



Engineers' Professional Competencies for the Efficient Management of Public Budgets from the Perspective of Municipal Experts

Rodolfo Fernández Reynaga ^{1*}

¹ Universidad Ricardo Palma, Perú.

*Corresponding author: rodolfo.fernandez@urp.edu.pe

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Abstract: Engineers' professional competencies are predominant for the efficient management of public budgets from the perspective of municipal experts. **Objective:** To project, from the perspective of project and budget experts in a Peruvian municipality, the competencies civil engineers should develop to manage the public budget efficiently and the educational strategies that would make this possible. **Methodology:** Qualitative, exploratory, and propositional study. A semi-structured interview guide, reviewed by specialists, was designed for eight experts selected through purposive sampling, and the thematic analysis was organized into six categories. Based on documentary evidence and the guide's axes, training proposals were projected for validation with the experts. **Results:** Three lines of proposals are projected: (1) training in costing, technical files, investment, and public procurement; (2) learning through real municipal cases and projects, with mentoring and internships; and (3) integrating risk management, ethics, and community communication. Two public building projects are also proposed as learning cases. **Conclusions/Contributions:** Low local investment execution and the small share of budgeting in civil engineering programs suggest linking curricula and municipalities. A replicable interview guide and a proposal matrix for validation are provided.

Keywords: Public budget, professional competencies, education, engineering, projects.

Competencias profesionales de los ingenieros para la gestión eficiente de presupuestos públicos desde la perspectiva de expertos municipales

Resumen: Las competencias profesionales de los ingenieros son predominantes para la gestión eficiente de presupuestos públicos desde la perspectiva de expertos municipales. **Objetivo:** Proyectar, desde la perspectiva de expertos en proyectos y presupuestos de una municipalidad peruana, las competencias que debería desarrollar el ingeniero civil para gestionar con eficiencia el presupuesto público y las estrategias educativas que lo permitirían. **Metodología:** Estudio cualitativo, exploratorio y propositivo. Se diseñó una guía de entrevista semiestructurada, revisada por especialistas, para ocho expertos seleccionados por muestreo intencional, y se organizó el análisis temático en seis categorías. Con la evidencia documental y los ejes de la guía se proyectaron propuestas formativas para validar con los expertos. **Resultados:** Se proyectan tres líneas de propuesta: (1) formar en costos, expediente técnico, inversiones y contrataciones públicas; (2) aprender con casos y proyectos municipales reales, con mentoría y prácticas; y (3) integrar gestión de riesgos, ética y comunicación con la comunidad. Se plantean además dos proyectos de edificación pública como casos de aprendizaje. **Conclusiones/Aportes:** La baja ejecución de la inversión local y la escasa carga horaria de presupuestos en la formación de ingenieros civiles sugieren articular currículo y municipalidad. Se aporta una guía de entrevista replicable y una matriz de propuestas para su validación. **Palabras clave:** Presupuesto público, competencias profesionales, formación, ingeniería, proyectos.

Competências Profissionais dos Engenheiros para a Gestão Eficiente dos Orçamentos Públicos sob a Perspectiva de Especialistas Municipais

Resumo: As competências profissionais dos engenheiros são predominantes para a gestão eficiente dos orçamentos públicos sob a perspectiva de especialistas municipais. **Objetivo:** Projetar, a partir da perspectiva de especialistas em projetos e orçamentos de um município peruano, as competências que o engenheiro civil deveria desenvolver para gerir com eficiência o orçamento público e as estratégias educacionais que o permitiriam. **Metodologia:** Estudo qualitativo, exploratório e propositivo. Elaborou-se um roteiro de entrevista semiestructurada, revisado por especialistas, para oito especialistas seleccionados por amostragem intencional, e organizou-se a análise temática em seis categorias. Com a evidência documental e os eixos do roteiro, projetaram-se propostas formativas para validação com os especialistas. **Resultados:** Projetam-se três linhas de proposta: (1) formar em custos, projeto técnico, investimentos e contratações públicas; (2) aprender com casos e projetos municipais reais, com mentoria e estágios; e (3) integrar gestão de riscos, ética e comunicação com a comunidade. Propõem-se também dois projetos de edificação pública como casos de aprendizagem. **Conclusões/Contribuições:** A baixa execução do investimento local e a pouca carga horária de orçamentos na formação de engenheiros civis sugerem articular currículo e município. Oferecem-se um roteiro de entrevista replicável e uma matriz de propostas para validação. **Palavras-chave:** Orçamento público, competências profissionais, formação, engenharia, projetos.





