

● GOVTECH INNOVATION & COGNITIVE AI RESEARCH

TAXPACT

Virtual Assistant for Property Tax Reform

A cognitive GovTech platform uniting Retrieval-Augmented Generation (GPT-4o), psychological adaptive contexts, real-time 3D talking head avatars, and empirical civic trust analytics.

RESEARCH INSTITUTION

University of Warmia and Mazury (UWM)

CORE LANGUAGE MODEL

OpenAI GPT-4o (Streaming SSE)

PRODUCTION INSTANCE

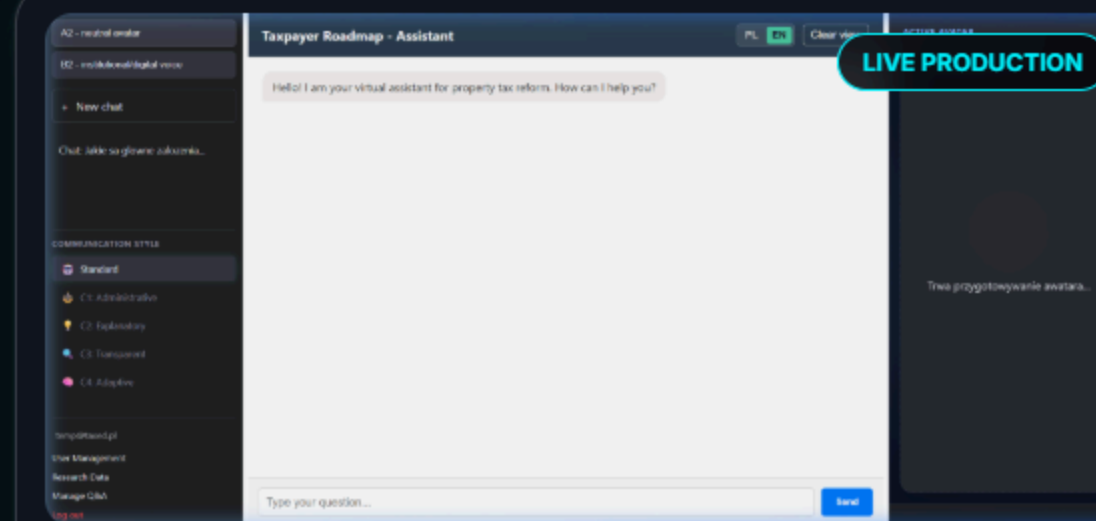
alphai.uwm.edu.pl ↗

3D GRAPHICS & VOICE

Three.js TalkingHead + OpenAI TTS

Start Presentation →

▶ Platform Preview



TAXPACT in action: Interactive taxpayer chat coupled with an integrated 3D facial animation engine and synthesized speech lip-sync.

PROJECT BACKGROUND

Civic Challenge & Academic Research Goals

Property tax reform is a delicate touchpoint between citizen and state. Traditional government communication channels fail due to three critical friction points:



1. Legal Complexity Barrier

Citizens struggle with terminology: cadastral value, mass valuation algorithms, zoning multipliers. Standard legal notices trigger helplessness and financial panic.

82% of citizens do not understand tax formulas



2. Costly Appeal Spiral

Citizens who perceive assessments as opaque or arbitrary immediately file appeals to Regional Appeal Boards (SKO), heavily burdening municipal administrations.

-40% disputed cases with procedural transparency



3. The TAXPACT Solution

A digital representative combining 100% statutory legal compliance with adaptive psychological styles tailored to individual citizen emotions.

Empathy + Procedural Justice

IT ARCHITECTURE

Modular System Stack: RAG, LLM & Web3D

Strict separation of concerns: from a verified knowledge pipeline to an embodied Web3D client interface.

