Optimizing Municipal Teams: Personalized Learning for T-Shaped Profile Development

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***Abstract*—As Smart Cities mature from technological pilots to complex Cooperative Cities, the primary barrier to success is often not technical, but organizational. Traditional municipal structures rely on vertical silos that inhibit the cross-departmental collaboration required for climate neutrality and system-level resilience. This paper argues that the Cooperative City requires a fundamental shift in human capital development toward T-shaped professionals—experts who combine deep vertical specialization with broad horizontal skills in boundary spanning and strategic collaboration. We present findings from a qualitative study of Czech municipalities identifying a critical gap in these horizontal competencies and a reactive approach to upskilling. In response, we introduce a Proof of Concept for an AI-driven system and explore the potential of Large Language Models (LLMs) to transform municipal education. We specifically identify the challenges of moving beyond static recommendations toward automated, individualized content generation. By synthesizing practical best practice examples into personalized learning paths, we demonstrate a vision for a "human infrastructure" that fosters true inter-institutional cooperation.**

***Index Terms*—T-shape, Multidisciplinarity, Smart Cities, Cooperative City, Collaboration**

I. Introduction

The transition toward Climate-Neutral Cities by 2030, a central theme of the Smart City Symposium Prague 2026, represents a shift from purely technological implementation to systemic transformation. Research by Anderson and Jung [1] distinguishes between two primary formulations of this transition: a technocratic, "solutionist" vision that treats the city as a linear system to be optimized, and a cooperative vision that views the city as a complex, contested ecosystem of interdependent actors. To achieve the latter, smartness must be redefined not as top-down computational control, but as a democratic practice of organizing technologies and collective capabilities toward inclusive urban futures.

Achieving this cooperative ideal is often hindered by the I-shaped vertical silos of traditional municipal governance. Departments like transport, energy, and ICT frequently operate in isolation, failing to address the constitutive heterogeneity of urban life. Meijer and Bolivar [2] highlight that smart city governance must be built upon socio-techno practices, yet a gap remains in understanding the interconnections between technology and human capital. If smartness resides in a city's collaborative capacity, then the organizational design and the professional profiles within these institutions become the primary constraints on progress.

For a collaborative city to function, it is not enough to adopt modern technologies; the municipality must cultivate T-shaped professionals capable of boundary spanning. A T-shaped expert combines deep disciplinary knowledge (the vertical bar) with broad skills in systems thinking and interdisciplinary communication (the horizontal bar) [3]. However, current evidence from Czech municipalities suggests that while technical expertise is high, the horizontal skills necessary for cross-boundary coordination are often undeveloped. This lack of human infrastructure remains a critical bottleneck for implementing the integrated solutions required for climate neutrality.

This paper addresses this challenge by introducing a Proof of Concept (PoC) for an AI-driven Recommender System developed within the CESMOD project[1]. As a multidisciplinary research platform, CESMOD provides the necessary environment to bridge service science and urban planning [4]. Our system operationalizes the T-shape model into a diagnostic tool that identifies competency gaps and prescribes personalized learning paths. By leveraging data to cultivate these horizontal skills, we demonstrate how municipal teams can move beyond fragmented silos toward a truly cooperative and resilient urban ecosystem.

II. Problem statement: What Prevents a Cooperative City

Within the CESMOD project, a large-scale sociological survey was conducted to generate an empirical baseline for understanding how the Czech public perceives SMART solutions and the broader Smart Cities agenda. Methodologically, the study used an online questionnaire targeting adult residents of the Czech Republic. Sampling was organized with quotas set by gender, age, highest education, region, municipality size, and housing type (house vs. apartment). The survey report analyzed 5041 responses. Substantively, the survey's goals were to support evidence-based decision-making at municipal, regional, and national levels by capturing public attitudes, preferences, and behavioral barriers relevant to SMART and the national Smart Cities concept, positioning the public (civil society) as the quadruple-helix stakeholder represented by the dataset [5].

The survey's conclusions points to problems that complicate the transition from technological modernization to a smart cooperative city. The first is low trust and a high level of uncertainty in the context of technological and environmental change. While trust, uncertainty, and quality of life have

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[1]A project financed by the Technological Agency of Czech Republic (TACR), focused on supporting implementation of smart concept in Czech Republic. More at: https://cesmod.cz/en/

been identified as key factors shaping perceptions of SMART solutions, the responses across the survey topics repeatedly show low trust in institutional actors and a high share of uncertain responses. The report highlights that low trust in regulation, corporate responsibility, and institutions' ability to manage technological change constitutes a barrier to their acceptance [5]. In the context of cooperative governance, this implies a weakened link between the city, the private sector, and the public.

