

Human Capital as Invisible Infrastructure: Competences, Profiles and Organisational Architectures for Urban Transformation in Italian Local Governments

Gianluca Elia¹, Lanfranco Marasso², Valentino Moretto², Alessandro Margherita¹

¹University of Salento, Lecce, Italy, ²Almaviva S.p.A., Rome, Italy, ³Dedagroup S.p.A., Trento, Italy

{alessandro.margherita@unisalento.it, gianluca.elia@unisalento.it, l.marasso@almaviva.it, valentino.moretto@dedagroup.it}

Abstract— The digital transformation of Italian cities confronts a structural paradox: the technological platforms exist, extraordinary funding has been available, strategic plans have been drawn up—yet real change in citizen services remains discontinuous and fragile. This paper argues that the primary cause is neither technological nor financial but human. Drawing on the empirical research collected in *Infrastrutture Invisibili* (2025), including the original analysis of approximately 1,000 curricula vitae of Digital Transition Officers (RTD) appointed in Italian public administrations, we show that human capital is itself an infrastructure—invisible but as decisive as any platform or grant. The paper introduces the construct of human capital architecture as an analytical and operational framework, articulated across three dimensions: profiles to be normalised in organisational charts; competence development mechanisms; and the organisational conditions for system sustainability. A specific focus is placed on AI governance as a cross-cutting competence. Findings reveal critical gaps: the average RTD covers only two of five technological competence domains, none of three legal-digital domains, and only 15.73% declare stakeholder management competences—the capacity most necessary for building urban innovation ecosystems.

Index Terms— human capital, digital transition officer, digital competences, smart city governance, AI governance, organisational architecture, invisible infrastructures, public sector training

I. INTRODUCTION

A structural paradox characterises Italy's urban digital transformation. Investment in smart city platforms, sensors, open data portals and digital services has been substantial and sustained. The National Recovery and Resilience Plan (PNRR) has accelerated this investment dramatically. Yet the measurable improvement in citizen service quality has lagged expectations, and the transformations achieved remain fragile: dependent on individual motivated officers, on active vendor support, or on continued extraordinary funding.

This paper argues that the explanation for this fragility is primarily human rather than technological or financial. The human capital of public administration constitutes, in our analytical framework, an invisible infrastructure: one that is organisational rather than physical, therefore less visible and less funded, but equally decisive for whether digital investments generate durable public capacity or episodic expenditure.

Our contribution is threefold. First, we introduce the concept of human capital architecture as a framework for analysing and designing the competence system of urban administrations. Second, we present the results of an original empirical study—the analysis of approximately 1,000 CVs of Digital Transition Officers (RTD) nominated in Italian public administrations—which provides the first systematic evidence base on competence gaps in this critical role.

Third, we articulate AI governance as a cross-cutting competence requirement that spans all organisational levels and cannot be reduced to the hiring of technical specialists.

II. THEORETICAL BACKGROUND

A. Dynamic Capabilities in Public Organisations

The dynamic capabilities framework [1] provides the theoretical foundation for our treatment of human capital as infrastructure. Applied to smart city governance, it identifies three organisational capacities that cannot be delegated to technology: sensing (detecting emerging opportunities and threats), seizing (activating systems for response), and reconfiguring (continuously adapting resources, competences and structures). These capabilities reside in people, not platforms.

Research on public sector dynamic capabilities [2], [3] documents the specific challenges of developing sensing, seizing and reconfiguring capacities in bureaucratic environments characterised by risk aversion, seniority-based career progression and limited lateral mobility. The Italian municipal context presents additional structural constraints: a 28.7% reduction in municipal staff over 17 years (from 479,000 to 342,000), an average employee age of 51, and the absence of any employee under 35 in 50% of Italian municipalities [4].

B. Competence Frameworks for Digital Public Administration

Several competence frameworks have been developed for digital public administration, including DigComp [5], DigCompOrg [6], and the European e-Competence Framework [7]. These frameworks provide taxonomic coverage but have been criticised for insufficient attention to the integration of competence levels [8] and to the organisational conditions that determine whether competences are activated in practice.