1. KNOWLEDGE PIPELINE & SOURCE LAYER



Reform Documents

Official statutory DOCX guidelines & Q&A



Extraction Engine

extract_text.py + process_docs.py regex



Knowledge Base

knowledge_base.json & PostgreSQL tables

2. INTELLIGENCE CORE & BACKEND (PYTHON / FLASK)



Context Injection

Full knowledge injection into System Prompt



OpenAI GPT-4o

Server-Sent Events (SSE) Streaming



TTS & Lip-Sync Adapter

Speech API audio → Phonetic Visemes

3. USER EXPERIENCE & APPLICATION MODULES



Citizen Chat Interface

Streaming text, Markdown, EN/PL



3D TalkingHead Avatar

Three.js, blendshapes, facial gestures



3D Avatar Studio

Customizer for face, hair & styling



UWM Research Lab

Behavioral analytics & A/B testing

COGNITIVE INNOVATION

Psychological Adaptive Contexts (C1 – C4)

Dynamic adjustment of tone, detail, and emotional cadence tailored to citizen archetypes and sentiment in real time.

 **C1: Administrative** **C2: Explanatory** **C3: Transparent** **C4: Adaptive (Auto)** **Administrative Style (C1)**

Goal: Formal delivery of official assessment decisions.

Language: Strictly institutional, concise, no digressions.

Content: State the outcome and statutory legal basis.

Target: Analytical users, CFOs, auditors requiring pure legal facts.

TAXPACT SAMPLE RESPONSE IN C1 STYLE:

“The real estate tax has been assessed pursuant to Art. 4(1) of the Local Taxes and Fees Act, determined through the mass appraisal model and registered transaction data for cadastre zone 1402.”

COGNITIVE INNOVATION

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 C2: Explanatory

 C3: Transparent

 C4: Adaptive (Auto)

Explanatory Style (C2)

- Goal:** Quick understanding and plain simplification.
- Language:** Short sentences, everyday vocabulary, zero legal jargon.
- Content:** Core primary factors (square footage & neighborhood average).
- Target:** Busy citizens seeking immediate practical clarity.

TAXPACT SAMPLE RESPONSE IN C2 STYLE:

“Your tax amount is based on two simple factors: the size of your house and recent average property prices in your immediate neighborhood. Nothing else influenced this calculation.”

COGNITIVE INNOVATION

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Dynamic adjustment of tone, detail, and emotional cadence tailored to citizen archetypes and sentiment in real time.

 C1: Administrative C2: Explanatory C3: Transparent C4: Adaptive (Auto) **Transparent & Empathetic Style (C3)**

Goal: Establishing procedural justice, trust, and calming frustration.

Language: Warm, patient, transparent, step-by-step guidance.

Content: Data breakdown: 1.5 km radius, 24-month transactions, weighting.

Target: Angry or distressed taxpayers protesting their tax bill.

TAXPACT SAMPLE RESPONSE IN C3 STYLE:

“Hello! I want to ensure everything is completely fair, clear, and reassuring for you. Let's break down the exact calculation together: the system examined 14 verified property transactions within 1.5 km of your address over the past 24 months...”

COGNITIVE INNOVATION

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 C1: Administrative

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C4 Adaptive Mode – Autonomous Sentiment Classifier

Mechanism: Two-stage cognitive inference loop.

Step 1: Prior to generation, a micro-agent classifies citizen stress, hostility, and tone.

Step 2: Dynamic injection of style flag [C1, C2, or C3] into the master RAG prompt.

Outcome: Seamless mid-conversation transition from legalistic to calming empathy.

1 User angrily protests 'unfair confiscatory taxation'



2 C4 Detector flags elevated stress and distrust



3 Auto-activates C3 Transparent / Empathetic Style

CITIZEN EXPERIENCE

Citizen Interaction: Real-Time SSE Stream & Multilingual Mode

Production interface deployed on UWM infrastructure (alpai.uwm.edu.pl).

POLISH EDITION (PL)

Click to enlarge

A1 - brak awatara

B1 - tekst

+ Nowa rozmowa

Rozmowa. Jak to są główne założ...

STYL KOMUNIKACJI

Standardowy

C1: Administracyjny

C2: Wyganający

C3: Transparentny

C4: Adaptacyjny

temp@taxod.pl

Zaszczenie content

Dane budowlane

Zaszczenie GbA

Wyloguj się

Roadmapa Podatnika - Asystent

EN Wyczyść widok

Dzień dobry! Jestem Twoim wirtualnym asystentem ds. reformy podatku od nieruchomości. W czym mogę pomóc?

Jakie są główne założenia reformy podatku od nieruchomości?