Results [5] also indicates that labour-market transformation driven by new technologies and AI is widely perceived as inevitable, but concerns of respondents about job loss and negative impacts are disproportionately concentrated among lower-income and economically insecure groups. These groups more often evaluate AI negatively and report higher uncertainty, while higher-income and well-secured respondents anticipate more positive effects. This socio-economic gradient strengthens the case for robust accompanying policies, especially requalification, lifelong learning, and targeted adaptation support, to prevent AI-driven change from deepening existing inequalities in employment security and life chances.

Overall, the preliminary findings by the sociological survey indicate that technological solutions alone are insufficient, because their societal value is mediated by social conditions – most notably residents' quality of life, levels of trust, the comprehensibility of proposed measures, and meaningful opportunities to participate in decision-making [5].

Beyond the public perspective, the CESMOD project also conducted an extensive qualitative study [6] to capture the institutional dimension of urban transformation. This research phase involved twenty two in-depth interviews with representatives from Czech municipalities, regions, and innovation centers, aiming to identify the operational barriers and success factors of smart mobility governance. The empirical findings reveal significant heterogeneity in strategic implementation, which frequently oscillates between systematic long term conceptualization and fragmented, subsidy dependent initiatives.

The qualitative findings from the CESMOD project reveal several systemic challenges, particularly the prevalence of fragmented, subsidy dependent initiatives and the persistence of organizational silos that hinder horizontal communication [6]. These data further highlight a critical deficit in monitoring and evaluation frameworks, which, combined with limited public participation, creates significant barriers to integrated urban governance. From these observations, it can be inferred that the success of smart city strategies is no longer just a matter of technological deployment, but a challenge of human capital. This necessitates a shift toward a new professional paradigm where experts must transcend narrow specialization. By bridging technical, legal, and communicative dimensions, these change agents facilitate the transition to a truly cooperative city. Consequently, the development of such multifaceted professional profiles becomes the fundamental prerequisite for sustainable urban transformation.

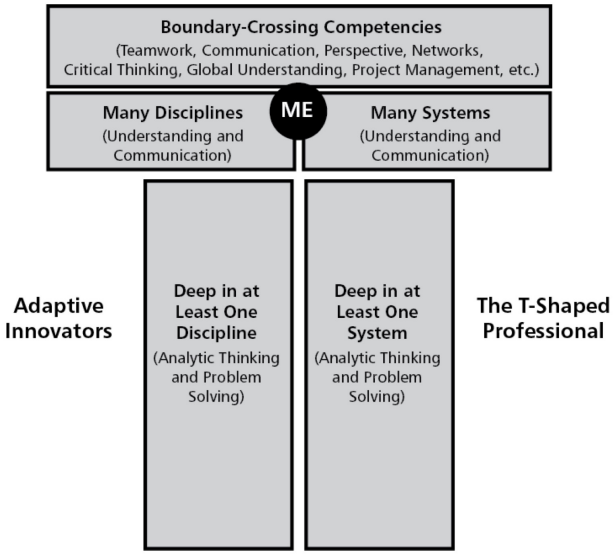

Fig. 1. T-shape competency profile explained by Moghaddam et al. [9]

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III. Theoretical Framework: The T-Shape as a Unit of Cooperation

To achieve a collaborative smart city, it is necessary to redefine the fundamental unit of its organization: the professional profile. While traditional administrative models rely on vertical specialization, the Cooperative City demands a workforce capable of systemic interaction. In such dynamic contexts, professionals can no longer rely solely on in-depth specialization but must also develop horizontal capabilities that enable them to adapt quickly to changing system needs [7]. The T-shaped professional model provides a foundational framework for this breadth and depth.

Others [8] also agree that critical distinction must be made between technical transformation and true digital transformation. Many organizations fall into the trap of "Technical Transformation," where the focus is strictly on adopting new tools to improve the efficiency of existing, well-known processes. In the context of a municipality, this is analogous to E-Government and digitizing paper forms without changing the underlying siloed logic.