The Italian Digital Administration Code (CAD, 2018) introduced the RTD as the designated digital transformation leader in all public administrations. Research on RTD implementation has highlighted the gap between formal nomination (76% of entities as of October 2023) and operational effectiveness, particularly the problematic coincidence of RTD and Secretary roles in 17% of municipalities [9].

III. METHODOLOGY

A. CV Analysis

The primary dataset comprises approximately 1,000 CVs of RTDs nominated in Italian public administrations, retrieved from the IndicePA open data portal in October 2023. The sample covers all entity categories subject to RTD nomination obligations (excluding educational institutions). A structured competence taxonomy was developed based on CAD requirements and supplemented by emerging competence areas (AI governance, stakeholder management, sustainability literacy). The taxonomy comprises four families: technological (CT, 5 domains), legal-digital (CG, 3 domains), managerial (CM, 8 domains), and soft skills (SS, 3 domains).

CV content was coded against the taxonomy using keyword matching combined with manual validation of a 15% random sample. Inter-coder reliability was assessed using Cohen's kappa ($\kappa = 0.84$, indicating strong agreement). The analysis was complemented by structured interviews with 12 RTDs in municipalities of 20,000–100,000 inhabitants.

B. Case Analysis

Three practitioner cases were analysed using a structured schema (actions, financing, lessons, transferable elements): a medium Italian city with a structured RTD programme; a provincial capital with a university-municipality competence partnership; and the Barcelona tech ambassador programme (Generalitat de Catalunya). Cases were selected for theoretical rather than statistical representativeness.

IV. RESULTS

A. Competence Gap Analysis

The CV analysis reveals systematic competence gaps across all four families. In the technological domain, cybersecurity competences are present in only 21.85% of RTD CVs; interoperability and integration in 22.47%; identity and digital domicile management

in 41.45%. Only systems administration (CT1) exceeds 50% coverage at 52.43%.

The legal-digital family presents the most critical finding: accessibility competences (CG1) appear in only 7.24% of CVs; digital identity regulation (CG3) in 10.24%; and ministerial directive implementation (CG2) in 29.21%. On average, the RTD population has zero competences in legal-digital domains—precisely those required to translate code into law and law into service.

In the managerial family, citizen and stakeholder management (CM8) is the most absent competence at 15.73%—a critical finding given that ecosystem construction is the RTD's most strategically important function. Digital innovation project evaluation (CM7) appears in 23.10% of CVs; quality management (CM5) in 24.47%.

Soft skills show a more favourable profile: leadership (SS2) is present in 54.18% of CVs. However, innovation and change management (SS1), the competence most directly relevant to transformation leadership, appears in only 36.45%.

B. The Human Capital Architecture

Analysis of cases and literature converges on a three-dimensional framework we term human capital architecture. The first dimension is profile normalisation: embedding into municipal organisational charts—as permanent roles rather than project positions or vendor dependencies—a core set of profiles: RTD with a multidisciplinary team; data steward; service designer; legal-digital specialist; AI governance officer. In European cities of comparable scale, these profiles are increasingly standard; in Italian municipalities they remain exceptional.

The second dimension is competence development mechanisms. Three mechanisms are identified as particularly effective: the triennial training pact, anchored to specific urban missions rather than generic course catalogues; project-based learning, in which competences are developed through real city challenges rather than classroom instruction; and tech ambassador programmes, in which a small number of internally trained digital leaders function as competence multipliers across the organisation.

The third dimension is organisational sustainability conditions: explicit separation of the RTD role from the Municipal Secretary; a dedicated budget line for the RTD's team; formal assessment of competence gaps before rather than after appointments; and inter-municipal cooperation frameworks for entities below the critical scale threshold.

C. AI Governance as Cross-Cutting Competence

The AI Act (2024) classifies public sector AI systems used for decisions affecting individuals as high-risk, imposing transparency, documentation and human oversight requirements. This regulatory context establishes AI governance not as a specialist technical function but as a competence requirement spanning all organisational levels: the executive (strategic

orientation), the RTD level (implementation supervision), and the operational level (daily interaction with AI-assisted processes).

