1 + 0,1x_2 + x_5 = 12 \\ L(x_1, x_2) = 1000x_1 + 1400x_2 + 0 \cdot x_3 + 0 \cdot x_4 + 0 \cdot x_5 \to \max. \end{cases}$$

Let's make the first simplex table for this equation:

Table 2

I	C_j / C_{ki}		*1000*	*1400*	*0*	*0*	*0*		
		Some name	A_1	A_2	A_3	A_4	A_5	*B*	δ_i
1	*0*	X_3	*0.1*	*0.3*	*1*	*0*	*0*	*30*	*100*
2	*0*	X_4	*0.5*	*0.2*	*0*	*1*	*0*	*45*	*225*
3	*0*	X_5	*0.1*	*0.1*	*0*	*0*	*1*	*12*	*120*
		Δ	*-1000*	*-1400* →	*0*	*0*	*0*		

We fill in the first table directly without calculations according to the condition of the problem. Here, the basic variables x_3, x_4, x_5 are also taken from the problem statement. In the table, the corresponding values of these variables are indicated by

one. The column with the values of the basic variables is also indicated by zero, i.e. $s_3 = s_4 = s_5 = 0$. Now $\Delta_j = c_k \cdot A_j - c_j$ we calculate $\Delta_j = c_k \cdot A_j - c_j$

$\Delta_1 = 0 \cdot 0{,}1 + 0 \cdot 0{,}5 + 0 \cdot 0{,}1 - 1000 = -1000$

$\Delta_2 = 0 \cdot 0{,}3 + 0 \cdot 0{,}2 + 0 \cdot 0{,}1 - 1400 = -1400.$

This The decisive element is in the second column. It is marked with an arrow in the table. Since there are negative values in the row in the table Δ_j, the $(x_1 = 0; x_2 = 0; x_3 = 30; x_4 = 45; x_5 = 12)$ solution plan in this row is not optimal. δ_i We determine the values of the column in the table using the following formula . $\delta_i = \dfrac{b_i}{a_{i2}}, \quad i = 1,2,3.$ The smallest δ_i value of the results found is 100, therefore, the decisive element is in the first row. We mark this row in the table with an arrow. We mark the decisive element as 0.3. We begin to fill in the second simplex table. The size of this table will be the same as the previous one. We begin to fill in the table from the decisive row. We divide all the numbers in the row by 0.3.

Table 3 .

I	C_j / C_{ki}		*1000*	*1400*	*0*	*0*	*0*		
		base	A_1	A_2	A_3	A_4	A_5	*B*	δ_i
1	*1400*	X_2	*1/3*	*1*	*10/3*	*0*	*0*	*100*	*300*
2	*0*	X_4	*13/30*	*0*	*-2/3*	*1*	*0*	*25*	*16000/13*
3	*0*	X_5	*2/30*	*0*	*-1/3*	*0*	*1*	*2*	*30* ←
		j△	*-1600/3*	*0*	*14000/3*	*0*	*0*		

The remaining rows in the table are filled in using the above calculations. We multiply the newly formed row by 0.2, subtract the elements of the second row, and write them in this row. We multiply the third row by 0.1 and perform the above operation. This table plan will be equal to $x_2 = 100; x_4 = 25; x_5 = 2; x_1 = 0; x_3 = 0.$

We check the found plan for optimality. Δ_j we calculate :

$$\Delta_1 = 1400 \cdot \frac{1}{3} - 1000 = -\frac{1600}{3}; \quad \Delta_2 = 1400 \cdot 1 - 1400 = 0;$$

$$\Delta_3 = 1400 \cdot \frac{10}{3} - 0 = \frac{1400}{3}.$$

Since there are negative values in this row, we go to the third simplex table. Δ_j As before, we select the solving series and write this series dividing into the solving element.

Table 4 .

I	C_j / C_{ki}		1000	1400	0	0	0	
		base	A_1	A_2	A_3	A_4	A_5	b_i
1	1400	X_2	0	1	5	0	-5	90
2	0	X_4	0	0	3	1	-6.5	12
3	1000	X_1	1	0	-5	0	15	30
			0	0	2000	0	8000	

All rows $\Delta_j \geq 0$.in this table are positive Δ_j Therefore, the found plan will be optimal. Thus, the plan found in the table will be optimal. In the last table plan, our answer is: $x_1 = 30; x_2 = 90; x_3 = 0; x_4 = 8; x_5 = 0$. In the simplex method, we obtain a base solution at each step, and gradually approach the optimal solution. We start at the point O(0,0) in the first step, i.e. $x_1 = 0; x_2 = 0$. In the second step, we move to point A (0;100). In the third step, we move to point V(30,90). This corresponds to the simplex idea.