However, a Cooperative City faces wicked problems (e.g., climate neutrality, social resilience) that are new, emergent, and unexperienced. Managing these dynamics requires more than technical proficiency; it requires a Cognitive Transformation. This shift demands that human resources move from a problem-solving perspective (reacting to known issues) to a decision-making perspective (understanding dynamic interactions).

The T-shaped profile characterizes an individual equipped with the boundary-spanning competencies necessary to meet the complex demands of a smart city. Their skills and knowledge can be represented by the vertical and horizontal bar of the letter T. As visualized in Figure 1, a T-shaped professional possesses both depth, representing deep knowledge

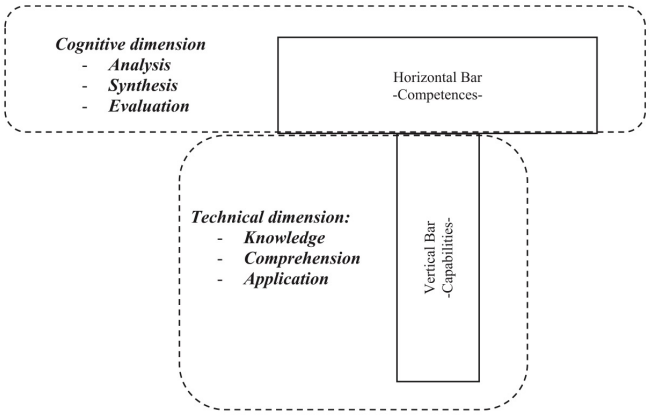

Fig. 2. T-shape competency profile explained by Caputo et al. [8]

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and specialization in one discipline area, and breadth, the ability and experience necessary to communicate across a range of disciplinary areas. The vertical bars represent a dual depth: deep disciplinary knowledge (analytical thinking in a specific field) and deep system knowledge (problem-solving within a complex infrastructure). These pillars are bridged by a horizontal bar signifying the ability to function across many disciplines and systems. Professionals with this breath use their horizontal knowledge to interpret and describe complex problems that they may be unable to solve independently, but about which they can effectively reason and collaborate with experts from other fields to resolve.

To further illustrate this concept and provide a deeper application of the model to the smart city problem, the T-shape framework can be mapped to Bloom's taxonomy of educational objectives as shown in Figure 2. Caputo et al. [8] utilize this taxonomy to explicitly define the "capability" and "competency" dimensions of the T-profile, offering a structured way to understand the cognitive requirements of modern municipal teams.

The vertical bar represents deep capabilities. It encompasses the lower levels of Bloom's taxonomy: Knowledge, Comprehension, and Application. For a municipal officer, this is the deep disciplinary expertise required to execute specific tasks (e.g., traffic engineering protocols, legal drafting, database management). While essential, these skills are often isolated within departmental silos

The horizontal bar represents competencies. It corresponds to the higher levels of Bloom's taxonomy - the ability to analyse, synthesise and evaluate. For a smart city professional, this would translate to the ability to separate concepts into components to understand the interactions among parts of the city system, the ability to blend elements to form a whole, facilitating cross-departmental projects and the ability to judge the value of new protocols for solving emerging, undefined problems.

Recent empirical surveys among industry stakeholders underscore the critical need for this horizontal cognitive layer. According to Salaj et al. [10], existing STEM education frameworks are inadequate for preparing professionals for Smart City and Industry 4.0 challenges without the integration of transversal competencies. Their research identifies 'Communication and system thinking' (encompassing critical thinking, analytical thinking, and media literacy) as one of the primary competency factors missing in the current workforce.

Despite the clear theoretical need for cognitive transformation, the practical reality within municipal administrations often falls short. The professional profile of many public officials remains equipped with predominantly deep, specialized knowledge in a single vertical area (e.g., transport, environment, or legislation) but lacking the critical horizontal bar of T-shaped skills.

The need for workers with generalist skills profiles, who can translate data and findings into actionable policy responses is also highlighted by the Cedefop policy brief [11]. Furthermore, it identifies the limited learning or training opportunities for municipal staff as a major issue. Without the ability to communicate across disciplines and understand the systemic implications of their work, this specialist-only focus leads to fragmented decision-making and a lack of integrated strategy, offering an explanation for the CESMOD [6] results. This structural vulnerability is further complicated by a widespread shortage of personnel capable of managing complex, cross-cutting urban projects.

