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Systems Thinking in the Age of Environmental Complexity: A Practical Urban Problem-Solving Framework

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ABSTRACT

Urban environments are becoming increasingly complex, so urban planning requires new and innovative approaches to address these challenges. This study explores a detailed framework to address these challenges by combining different problem-solving techniques across three key stages: identifying the problem (What), analysing the problem (Why), and developing solutions (How). The research employs various tools, including SWOT analysis, Fishbone diagrams, World Café, and Causal Loop diagrams. Also, it evaluates the effectiveness of their usage by combining various methods, including questionnaires with urban planning students and real-world case studies. The findings underscore the importance of integrating qualitative and quantitative techniques to promote collaboration and informed decision-making. For example, tools like Discovery & action dialogue (DAD) help create inclusive engagement, while data-driven approaches like GIS mapping provide actionable insights. The study also highlights patterns in how these techniques perform at different stages. The proposed framework addresses a wide range of challenges, from simple to complex, such as ill-defined, ethical, and wicked problems. It highlights the importance of adaptability and learning through iterative processes. This research offers a comprehensive, structured, and integrative framework for urban settings. This framework is designed to help urban practitioners, policymakers, and educators navigate the complexities of urban systems while improving decision-making, and it can be adapted to different contexts.

Keywords

Urban problem-solving, Problem-solving techniques, System thinking, Case analysis, Integrated methodology.

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1. Introduction

Problem-solving is one of the most essential elements of a system. The growing complexity of modern urban planning challenges conventional planning and design approaches to their limits (Koenig et al., 2020). In academic settings, educators train urban planning students to apply scientific and technical knowledge to well-defined problems. However, graduates must also be prepared to tackle complex, open-ended urban challenges involving economic, environmental, social, political, ethical, and sustainability constraints (Ruby et al., 2013). Problem-solving is a core skill that combines critical and creative thinking. It improves deep cognitive processing and requires mastery of analytical and evaluative tools (Gusau et al., 2020). The process of problem-solving enables people to use both critical and creative thinking to solve common issues. By avoiding a tendency to approach problems randomly, creative problem-solving prevents surprises and dissatisfaction with the outcome (Treffinger et al., 2023).

Additionally, this process fosters higher-order skills and is recognized as one of the essential competencies in the field (Guaman-Quintanilla et al., 2023). This study proposes a structured framework to address these challenges by focusing on three key questions: What are the issues? Why do they exist? How can they be solved? Through a systematic literature review, case study analysis, and a questionnaire collecting student feedback, the research evaluates the effectiveness of problem-solving techniques. It introduces a novel framework tailored to urban contexts.

2. Literature review

This section studies problems and problem-solving concepts. The section also examines problem-solving frameworks and techniques while reviewing and evaluating related case studies.

2.1. Problem and problem-solving concepts specifically in urban areas

Problems are general terms that carry both positive and negative meanings, exist in varying degrees, and have multiple levels. Getzels (1982) distinguished between two definitions: a problem happens when a desired action is blocked, and a problem occurs in unfavourable circumstances with clearly defined issues (Abdulla and Cramond, 2018). Any unanticipated, undesirable incident or circumstance that must be addressed and managed before it becomes overly complicated is a problem in any project or assignment. Another way to describe a problem is the difference between what should happen and what occurs (Pal and Poyen, 2017).

2.1.1. Urban problem

To gain a deeper understanding of urban problems, a bibliometric analysis was conducted using Vos Viewer software, focusing on the keywords "problem" and "urban studies". This analysis identified the most frequently addressed urban challenges in the academic literature over the past few years. The software output divided the keywords into twelve clusters. Each node symbolizes a keyword, and its size is related to its value and importance. Additionally, the keywords clustered together were strongly related and found in similar documents. Furthermore, in monitoring the years of publication, papers utilized keywords such as mental health, Transportation, climate change, urbanization, and behavioural problems, which reflect the challenging and complex nature of urban problems. For instance, mental health is often linked with keywords such as stress and depression in urban studies. Moreover, Transportation is another key issue related to cost reduction, efficiency, and environmental impact mitigation. The primary objective of using this bibliometric analysis was to highlight the complexity and interconnectedness of urban challenges, demonstrating that these problems rarely occur in isolation. The Co-occurrence analysis (Figure 1) revealed the need for a structured and adaptable problem-solving framework capable of navigating the multidimensional nature of urban planning. These findings support the study's goal of identifying and refining a practical framework suitable for the complex and evolving demands of urban planning practice and education.