Główne założenia reformy podatku od nieruchomości koncentrują się na przejściu z systemu opartego na powierzchni na system wartościowy. Obecny system nie uwzględnia różnic w cechach techniczno-lokalizacyjnych nieruchomości o tym samym przeznaczeniu, co prowadzi do niesprawiedliwego rozłożenia obciążeń podatkowych. Reforma ma na celu lepsze różnicowanie obciążeń w oparciu o rzeczywistą wartość nieruchomości, a nie tylko jej powierzchnię. Wprowadzenie wartości jako podstawy opodatkowania ma zwiększyć spójność systemu oraz odzwierciedlać rzeczywistą zdolność podatkową właścicieli. Dodatkowo, zakłada się wprowadzenie mechanizmów łagodzących skutki przejścia na nowy system, takich jak limity wzrostu, okresy przejściowe i ulgi.

Wpisz swoje pytanie...

Wyślij

Real-Time Streaming & Style Indicators

Token-by-token SSE streaming response. The style pill visibly informs the citizen of the active context ("Style: Default / C3"), with intelligent follow-up chips.

ENGLISH EDITION (EN)

Click to enlarge

A1 - no avatar

B1 - text

+ New chat

Chat: What is the main goal ...

Chat: What is the main goal ...

COMMUNICATION STYLE

Standard

C1: Administrative

C2: Explanatory

C3: Transparent

C4: Adaptive

temp@taxod.pl

User Management

Research Data

Manage GbA

Log out

Taxpayer Roadmap - Assistant

PL EN Clear view

Hello! I am your virtual assistant for property tax reform. How can I help you?

What is the main goal of the reform?

The main goal of the reform is to address the long-term inconsistencies between the current area-based property tax system and the actual diversity in property values. The existing system, which is based solely on surface area, does not take into account factors like location, standard, or function of the property, leading to tax burdens that are poorly aligned with the actual financial capacity of property owners. The reform aims to gradually align the tax base with the true economic value of properties, while also introducing mechanisms to mitigate the transition's impact. If you have further questions, feel free to ask!

Who will be most affected by the changes?

The reform aims to redistribute tax burdens more fairly based on the actual economic value of properties, rather than simply their size. This means those owning properties that are undervalued in the current system might see an increase in their tax obligations, while those with overvalued properties might experience a decrease. However, the reform includes protective mechanisms, such as limits on tax increases and transitional periods, to prevent sudden financial impacts on taxpayers. If you have specific concerns or need more detailed

Type your question...

Send

Full Internationalization

Dedicated English system prompt ensuring foreign property owners and expatriates receive comprehensive assistance while preserving official Polish statutory terms in brackets.

MULTISENSORY WEB3D

3D TalkingHead Avatar & Phonetic Lip-Sync Engine

Merging real-time browser WebGL rendering with millisecond phonetic speech synchronization.

REAL-TIME 3D RUNTIME

Three.js Engine + TalkingHead Library

Avatars rendered inside a client canvas with Mixamo skeletal rigs and ARKit/Oculus facial blendshapes.