IV. Proof of Concept

Since municipal professionals come from diverse educational backgrounds and possess varying levels of prior knowledge, traditional, one-size-fits-all training programs are often ineffective. Cultivating the horizontal bar of the T-shaped profile therefore requires a fundamental shift in how municipalities approach human resources and professional development. To overcome these barriers and actively engineer T-shaped teams, it is imperative to transition away from static and deeply-specialized training models toward dynamic, adaptive education.

This is where personalized learning, facilitated by data-driven recommendation systems, becomes essential. Recommendation systems leverage learner data—such as current skill levels, learning preferences, and performance metrics—to provide adaptive, targeted learning pathways and tailor instructional content to individual needs [12]. By diagnosing specific gaps in a professional's horizontal or vertical knowledge base, these systems can precisely prescribe the necessary training modules required to cultivate a well-rounded, T-shaped competency profile.

As established, the labor-market transformation driven by AI and new technologies necessitates robust lifelong learning and requalification policies to prevent the deepening of socioeconomic inequalities. In the context of urban governance, this transformation is particularly acute; smart cities currently face substantial shortages in skillful employees equipped to handle emerging, complex technological demands. To ensure a fair, efficient, and sustainable urban transition, continuous education must focus on targeted competency building—upskilling the existing workforce to manage both the technical and systemic dimensions of smart city operations. This requires

cultivating specific competencies across various domains, such as digital skills, soft skills, and smart city-specific governance [13].

The practical application of this vision was realized through a pilot study conducted at the Service Systems and Services Laboratory (SeSLab), Faculty of Informatics, Masaryk University. Developed as a direct output for the CESMOD project in collaboration with the VSB – Technical University of Ostrava, this PoC addresses the pervasive lack of strategic human resource development in Czech municipalities. The implemented PoC leverages the GPT-4o (version 2024-05-13) foundation model, integrated within a secure Azure OpenAI environment to ensure municipal data privacy. The system's logic is grounded in a qualitative probe involving key stakeholders of digital transformation, including members of the National Network of Healthy Cities and the Association of Local Self-Governments. By reflecting the specific needs of mayors, deputy mayors, and strategic development officers, the tool focuses on the real world necessity of evolving from a narrow I-shaped focus to a more resilient T-shaped professional profile [14].

To address the critical challenge of AI hallucinations identified during initial testing, the system employs a Retrieval-Augmented Generation (RAG) architecture rather than traditional fine-tuning. This approach grounds the model's outputs in a verified knowledge base comprising strategic documents from the CESMOD platform and qualitative data from Czech municipal surveys. Technical reliability is further enhanced by setting the model's temperature to 0.0, ensuring deterministic, fact-based recommendations. The system operates via a semantic search layer using vector embeddings, which allows it to bridge the gap between an officer's current competency profile and the specific interdisciplinary requirements of T-shaped professional development [14].

The technical architecture of the system utilizes LLM algorithms to transform a user's professional profile into a dynamic development roadmap. As illustrated in the system architecture (see Figure 3), the process initiates with a multi-dimensional competency questionnaire. Here, the user evaluates their proficiency across both vertical I-shaped professional expertise and horizontal T-shaped boundary spanning skills. The core innovation lies in the automated Gap Analysis; rather than mere keyword matching, the LLM interprets the nuances of the identified skill deficits to suggest specific educational interventions. This mechanism allows for a highly granular approach, enabling even small municipal offices to implement sophisticated HR diagnostics that facilitate the systematic cultivation of T-shaped competencies across their teams.

However, the transition from an I-shaped specialist to a T-shaped professional through digital recommendation has inherent limitations. The current reliance on subjective self assessment represents a methodological challenge, as personal perceptions of competence may not always align with objective performance. To evolve this PoC into a standard administrative tool, it is essential to integrate these diagnostic outputs directly into long term municipal HR strategies. Future iterations should aim to supplement self evaluation with objective testing and real world project outcomes. Ultimately, the success of such digital tools depends on shifting the organizational culture of public administration from occasional isolated training sessions toward a continuous, strategically managed process of T-shaped profile development.