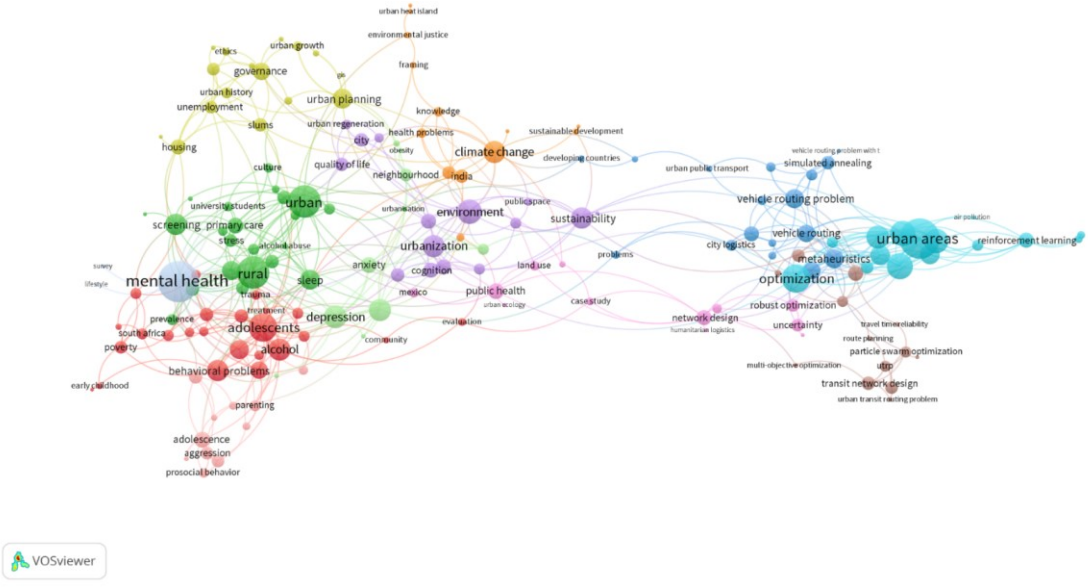

Figure 1. Co-occurrence analysis by keyword in the Network visualization (Vos viewer)

It is essential to understand the various types of problems and their importance, including wicked problems, which are particularly relevant to urban challenges due to their complexity. Therefore, Table 1 demonstrates the problem and the wicked problem.

Table 1. Exploring the concept of the problem and the wicked problem (Ruhl and Salzman, 2020)