PHONETIC LIP-SYNC ADAPTER

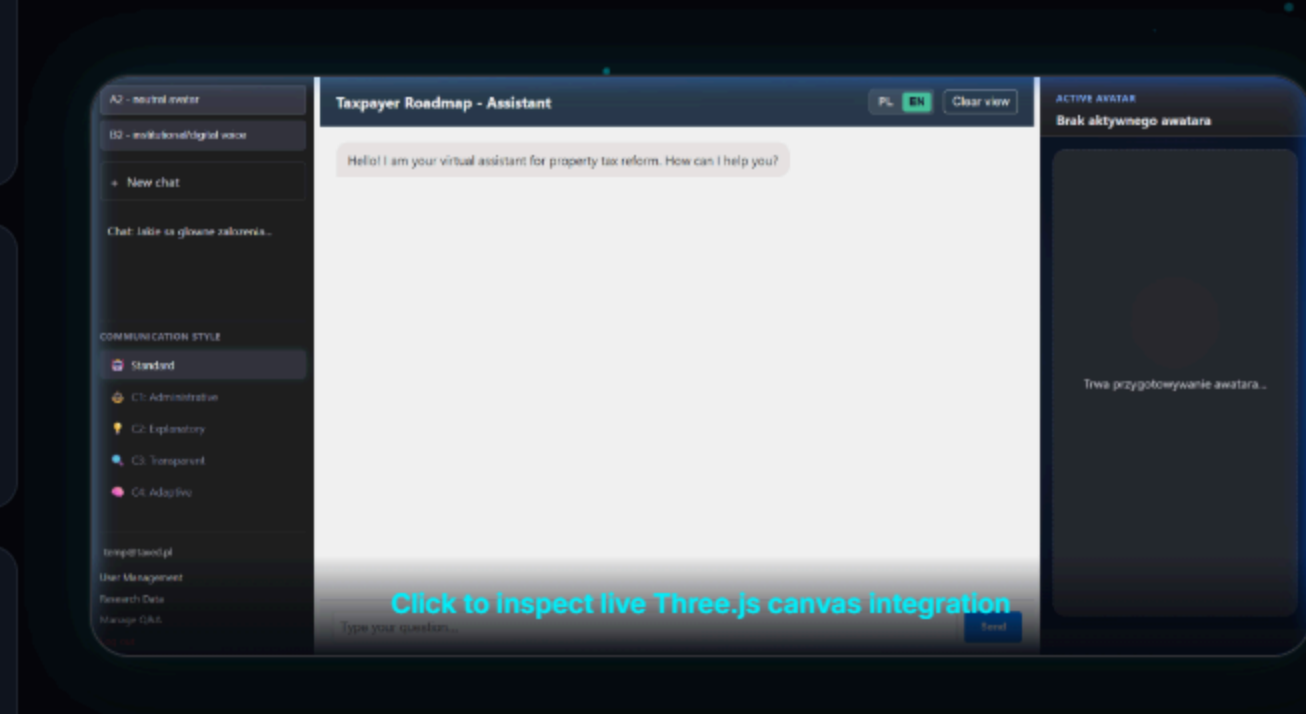
Direct Text-to-Viseme Scaler

OpenAI TTS generates audio (MP3/WAV), while our backend adapter decomposes text into visemes (aa, 0, U, RR, TH, sil) scaled to the precise audio duration.