1. Introduction

Public budgets decide which works get built, but executing them requires professionals capable of costing, scheduling, and supervising. In Peru, this process is governed by the National Public Budget System (Poder Ejecutivo, 2018), participatory budgeting (Congreso de la República del Perú, 2003b), the Invierte.pe investment system (Poder Ejecutivo, 2016), and the General Public Procurement Law and its regulations (Congreso de la República del Perú, 2024; Poder Ejecutivo, 2025). Municipalities act within the framework of decentralization and their organic law (Congreso de la República del Perú, 2002, 2003a).

This framework organizes the budget cycle into successive phases, from multiyear programming to evaluation (Poder Ejecutivo, 2018); requires that investments go through multiyear programming and investment management (Poder Ejecutivo, 2016); and subjects purchases to public procurement rules (Congreso de la República del Perú, 2024; Poder Ejecutivo, 2025). Therefore, the civil engineer who joins a municipality must move at the same time among budget regulations, the investment system, and procurement. Since the organic law recognizes local governments as promoters of local development (Congreso de la República del Perú, 2003a), whoever manages municipal projects works at the intersection between the technical and the public.

The execution figures show that this intersection is difficult. Between 2010 and 2022, Peruvian local governments executed on average only 63 % of their investment budget, compared with 80 % for the national government (Ramos Vera et al., 2024). In 37 poor districts of Apurímac, 92 % of officials knew performance-based budgeting and 86 % applied it, while poverty fell from 52 % to 34 % between 2011 and 2015 (Palomino Flores et al., 2026). These data do not by themselves prove a causal relationship, but they suggest that the technical knowledge of those who execute spending is part of the discussion about its quality.

Citizen participation, by itself, is not enough either. In four districts of Chiclayo ($n = 602$), 60.3 % rejected the idea that participatory budgeting is the basis of good municipal decisions, although both variables were correlated ($r = 0.783$) (Urbina Cárdenas et al., 2021). According to the IDB, cited in a review, inefficiencies in public spending amount to 4.4 % of Latin American GDP (Huárac Quispe et al., 2022). Evidence from Ukraine also warns that deficient medium-term planning leaves local projects without funds (Khudolei et al., 2022). Taken together, these sources indicate that spending better depends as much on participation mechanisms as on the capacity to plan, cost, and schedule.

That capacity is formed, to a large extent, at the university. In an analysis of 16 civil engineering programs in Belém (Brazil), the eight in-person programs devoted on average 1.89 % of their course hours to budgeting, with a range from 0.97 % to 5.95 % (Maciel et al., 2022). If graduates must later cost works, prepare technical files, and supervise contracts, this proportion raises the question of what is taught in the classroom and what is learned only on the job. For building, the National Building Regulations set the minimum design and execution requirements (Ministerio de Vivienda, Construcción y Saneamiento, 2006). Knowing that regulation is necessary, but it is not equivalent to knowing how to manage a project's budget, and that difference is what is of interest to explore.



The reviewed literature makes it possible to locate the problem; this study seeks to project which competencies, which public building or real estate projects, and which educational strategies would be proposed by experts who manage projects and budgets in a Peruvian municipality in order to train more competent engineers.

2. Methodology

A qualitative, exploratory, and propositional study was designed, with a projection from the educational field. It contemplates semi-structured interviews with eight experts in projects and budgets from a Peruvian municipality (E1 to E8), chosen by purposive sampling with two criteria: at least five years of experience and having supervised or hired young engineers. The qualitative approach is appropriate because the aim is to understand experiences, decisions, and criteria that execution indicators do not capture. The sample size responds to the exploratory purpose and not to that of generalizing. Position, years of experience, and type of municipality.

Instrument

The interview guide (Table 1) uses four techniques so that ideas emerge from the interviewee: real cases, budget constraint scenarios, retrospective visualization, and provocative statements. Real cases anchor the conversation in lived experiences. Scenarios (for example, a hypothetical reduction of the investment budget) force prioritization. Retrospective visualization invites the interviewee to imagine a year of better execution and to describe what was done differently. Provocative statements test assumptions and are treated as working hypotheses, not findings. Probes are used only if the idea does not emerge and are recorded as “induced,” so that what the expert contributed on their own can be distinguished from what they answered in response to a suggestion.

Table 1. Semi-structured interview guide (approx. 60 minutes)

Block and duration	Guiding question	Probes (only if the idea does not emerge)	Purpose
0. Opening (5 min)	Tell me how you came to work in projects and budgets and which project you remember with the greatest pride.	What did you do differently?	Context and trust
1. Real cases (10 min)	Think of a project that was executed well and another that was delayed or became more expensive. What happened in each, from programming to closing?	At what stage was time or money lost? What data or decision was missing?	Leaks and bottlenecks
2. Budget optimization (15 min)	(a) If your investment budget dropped 20 % tomorrow, what would you do so as not to stop results? (b) If you could change three rules or practices without asking permission, which would you change to spend better? (c) Imagine that a year has passed and you executed 95 % with better works: what did you do differently? (d) What expense or habit is a waste that everyone accepts?	Technical files, standardization, pooled purchases, procurement calendar, maintenance, use of data, supervision	Optimization ideas