Type	Definition	Example
Simple or well-defined problems	Clear, straightforward, have solutions, easy to identify and implement	The problem of streetlights is easy to identify and solve; it can be quickly repaired or replaced to ensure public safety and visibility.
Complex problems	More complicated, involving multiple factors, still solvable, requiring a more profound understanding	Traffic congestion involves numerous factors and requires a detailed analysis, but it can still be effectively managed through targeted strategies.
Ill-defined problems	Harder to articulate clearly, difficult to determine the best path, unclear objectives, incomplete data, and uncertainty about the proper method.	Urban water supply management is a complex task that requires balancing the demands of residential, industrial, and agricultural sectors.
Social problems	Impact large groups of people; more complex than technical problems, they involve human behavior, values, and varying perspectives.	Cities face challenges integrating migrants and refugees, resulting in social tensions, housing shortages, and public service pressure.
Ethical or moral problems	Concerns and dilemmas that involve right and wrong, often with no clear or universally accepted solutions, require subjective judgments and may lead to different solutions.	Cities are integrating surveillance technologies for traffic management, public safety, and urban planning, which raises ethical concerns about privacy. Balancing efficiency, security, and individual rights is crucial.
Wicked problem	No definitive problem definition	Wicked problems resist simple and definitive understanding or framing.	Cities face diverse and evolving impacts of climate change, making it difficult to define the exact nature of the problem or find a one-size-fits-all approach.
	No stopping rule	Wicked problems evolve continually, making it impossible to declare any solution truly "complete.	Air pollution control is an ongoing process with no clear endpoint.
	Solutions are not true-or-false but better-or-worse	The complexity of wicked problems means that solutions cannot be neatly categorized as correct or incorrect.	Expanding public transit doesn't have a single "right" answer, but options must be weighed in terms of cost, coverage, and efficiency, considering their varying impacts on different groups.
	No immediate test of a solution	Solutions to wicked problems can take years or even decades to fully manifest.	The effects of redevelopment, such as economic revitalization or displacement, may take years or challenging to assess success even after several decades.
	One-shot operations	Every attempt to solve a wicked problem has lasting consequences.	Large infrastructure projects (such as building a bridge or tunnel) are costly and difficult to reverse, so each decision has long-term, irreversible consequences.
	Unique nature	Every wicked problem has its own unique set of characteristics, based on its specific context.	Each city faces unique risks from natural disasters, necessitating tailored solutions that are specific to its geography, infrastructure, and population needs.
	Interconnectedness	Wicked problems are often interconnected. Addressing one issue may lead to unintended consequences in another area.	Affordable housing projects are often linked to transportation access, so improving housing far from urban centers can increase commute times and create new challenges, such as traffic congestion.
	No exhaustive set of solutions	Wicked problems don't have a finite or exhaustively known set of possible solutions, and there's no guarantee that the "best" solution exists.	Urban waste management must strike a balance among various approaches, including recycling, landfills, and composting. No single solution fits every city's needs and resources.
	Symptom of another problem	Wicked problems are a symptom of a larger, more complex issue. For instance, urban poverty may be a symptom of broader issues such as economic inequality.	Poverty in cities often results from broader economic issues such as unemployment, inadequate education, or systemic inequality, making it a symptom of larger problems.
	The planner has no right to be wrong.	Mistakes can have severe, long-term consequences, and there is little room for learning through failure.	Mistakes in designing flood defenses can lead to catastrophic outcomes, such as property damage or loss of life, so planning must be highly accurate and risk-averse.

2.2. Problem-solving frameworks

Finding new solutions to address a problem is a key aspect of problem-solving (Almulla, 2023). The problem-solving steps and their evolution over the past century are demonstrated in Table 2. Each framework breaks down into distinct stages, including problem identification, problem analysis, solution application, and evaluation.

Table 2. Exploring the problem-solving frameworks

Authors	Stages		
	What?	Why?	How?
Polya, 1945	Understanding the problem	Devising a plan	Carrying out the plan Looking back
Parnes, 1967	Fact-finding	Problem finding	Idea finding Solution finding Acceptance finding
Branford and Stein, 1993	Identify problems and opportunities	Define the Problems, develop and understand the goals	Explore possible strategies Anticipate potential effects before applying Look back and learn
Woods, 2000	Engage Define the stated problem	Explore: create the internal notion of the problem	Plan a solution Do it: carry out the plan Evaluate: check and look back
Lau et al, 2006	Define the problem	Analyze the problem	Develop hypotheses and determine interventions Monitor progress and evaluate effectiveness Repeat as necessary
Marksberry et al., 2011	Clarify the problem	Break down the problem Target setting Root cause analysis	Develop countermeasures Monitor both results and processes Standardize successful processes
Singer and Voica, 2013	Decoding representing	Processing	Implementing
Basadur et al., 2014	Generating	Conceptualization	Optimization Implementation
Payne, 2016	Data collection and observation	Problem definition analysis and categorization	Stakeholder involvement Continuous assessment
Koenig, 2020	Problem representation	Objective definition	Optimization using evolutionary algorithms Iterative evaluation and selection Visual analysis and stakeholder engagement
Choi, 2021	Field Research	Define Problems	Establish alternatives Evaluate alternatives Apply the solution Validation
Fraser, 2023	Defining the problem Appreciative inquiry	Considering multiple solutions Exploring multiple approaches	Seven decision-making styles Overcoming common mistakes
Kondić et al, 2024	Preparation	Resolution	Resolution &improvement of solutions
Proposed process	Problem identification	Problem analysis	Solution development Evaluation and feedback

Regardless of variations in terminology and focus, these models collectively emphasize the importance of iterative learning, stakeholder involvement, and flexibility in problem-solving

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and decision-making processes. According to the studies, these frameworks can be categorized into three periods.