EXPRESSION BOOSTER

Audio Normalization & Aperture Gain

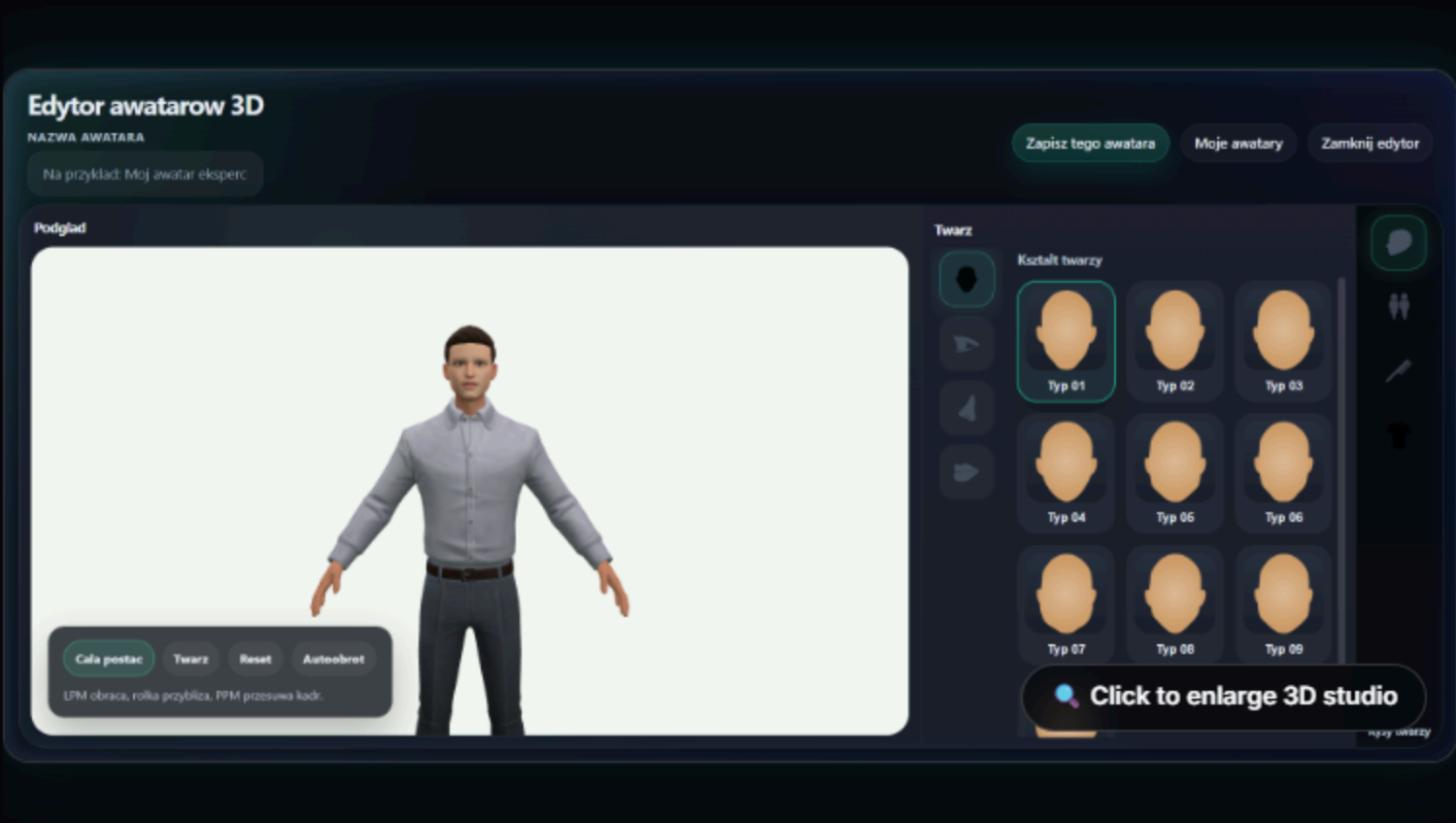
Client-side booster widens mouth aperture for vowels, ensuring lively, natural, and expressive articulation.



DIGITAL PERSONALIZATION

3D Avatar Studio & Face Customizer (`/edytor-awatarow-3d/`)

A dedicated visual studio enabling citizens and officials to design customized digital advisors.



GLB Base Mesh Selection

Optimized male and female base models designed for smooth, high-framerate rendering across desktop and mobile browsers.



Hairstyle & Accessory Library

Dynamic catalog with 2D thumbnails, auto-rigging, and instantaneous GLB asset mounting on character heads.



Facial Morphology & Color Shaders

Fine-grained sliders for skin tone, iris tint, hair coloration, and real-time studio lighting orbit.