Block and duration	Guiding question	Probes (only if the idea does not emerge)	Purpose
3. Projects (10 min)	What project that does not exist today would change the population's life the most and would be feasible? What real estate or public building projects could the municipality promote? How would you finance them and what risks do you see?	Municipal land, housing, facilities, markets, public spaces, partnerships with private parties	Project bank
4. Training and employability (10 min)	When a recent graduate engineer arrives, what do they do well and what are they missing? Describe a case in which a young person did not know how to resolve something about budgeting or management. If you designed a course for final-year students, which eight topics would you teach and which would you remove? What leads you to hire or reject a young person?	Costs and budgets, progress valuations, technical file, public procurement, risks, software, community communication, ethics	Gaps and employability profile
4b. Provocative statements (5 min)	They are read aloud and the interviewee is asked to confirm, qualify, or reject them: "whoever knows how to calculate structures already knows how to manage a project"; "budgeting is learned by working, not at the university"; "managing a public project and a real estate project is the same thing"; "more new works solve the problem."	Where do you agree or not? What example do you have?	Test assumptions (working hypotheses, not findings)
5. Closing (5 min)	What question did I not ask that I should have asked? If only one idea from what we discussed were applied, which one and why?	Rate each idea from 1 to 5 on impact and on feasibility	Prioritization

Note. Probes are used only if the idea does not emerge spontaneously and are recorded as "induced."

Procedure and analysis

The guide will be subjected to a pilot interview outside the sample and to review by expert judgment of specialists in public management and civil engineering; reporting the content validity index (for example, Aiken's V) is recommended. The interviews will be recorded with informed consent, transcribed verbatim, and anonymized (E1 to E8). The analysis will be thematic, with open and axial coding by two independent researchers and agreement by consensus. The codebook (Table 2) was built from the guide's blocks and will be refined with the transcripts.

Table 2. Codebook for the thematic analysis

Category	Description	Origin (block)	Example of what is coded
C1. Leaks and bottlenecks	Stages, decisions, or lack of data that cause delays or cost overruns	1	Incomplete technical file that forces the work to be modified
C2. Optimization ideas	Proposals to spend better or execute more	2	Change of a rule or practice to improve execution
C3. Project proposals	Works, buildings, or real estate initiatives and their financing	3	Project on municipal land with a private partnership
C4. Training gaps	Knowledge and skills that graduates lack	4a and 4b	Budgeting or procurement topic that the graduate does not master



Category	Description	Origin (block)	Example of what is coded
C5. Employability profile	Competencies that determine hiring	4	Criterion for hiring or rejecting a young person
C6. Institutional barriers	Rules, processes, or culture that hinder ideas	1 to 3	Rule or procedure that prevents applying an improvement

Note. The examples illustrate the coding criterion; they are not findings.

3. Results

The results are presented as projected proposals by category of the codebook. They are not yet empirical findings: each one is formulated as a hypothesis that the experts will confirm, qualify, or reject in the interviews. Table 4 summarizes the proposal matrix and its projected priority.

Budget optimization and associated competencies (C1 and C2). If local execution is 63 % (Ramos Vera et al., 2024), the probable leaks are located in programming, the technical file, and procurement. It is projected that the experts would ask for three competencies: preparing and reviewing complete technical files, costing and valuing works with sound judgment, and scheduling execution with a realistic procurement calendar. To develop them, it is proposed that the student solve, in the final year, a complete technical file for a real municipal project, with budget, schedule, and procurement plan.

Proposed projects as learning cases (C3). Two public building projects are projected as cases for the classroom: a community facility (for example, a market or a service center) on municipal land, and a building in partnership with the private sector. Both require compliance with the National Building Regulations (Ministerio de Vivienda, Construcción y Saneamiento, 2006) and passing through the investment system (Poder Ejecutivo, 2016), so they serve to integrate design, costs, financing, and risks. Their actual financing and risks will depend on what the experts say.

Training gaps and employability profile (C4 and C5). It is projected that the experts would ask for eight topics to be taught: costs and budgets, progress valuations, technical file, public investment and multiyear programming, public procurement, risk management, budgeting and scheduling software, and community communication with ethics. They would probably qualify the statement that whoever calculates structures already knows how to manage a project, because management also requires costing, contracting, and accountability. As an employability profile, it is projected that they would value someone who combines technical judgment, basic regulatory command, and the ability to work with the population.

Institutional barriers (C6). It is projected that the experts would point to staff turnover, the procedures of the investment and procurement systems, and the limited coordination with the university. In response, a formal university–municipality alliance is proposed to sustain internships, mentoring, and real projects on a continuous basis.