1. Early foundations (1950-2000): Frameworks, such as Polya (1945), introduced their ideas based on systematic stages. Polya's widely cited model follows a linear concept, encompassing understanding the problem, devising a plan, carrying out the plan, and reflecting on the outcome. Parnes (1967) also recommended "fact-finding" and "idea-finding" stages to improve active brainstorming.
2. Integrative Models (2000-2012): Models such as Woods (2000) and Lau et al. (2006) began to emphasize motivation and metacognition ("engage: I want to, and I can"), as well as cyclic analysis and repeated interventions. Marksberry et al. (2011) introduced more detailed tools like root cause analysis, countermeasure development, and process standardization. These frameworks reflect a shift toward regular learning and the integration of quality and systems thinking principles.
3. Contemporary models (2012-present): The most recent models, including Basadur et al. (2014), Payne (2016), Koenig (2020), Choi (2021), Fraser (2023), and Kondić et al. (2024), reflect the increasingly complex nature of modern challenges. These approaches stress optimization, continuous assessment, evaluation, and stakeholder involvement. For example, Payne (2016) and Koenig (2020) emphasized stakeholder engagement and advanced analytical tools (e.g., evolutionary algorithms, visual analysis), whereas Choi (2021) and Fraser (2023) integrate validation, a variety of decision-making styles, and appreciative or collective inquiry. Kondić et al. (2024) exemplify the evolution toward ongoing improvement for modern urban and organizational problem-solving.

2.2.1. Comparative analysis

A comparative analysis of models from different periods reveals problem identification terms. Although the terminologies mentioned by the authors differ, they all emphasize the importance of having a clear and collective understanding of the problem. In the early stages, the concept of the problem is a challenge that needs to be solved. On the other hand, in the late periods, Iterative Evaluation and Selection, Evaluating, Refining, and Repeating are central to most contemporary approaches. In summary, every framework adjusts to various situations. Previous models are appropriate for organizing individual problem-solving, whereas subsequent models concentrated on collaborative and dynamic activities .Accordingly, the proposed process combines the strengths of approaches and explicitly incorporates iterative feedback at each stage.

2.3. Exploration of techniques

This section outlines various problem-solving and strategic planning techniques, detailing the steps and providing examples of urban challenges. Table 4 provides a comprehensive resource for addressing challenges and generating actionable solutions. The 12 problem-solving techniques were selected based on their widespread application in urban planning education

and practice, as evidenced by their application in analysing complex urban issues. These techniques were selected for their simplicity, accessibility, and alignment with the three stages of problem-solving, as observed in an urban planning studio over several months. Techniques are categorized into three groups based on their purposes and nature: what, why, and how. Every technique offers a unique perspective for identifying problems, analyzing them, or finding solutions through creative steps. More complex tools were excluded due to their specialized training requirements and limited use in the educational context of this study. Importantly, the techniques were also selected for their adaptability to various urban planning contexts, from highly institutionalized systems in developed cities to informal or resource-limited environments. Tools like “Mind mapping”, “SWOT”, “Problem tree”, and the “Five whys” require minimal resources and facilitation, making them ideal for grassroots applications. Others, such as the “Causal loop diagram” or “Agreement certainty matrix”, can be scaled in complexity based on participants' expertise. Participatory techniques like “World café” and “Discovery & action dialogue” were chosen for their flexibility, cultural neutrality, and ability to engage diverse stakeholders across different settings.

1. WHAT: This category includes techniques like “SWOT”, “Mind maps”, and “Journalists”. SWOT analysis is a strategic approach to problem-solving and decision-making. It provides valuable insights for identifying essential internal and external factors that contribute to achieving the specified objective (Cui et al., 2019).
2. Why: Techniques like the “Five whys”, “Problem tree”, “Fishbone analysis”, and “Causal loop diagram” are presented in this category. For instance, the “Problem tree” (visual tool) or the “5 whys” techniques explore deeply to pinpoint the essential reasons behind issues. It ensures that solutions are extracted from the fundamental problems, rather than the symptoms.
3. How: Techniques like the “Agreement certainty matrix”, “World café”, “Discovery & Action dialogue (DAD)”, “Goal tree”, and “The Impact and effort matrix” are presented in this category. For instance, the “Impact and effort matrix” can guide teams in exploring unique and feasible ideas, as well as prioritize and plan for development.