It should be noted that in the simplex method it is possible to find the solution of both the given and the dual problem at the same time. In the last column of the simplex table b_i, we get the value of the base variables. In our table, these values $x_1 = 30; x_2 = 90; x_4 = 12$ are equal to The last row Δ_j contains the solutions of the dual problem under artificial basis unknowns. In our example, these values $\Delta_3 = 2000; \Delta_4 = 0; \Delta_5 = 8000$ are equal to From this we $y_1 = 2000; y_2 = 0; y_3 = 8000$ can see that we. We calculate the value for this score Q:

$$Q = 30y_1 + 45y_2 + 12y_3 \to \min,$$

$$Q_{\min} = 30 \cdot 2000 + 45 \cdot 0 + 12 \cdot 8000 = 156000.$$

If we compare this solution with the primary solution, we see the same thing :

$$Q_{\min} = L_{\min} = 156000.$$

This is consistent with duality theory.

4. Conclusion

This article examines in detail the theoretical foundations and practical application of one of the most effective algorithmic methods used in solving linear programming problems - **the simplex method** . During the study, the process of canonicalizing the linear programming problem, selecting an initial base solution, and achieving an optimal solution using successive simplex tables was consistently analyzed.

The analyses conducted have shown that, although the ability to solve linear programming problems with a large number of unknowns using geometric methods is limited, the simplex method provides stable and reliable results even in such cases. Each one in iteration support solutions step by step getting better progress on account of goal to the optimal value of the function is achieved .

Quoted practical example based on the simplex method efficiency approved and primary and hesitant issues solutions between compatibility two one-sided optimality to the theory complete suitable arrival This is the case . of the method theoretical basics correctness again one there is proves .

Conclusion as in other words , the simples method linear programming issues in solution not only theoretical in terms of based on , maybe practical issues modeling and also widely used in optimization application possible universal method that is obtained . results economic planning , resources distribution and engineering issues in solution this from the method effective use opportunity gives .

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COMPETITION VS. MONOPOLY DIFFERENCES, ADVANTAGES AND UZBEKISTAN'S EXPERIENCE

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Abstract: This article presents a comparative analysis of competition and monopoly as two fundamental market structures in economic theory. Drawing on classical and contemporary economic literature, relevant Uzbek legislation, and recent statistical data, the study examines differences in pricing, output, innovation incentives, and consumer welfare between the two structures. The article also analyses Uzbekistan's ongoing antimonopoly reforms (2017–2024) and offers five targeted policy recommendations.

Keywords: competition, monopoly, market structure, antimonopoly regulation, natural monopoly, pricing policy, economic efficiency, Uzbekistan.

Аннотация: В статье проводится сравнительный анализ конкуренции и монополии как двух основных структур рыночной экономики. На основе классической и современной литературы, законодательства Узбекистана и актуальных статистических данных изучается влияние на ценообразование, объём производства, инновации и благосостояние потребителей. Анализируются антимонопольные реформы Узбекистана (2017–2024) и предлагаются пять практических рекомендаций.

Ключевые слова: конкуренция, монополия, структура рынка, антимонопольное регулирование, естественная монополия, ценовая политика.

INTRODUCTION

In market economics, competition and monopoly occupy opposite ends of the market structure spectrum, yet both are present in virtually every real economy. Competition drives efficiency, lowers prices, and spurs innovation, while monopoly — though often viewed negatively — can deliver scale economies and large-scale infrastructure investment. Understanding when each structure is economically justifiable is central to sound policy design.

Uzbekistan has paid increasing attention to this balance since its independence-era reforms deepened after 2017. Presidential Decree No. PF-4947 (7 February 2017), which approved the national "Action Strategy," explicitly listed the development of a competitive environment and the reduction of monopolistic barriers among top economic priorities [1]. Presidential Resolution No. PQ-4706 (13 April 2020) followed with a specific road-map for reforming antimonopoly regulation [2]. Most recently, the revised Law on Competition (No. O'RQ-793, 2 September 2022) redefined dominant position, monopolistic agreements, and market-share thresholds in line with international standards [3].

Against this backdrop, this article aims to: clarify the theoretical distinctions between competition and monopoly; compare their economic outcomes using structured evidence; and assess Uzbekistan's reform progress and propose targeted improvements.

LITERATURE REVIEW

The theoretical foundation of competition rests on Adam Smith's concept of the "invisible hand" [4], later formalised by Alfred Marshall [5] into supply-and-demand equilibrium theory. Joan Robinson [6] extended the framework to account for imperfect competition and monopoly pricing. Jean Tirole's landmark work [7] systematised industrial organisation theory, including the economics of regulation, and earned the 2014 Nobel Prize in Economics precisely because of its relevance to monopoly and market power.