**Table 3.** Matrix of projected educational proposals from the perspective of municipal experts

Category	Proposal	Description	Competency it develops	Educational strategy	Projected priority
C2. Budget optimization	Technical file workshop	The student prepares a complete file for a real municipal project	Prepare and review technical files	Project-based learning	High
C2. Budget optimization	Applied costs and progress valuations	Work budget, unit price analysis, and progress valuations with cases	Cost and control the spending of the work	Real cases and software	High
C2. Budget optimization	Programming and procurement	Procurement calendar and schedule coordinated with regulations	Schedule execution and contract with sound judgment	Simulation of a procurement process	Medium
C3. Proposed project	Community facility on municipal land	Integrating case of design, costs, financing, and risks	Assess the feasibility of a public project	Final-year integrating case	Medium
C3. Proposed project	Building with a public-private partnership	Case to analyze roles, risks, and shared financing	Manage real estate projects with a public vision	Case study with guest experts	Medium
C4. Training gap	Public management course for engineers	Eight topics: budget, investment, procurement, risks, ethics	Move among budget regulations, investments, and purchasing	Elective course or module in the curriculum	High
C4. Training gap	Mentoring and internships at the municipality	Pre-professional internships with a tutor from the municipality	Learn on the job with supervision	University-municipality agreement	High
C4. Training gap	Communication and ethics with the community	Accountability and dialogue with the population	Communicate and act with integrity	Workshops and role-playing	Medium
C6. Institutional barrier	University-municipality alliance	Stable agreement for projects, internships, and curricular updating	Link training and practice	Joint monitoring committee	High

Note. The priority is a projection by the authors, not a rating by the experts; it will be replaced by the mean impact and feasibility (1 to 5) given by the experts in block 5. The codes refer to Table 2.

4. Discussion

Execution and technical capacity. The average local execution of 63 % (Ramos Vera et al., 2024) offers a framework for interpreting the projected proposals. If there are deficiencies in technical files, programming, or supervision, they will affect execution, which is why the highest-priority proposals focus on those points. The improvement associated with performance-based budgeting in districts of Apurímac (Palomino Flores et al., 2026) suggests that knowledge of the tool is related to better indicators, although that study does not allow causality to be attributed, and neither does this one.

Participation and decisions. The results from Chiclayo (Urbina Cárdenas et al., 2021) show that participation is associated with municipal decisions, but that a good share of participants



doubt that it is sufficient. For this reason, it is projected to include community communication in training, and the interviews will make it possible to contrast how the experts prioritize between citizen demand and technical judgment. The prevention of waste, which according to the IDB cited by Huárac Quispe et al. (2022) represents 4.4 % of Latin American GDP, reinforces the importance of deciding on technical as well as participatory criteria.

Medium-term planning. The warning by Khudolei et al. (2022) about deficient medium-term planning can be contrasted with multiyear investment programming (Poder Ejecutivo, 2016) and with multiyear budget programming (Poder Ejecutivo, 2018). It is projected that the student practice multiyear programming in the technical file workshop; the interviews should confirm whether the experts mention problems of continuity, maintenance, or project portfolios.

Training of the civil engineer. The 1.89 % of course hours devoted to budgeting found in Belém (Maciel et al., 2022) is a reference from another country, not a measure of Peru. For that reason, the main contribution of this study is what the experts would ask to be taught, and it is proposed to verify it by comparing the budgeting course hours of local programs with the topics the experts prioritize. The provocative statements will make it possible to test common assumptions, such as that whoever knows how to calculate structures already knows how to manage a project; it is expected that the experts will qualify them rather than confirm them, but this is a hypothesis.

Real estate projects and public building. Every building project must meet the minimum requirements of the National Building Regulations (Ministerio de Vivienda, Construcción y Saneamiento, 2006) and pass through the investment system and procurement rules (Congreso de la República del Perú, 2024; Poder Ejecutivo, 2016, 2025). The projected cases would require additional competencies in feasibility assessment, risk management, and negotiation with private parties, which the interviews should confirm or correct.

Limitations: The proposals presented are projections and not empirical findings, and they require validation with the interviews. Eight experts from a single municipality will allow the findings to be transferred with caution, not generalized. The ideas and ratings will correspond to the interviewees' perception and not to measurements of budget execution.

5. Conclusions

First, the available evidence suggests that improving execution requires strengthening in the engineer the preparation of technical files, costing, and the scheduling of procurement, and this is the highest-priority line of proposal. Second, public building projects, such as a community facility on municipal land or a building in partnership with private parties, can serve as integrating learning cases. Third, for the curriculum, a public management module of eight topics, internships with mentoring, and a formal university–municipality alliance are projected. As a methodological contribution, the study offers a replicable guide that brings out the ideas of the experts themselves and a proposal matrix ready to validate. Future studies could apply it in other municipalities and contrast the results with execution indicators.





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