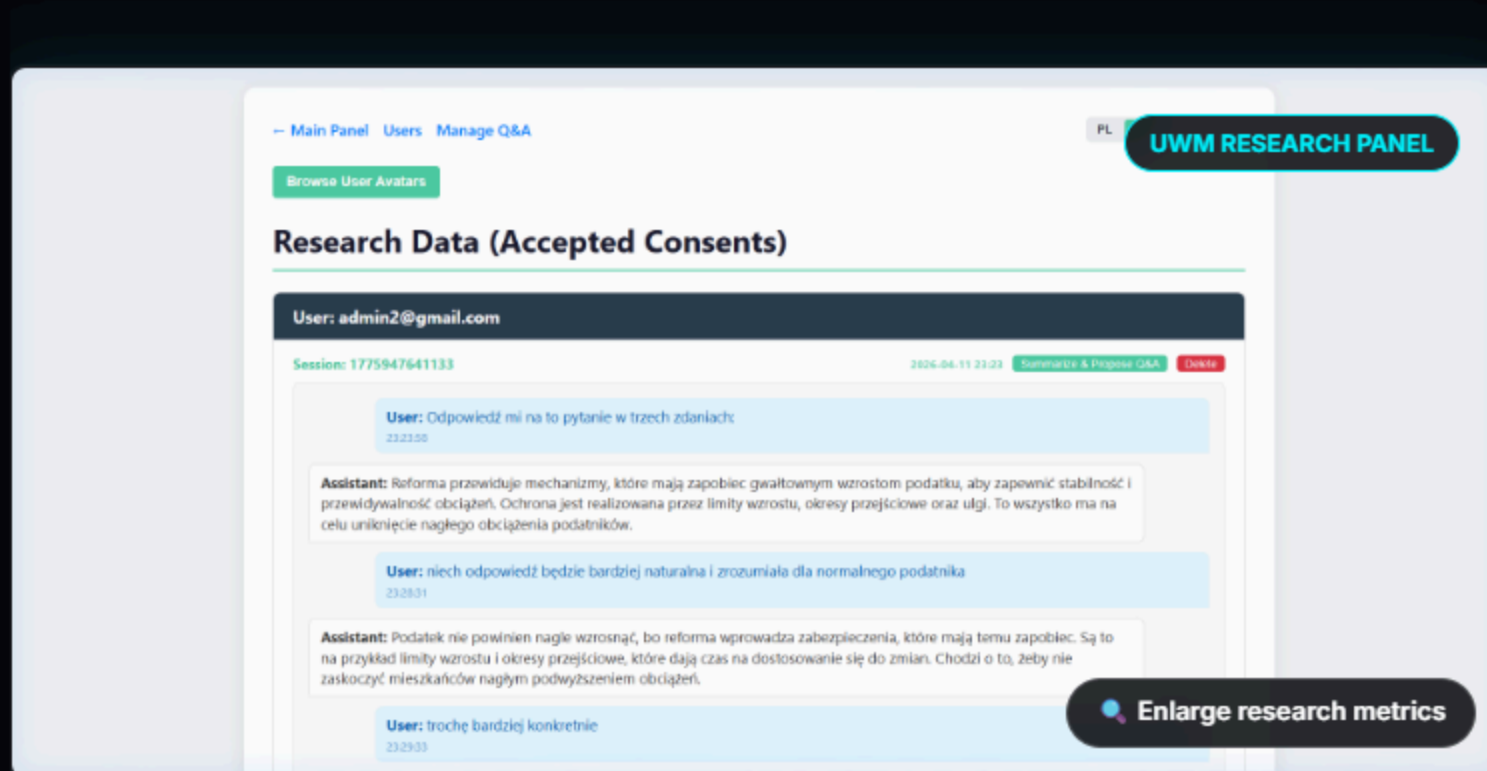
Database Persistence (`mrb\_saved\_self\_avatars`)

Automated PNG headshot thumbnail extraction stored alongside character JSON configuration in the user profile.

UWM ACADEMIC RESEARCH

Scientific Research Laboratory & Experimental Analytics

Dedicated telemetry monitoring the cognitive and behavioral reception of conversational AI in public finance.



100%

Statutory Adherence

< 400ms

First-Token Latency

4 Styles

Psychological Archetypes

Key Empirical Research Tracks at UWM:

Embodiment Effect (3D Avatar): Does visual presence statistically elevate trust in automated tax calculations compared to plain text?

De-escalating Frustration (C3): Measuring citizen acceptance rates when algorithmic decisions are broken down with radical procedural transparency.

A/B Cohort Testing: Contrasting user responses across voice synthesis pitch, avatar gender, and speech pacing.

CONTINUOUS LEARNING & KNOWLEDGE EXPANSION

Active Learning Loop: Dialogue Summarization & Automated Q&A Generation

How TAXPACT automatically turns citizen chat history into structured, reviewed Q&A knowledge base records via GPT-4o (`/api/summarize\_session`).

Session: 1792014385538

2026-10-14 21:46

Summarize & Propose Q&A

Delete

AI Summary:

The reform aims to address the disparity between property taxes based solely on surface area and the actual economic value of properties. It seeks to align taxes with property values, considering factors like location and standards. The reform is expected to adjust tax burdens, especially for properties in high-value locations or with unique features. Mechanisms are in place to limit sudden tax increases, ensuring a fair transition. The goal is to redistribute tax responsibilities rather than increase them universally.

Q&A Proposals:

Proposal #1

Remove completely

Question:

Clear

What is the main objective of the property tax reform?