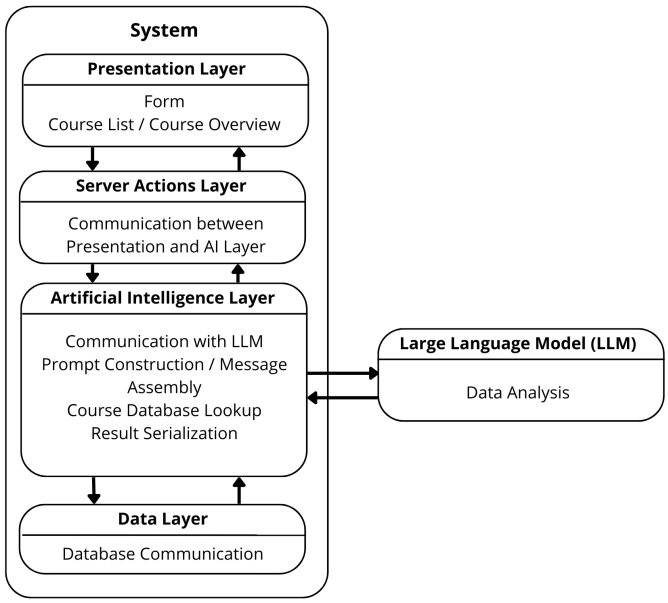

Fig. 3. Graphical Representation of the Entire System Architecture. Adapted from [14]

V. Discussion and Theoretical Framework for Empirical Validation

The development of the presented PoC reveals several critical layers that must be addressed to transition from a technocratic Smart City to a Cooperative City. Given the preliminary nature of our qualitative data, we propose the following theoretical framework as a basis for imminent empirical verification.

1) **Municipal Specifics and the Fragmentation Challenge:** Unlike the private sector, which is driven by market flexibility, Czech municipalities operate within a highly fragmented environment consisting of 6,258 autonomous units. This structural rigidity often leads to I-shaped specialization. However, we hypothesize that smaller municipalities may paradoxically show a higher demand for T-shaped profiles, as limited human resources force staff to span multiple agendas. Future research must identify whether this "forced multidisciplinarity" can be effectively transformed into a deliberate strategic advantage through targeted upskilling.
2) **From Recommendation to Automated Personalization via AI:** Our PoC argues that unified, one-size-fits-all training programs are destined to fail in such a diverse environment. The discussion shifts the role of AI from a simple filter to a generator of meaning. By utilizing LLMs, the system can not only recommend existing courses but also synthesize and adapt content based on the user's specific T-shape profile. This allows

for the automated creation of tailor-made learning paths that bridge the gap between general theory and local administrative practice.

3) **Integration with the CESMOD Ecosystem and Best Practices:** A key strength of the proposed system is its integration with the Information and Data Platform being developed within the CESMOD project. We argue that effective learning must be rooted in reality; therefore, the recommender system is designed to ingest real-world best practice examples from the platform. By analyzing the knowledge profiles of municipal workers alongside successful project data, the system can provide context-aware education.
4) **Qualitative Metrics and Future Work:** Finally, we must move beyond quantitative metrics (e.g., number of training hours). The success of individualized multidisciplinary education requires new qualitative indicators that measure a professional's actual boundary-spanning capability. Our future research will focus on developing these metrics in close cooperation with municipal partners, ensuring that the human infrastructure is as resilient and adaptable as the digital systems it manages [15].

VI. Conclusion

As cities strive toward the ambitious goals of climate neutrality and systemic resilience, the transition from technocratic smart cities to truly **Cooperative Cities** becomes imperative. This paper has argued that such a transition cannot be achieved through technology alone; it requires a foundational shift in municipal human capital. By identifying the critical gap in horizontal, boundary-spanning competencies within Czech municipalities, we have highlighted the urgent need for a more strategic approach to professional development.

Our proposed AI-driven Recommender System, developed within the CESMOD project, offers a scalable solution to this challenge. By operationalizing the T-shape model and integrating real-world data from the CESMOD Information and Data Platform, the system moves beyond generic training to provide personalized, context-aware learning paths. This approach not only addresses the fragmentation of the 6,258 Czech municipalities but also empowers individual officials to become the "bridge-builders" necessary for cross-departmental innovation.

Future work will focus on the empirical validation of the proposed theoretical framework, specifically investigating the unique needs of smaller municipalities and developing qualitative metrics to measure the actual impact of T-shaped development on urban governance. Ultimately, cultivating "Cooperative People" is the most critical infrastructure project a city can undertake to ensure an equitable and sustainable urban future.

Acknowledgments

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