Table 3 outlines urban environment techniques focusing on collaboration, inclusivity, and visualization for clarity. Collaboration and inclusivity are essential concepts for achieving optimal performance. Additionally, visualization for clarity is another aspect that offers explicit visual representations of relationships and focus areas. Structured problem-solving also helps to use these techniques step by step, providing a comprehensive view of problems and efficiently creating practical solutions.

Table 3. Exploration of problem-solving techniques

Categorization	Technique	Definition	Details	Source
What	SWOT	A SWOT analysis is a strategic planning tool. It identifies both external and internal elements needed to achieve a goal.	Steps Create a quadrant with "Strengths" and "Weaknesses" on the top left, "Opportunities" on the top right, and "Threats" on the bottom right. Generate ideas, sort, and create clusters. Start a group conversation to create broad categories for each cluster. Dot votes next to relevant categories, highlighting the most votes. Summarize the findings and engage the group in a creative exercise to evaluate weaknesses and threats in a positive light.	Cui et al, 2019 SessionLab,n. d.a
	Journalists	Journalists help groups avoid getting stuck in problem identification by allowing them to draft a fictional newspaper front page and determine stories' covers and headlines.	Steps Collecting potential stories for the first page. Choosing the most important story for thelead article. Write headlines for each article. Getting to the point in the first paragraph. Collecting essential facts for the second paragraph. Designing the entire page, if time allows	Smart, 2024
	Mind map	Mind mapping is a nonlinear learning technique that helps users explore the context through visual-spatial links that flow from a central theme to outer branches that may be interconnected.	Steps Pinpoint the central idea: choose a main idea for the environment, let it develop, and keep it straightforward. Provide branches for the categories, creating main branches for major concepts that represent specific knowledge or ideas. Expanding the sub-branches: generate sub-branches from main branches to investigate specific elements of each category, simplifying complex concepts into easily understood sections Using visuals: adding visual components to mind maps, such as colors, icons, or drawings, to make the content more interesting and memorable. Refine and review: step back and evaluate the effectiveness of the mind map.	Atlassian,n.d Rai and Kaur, 2025
Why	Fishbone analysis	Fishbone diagrams show cause-and-effect relationships in productivity and management. It reveals the main factors.	Steps Define the problem: clearly state the issue. Identify the main causes and determine the major categories. Brainstorm sub-causes: break down each category into specific factors. Analyze the diagram: examine relationships and prioritize potential causes for investigation.	Sakdiyah et al, 2022 SessionLab,n. d.b
	The 5 Whys	The Five Whys is a method for identifying the root cause of organizational issues, enabling a group to develop effective strategies. It involves creating and refining a problem statement through five	Stages / Examples by authors: air quality challenges Why? Why is the urban area's air quality relatively poor? Because the region has a significant concentration of vehicle emissions. Why? What causes the high car emissions in the urban area? Because a large number of individuals commute to work by car, which results in high pollution levels and frequent traffic congestion.	Smart, 2024