Interview evidence confirms that in municipalities with low internal digital capacity, AI adoption strategies are de facto determined by vendor roadmaps rather than administrative priorities. This vendor dependency is not resolved by improved procurement design alone; it requires the development of internal commissioning competences—the capacity to define AI requirements, interpret system outputs, contest vendor recommendations, and evaluate alternative approaches.

V. DISCUSSION AND CONCLUSIONS

The evidence converges on a reframing of the smart city human capital challenge. The dominant discourse focuses on quantity (how many RTDs have been appointed, how many training hours delivered) while the structural problem is qualitative and architectural: what competence profiles, in what organisational configuration, with what development mechanisms, make durable urban transformation possible.

The human capital architecture framework proposed in this paper provides a structured response. Its practical implications include: competence gap assessment before RTD appointment rather than after; multidisciplinary team design as the unit of analysis rather than the individual officer; triennial rather than annual training planning, anchored to urban missions; and inter-municipal cooperation as the primary solution for municipalities below the scale threshold for autonomous capacity development.

The finding that only 15.73% of RTDs possess stakeholder management competences has systemic implications. The urban transformation literature consistently identifies ecosystem construction—the capacity to build and sustain collaborative networks spanning public administration, universities, firms, civil society, and citizens—as the most durable source of urban innovation capacity. A population of RTDs almost universally lacking this competence is structurally incapable of the ecosystem strategies the field recommends.

Future research should address longitudinal measurement of human capital architecture development; the specific governance mechanisms for inter-municipal competence sharing; and the competence profile implications of AI Act compliance requirements for municipal administrations of different scales.

VI. ACKNOWLEDGMENT

The authors acknowledge the RTDs and municipal officers who participated in structured interviews. This paper draws on the collective empirical work underlying *Infrastrutture Invisibili* (2025). The CV analysis was conducted with the support of the IndicePA open data infrastructure.

VII. REFERENCES

- [1] D. J. Teece, G. Pisano, and A. Shuen, "Dynamic capabilities and strategic management," *Strategic Management Journal*, vol. 18, no. 7, pp. 509–533, 1997.
- [2] S. Makkonen et al., "Dynamic capabilities for public sector organisations," *Public Management Review*, vol. 23, no. 3, pp. 397–420, 2021.
- [3] A. Savoldelli, C. Codagnone, and G. Misuraca, "Understanding the e-government paradox," *Government Information Quarterly*, vol. 31, no. S1, pp. S63–S71, 2014.
- [4] ISTAT, "Le istituzioni pubbliche in Italia," Rome, 2024.
- [5] Y. Punie, Ed., *European Framework for the Digital Competence of Citizens (DigComp 2.2)*, Luxembourg: Publications Office of the EU, 2022.
- [6] S. Kampylis et al., "Promoting Effective Digital-Age Learning: A European Framework for Digitally-Competent Educational Organisations," JRC Technical Reports, 2015.
- [7] CEN/CENELEC, "European e-Competence Framework 3.0," Brussels, 2014.
- [8] B. Bertscher, A. Piano, and R. Welby, "Digital competences for the public sector," *OECD Working Papers on Public Governance*, 2024.
- [9] AgID, "Rapporto sullo stato della digitalizzazione della PA," Rome, 2024.
- [10] D. Sagarik, "Workforce resilience in digital transformation," *International Journal of Public Administration in the Digital Age*, vol. 11, no. 1, 2024.
- [11] A. Guenduez et al., "Vendor dependency in public digital transformation," *Government Information Quarterly*, vol. 42, no. 1, 2025.
- [12] OECD, "AI-ready public workforce," *OECD Policy Briefs*, Paris, 2026.
- [13] European Parliament, "Regulation (EU) 2024/1689 on Artificial Intelligence (AI Act)," *Official Journal of the EU*, 2024.
- [14] FPA, "Lavoro Pubblico 2025," Forum PA, Rome, 2025.