Ans A:

X

To increase overall tax revenue from properties.

Ans B:

X

To align tax liabilities with the actual economic value of properties.

Ans C:

X

To reduce the complexity of tax assessments.

Ans D:

X

To exclusively benefit owners of large properties.

Add this record to database

Proposal #2

Remove completely

Question:

Clear

Who could potentially experience changes in their property tax burdens under the new reform?

Ans A:

X

Owners of properties in high-value locations.

Ans B:

X

All property owners, regardless of location.

Ans C:

X

Only owners of commercial properties.

Ans D:

X

Residents who do not own any real estate.

Click to enlarge live AI summary and proposed Q&A records

STEP 1: AI DIALOGUE SYNTHESIS

One-Click Session Summarization (`/api/summarize\_session`)

The administrator triggers an asynchronous GPT-4o call that digests multi-turn citizen inquiries, distilling primary taxpayer concerns, ambiguities, and core legal issues into an executive summary.

STEP 2: STRUCTURED PROPOSAL GENERATION

Multi-Variant Answer Drafting (Variants A, B, C, D)

The model autonomously crafts 1 to 3 candidate Q&A records. Each proposal provides a clear canonical question and four distinct answer variants tailored for diverse citizen mindsets.

STEP 3: HUMAN-IN-THE-LOOP PUBLISHING

Single-Click Injection into `/admin/qa`

Officials can edit proposed texts directly in browser textareas and click 'Add this record to database'. The candidate is instantly tagged as 'Suggested from chat' and committed into the active RAG prompt with zero system downtime.

ADMINISTRATIVE GOVERNANCE

Knowledge Base Management & Research Cohorts

Autonomous maintenance of statutory reform Q&A, user permissions, and experimental test cohorts.

Q&A KNOWLEDGE BASE ('/ADMIN/QA')

Enlarge

Main Panel

Research Data

Users

PL

EN

Log out

Manage Q&A Knowledge Base

Add Manually

Reform Stage

e.g. Diagnosis, Validation...

Question

Answer A (Optional)

Answer B

Answer C

Import from Document (AI)

Upload a .txt or .docx file. AI will analyze the text, summarize it, and propose new Q&A records.

Select File (.txt, .docx)

Real-Time Statutory Updates

Legal experts can inject new Q&A pairs, adjust response variants (A/B/C/D), and modify reform phases without software restarts.

USER COHORTS ('/ADMIN/USERS')

Enlarge

Main Panel

Research Data

Manage Q&A

Log out

PL

EN

User Management

ID	Email	Group	Role	Status	Creation Date	Actions
219	uwm.gr2.161439@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block
216	uwm.gr2.166544@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block
227	uwm.gr2.170006@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block
217	uwm.gr2.170346@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block
211	uwm.gr2.171340@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:38	Unblock Block
228	uwm.gr2.171343@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block
222	uwm.gr2.171346@test.xyz	UWM_Adrian_Wysoki	User	Blocked	2026-05-25 09:39	Unblock Block

Citizen Cohort Segmentation & A/B Testing

Assigning users to experimental groups, enforcing default avatars, blocking accounts, and monitoring user engagement logs.

CONCLUSIONS & FUTURE HORIZONS

TAXPACT: Transforming Public Sector Intelligence

A technological and cognitive bridge uniting tax legislation with citizen trust and understanding.



Zero-Hallucination RAG

GPT-4o operates strictly within the verified statutory boundaries. Zero fictitious answers in matters with legal and financial consequences.



Procedural Justice

Adaptive styles C1-C4 de-escalate civic tension by explaining municipal calculations step-by-step in accessible language.



Embodied 3D Interaction

A visual 3D avatar with phonetic lip-sync introduces a human, empathetic touch to impersonal e-government platforms.

TAXPACT Strategic Roadmap (2026+):

1

Hybrid pgvector indexing over 100,000+ Supreme Administrative Court rulings

2

National electronic identification integration (Login.gov.pl / Węzeł Krajowy)

3

Monograph publication on cognitive AI avatar reception in public finance

Thank You for Your Attention!

We invite questions, collaboration, and live testing:

alphai.uwm.edu.pl

[Back to Beginning](#)