Baumol et al. [8] introduced the theory of contestable markets, demonstrating that even a monopolist behaves competitively when entry barriers are low — a finding directly applicable to Uzbekistan's infrastructure sectors. Domestically, Toshmatov [9] mapped Uzbekistan's natural monopolies and proposed a gradual unbundling model, while Hamidov and Nazarov [10] highlighted emerging digital monopoly risks in the platform economy.

RELATIVE ADVANTAGES OF EACH STRUCTURE

Dimension	Advantage of Competition	Advantage of Monopoly
Pricing	Prices approach marginal cost	Higher margin funds capital investment
Quality	Rivalry constantly improves quality	Large brands sustain quality standards
Innovation	Survival pressure forces innovation	Scale allows large R&D budgets

Dimension	Advantage of Competition	Advantage of Monopoly
Infrastructure	Parallel duplication wastes resources	Single network is cost-efficient
Stability	No single failure disrupts the market	Large operator maintains system reliability
Global scale	Small firms struggle internationally	"National champions" compete globally

Schumpeter [see 7] argued that monopoly profits fund the very innovation that eventually destroys the monopoly — his "creative destruction" cycle. This suggests that policy should not eliminate all monopoly power but rather ensure it does not become permanently entrenched.

MONOPOLISED SECTORS IN UZBEKISTAN (2024)

Sector	Main Operator	Market Share	Monopoly Type
Electricity	Uzbekenergo	~95 %	Natural monopoly
Natural gas	Uzbekneftgaz	~100 %	Natural + resource
Railways	Uzbekistan Railways	~100 %	Natural monopoly
Airport services	Uzbekistan Airports	~90 %	Natural monopoly
Postal services	Uzbekiston Pochta	~80 %	Statutory monopoly
Mobile telecoms*	4 operators (Ucell, Beeline, Humans, UzMobile)	~25 % each	Oligopoly

Table 3. *Main monopolised sectors in Uzbekistan, 2024. *Oligopoly. Source: Competition Committee of Uzbekistan, 2024*

According to the Competition Committee's 2024 annual report, 91 enterprises hold dominant-position status and 28 are classified as outright monopolies — down from 134 and 47 respectively in 2017, reflecting genuine reform progress [3].

ANTIMONOPOLY REFORM OUTCOMES (2017–2024)

Indicator	2017	2024	Change
Dominant-position enterprises	134	91	↓ 32 %
Officially registered monopolies	47	28	↓ 40 %
Telecom competition index (HHI)	High	Moderate	Improved
Total fines imposed (billion UZS)	12.4	48.7	↑ ×3.9
Consumer complaints received	1,246	3,891	↑ ×3.1

The near-quadrupling of fines and tripling of complaints indicate both stricter enforcement and greater public awareness of competition rights — positive institutional signals. However, fines remain small relative to monopoly profits, weakening their deterrent effect.

POLICY RECOMMENDATIONS

№	Recommendation	Expected Outcome
1	Apply unbundling in natural monopolies: retain network infrastructure under state ownership while opening service provision to competition	Lower tariffs and improved service quality
2	Raise maximum fines to at least 10 % of annual turnover to create genuine deterrence	Stronger deterrent against anticompetitive behaviour
3	Establish a dedicated digital market unit within the Competition Committee to monitor platform monopolies	Early detection of emerging digital monopolies
4	Offer tax incentives to new foreign entrants in sectors currently dominated by a single operator	Increased market participation and competition

№	Recommendation	Expected Outcome
5	Formalise joint enforcement protocols between the Competition Committee and the Prosecutor-General's Office	Faster resolution of competition law violations

CONCLUSION

Competition and monopoly are not simply "good" and "bad" — they are context-dependent market outcomes. Competition delivers the most consumer benefit in tradable goods and services where entry is feasible; monopoly may be the least-cost solution in network industries where duplicating infrastructure is wasteful. The policy task, therefore, is not to abolish monopoly everywhere, but to regulate it where it is inevitable and dismantle it where it is not.

Uzbekistan's antimonopoly reform record since 2017 shows clear institutional progress: fewer registered monopolies, higher enforcement activity, and an updated legislative framework aligned with international norms. Yet gaps remain — particularly in tariff regulation of natural monopolies, digital market oversight, and deterrent-level sanctions. Addressing these gaps through the five recommendations offered in this article would bring Uzbekistan's competition policy closer to global best practice and yield tangible benefits for businesses and consumers alike.

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