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Categorization	Technique	Definition	Details		Source
		stages, providing a comprehensive approach to identifying and resolving problems.	Why? Why? Why?	Why do so many people drive to work instead of using public transportation? Because there aren't enough convenient or efficient options. Why aren't there more convenient options for public transportation? The city's limited budget for public transportation investments. Why hasn't the expansion of transit infrastructure been given priority? The city's development and planning regulations have traditionally prioritized car capacity.	
	Problem tree	The problem tree involves groups brainstorming and organizing problems into a hierarchy, ranging from most important to least important or abstract to practical.	Steps Define the core problem: identify and state the main issue. Identify causes: determine the underlying factors contributing to the problem (these are the roots). Identify effects: note the consequences of the problem (placed as branches). Analyze relationships: examine how causes and effects interact and influence each other.		Smart, 2024
	Causal loop diagram	A Causal loop diagram (CLD) is a systems thinking tool that uses variables and arrows to represent and analyse a system's feedback structures.	Steps Problem articulation: identify research problems, identify stakeholders based on role and impact, and gather variables through literature reviews. Formulating a dynamic hypothesis: classifying variables, defining relationships, and developing a preliminary CLD diagram. Refinement and validation: Refine relationships and identify and add any overlooked variables.		Dhirasasna and Sahin, 2019.
How	World café	The World café is a methodical discourse technique used in community or organizational settings for teamwork, information exchange, strategic planning, problem-solving, and brainstorming, fostering a shared understanding and robust discussions.	Steps Set the Context Form small groups Share insights Connect ideas Synthesize results	Examples by authors: homelessness in the city Community members, nonprofits, and city officials are collaborating to discuss strategies for reducing homelessness, including improving access to living spaces and implementing local services to prevent homelessness. Attendees break into small groups to discuss each question. Each group records ideas, such as increasing affordable housing or expanding mental health services. Participants rotate and add to prior groups' discussions. Collective insights are shared, forming actionable strategies to address homelessness collaboratively.	Smart, 2024 SessionLab,n, d.c
	Discovery & action dialogue (DAD)	Creating a safe space for a group to share and discover practices and behaviours can help them find solutions. DAD helps groups choose their problems and approaches, removing resistance to change and gaining buy-in at all levels. This process of enabling frontline ownership ensures follow-through	Steps Identify Participants Set the problem context. Ask guiding questions Identify Positive Deviants	Examples by authors: enhancing urban green spaces Gather city planners, residents, environmental groups, urban planners, and landscape architects. Frame the issue around a lack of accessible green spaces, and mention neighbourhoods with effective park use. Use questions like, "What do people love about green spaces in other areas?" Identify neighbourhoods where green spaces thrive and are well-used.	SessionLab,n.d,d Smart,2024

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Categorization	Technique	Definition	Details	Source
		and is a valuable tool for facilitators to have in their toolbox.	Discuss Barriers and Opportunities Recognize funding, space, or accessibility challenges while brainstorming applicable successes. Create an Action Plan Define steps like improving park access, landscaping, or organizing community events.	
	The impact and effort matrix	The "Impact and effort matrix" is a problem-solving technique that encourages critical thinking by categorizing ideas into a 2x2 matrix, guiding participants from ideas to evaluating potential solutions.	Steps Idea generation: Collect potential projects or tasks that align with a specific goal. Plot on matrix: assess each idea by plotting it on a 2x2 grid: high impact, low effort: quick wins (top priority), high impact, high effort: consider, if resources allow, low impact, low effort: fill-ins, for available time, and low impact, high effort: Often discard. Prioritize and plan: Focus on high-impact, feasible tasks first.	Smart,2024
	The goal tree	A goal tree is a hierarchical tool that breaks down high-level objectives into smaller, more manageable objectives and functional activities.	Steps Identify high-level goals: the project should have suitable and sufficient goals that align with the strategic objectives. Decompose into sub-goals: breaking down high-level goals into sub-goals that serve as intermediate achievements. Define operational tasks: the task should be actionable and assignable for each sub-goal, outlining the specific tasks, actions, or requirements. Establish traceability links: establish clear connections between high-level goals, sub-goals, and operational tasks. Analyze and validate the goal tree by reviewing it for alignment, consistency, and completeness.	Van Lamsweerde, 2001 Lukyanova, 2024
	Agreement certainty matrix	The "Agreement and certainty matrix" is a tool that categorizes issues into technical and adaptive challenges. Technical challenges have clear, agreed-upon solutions, while adaptive challenges are complex and lack agreement on causes or solutions. The matrix facilitates understanding of problem types and exploring suitable solutions.	Steps Identify the problem and root causes. Plot root causes: draw a matrix and use sticky notes to represent each root cause, arranging them based on team members' certainty and agreement levels. Evaluate agreement and certainty: Discuss the team's agreement and certainty for each root cause to determine whether the problem is technical, complicated, or adaptive. Choose solution approaches: based on where each root cause falls on the matrix, find suitable approaches for addressing the problem (e.g., direct action, changing processes, or examining patterns). Brainstorm solutions: Utilize the chosen approach to develop targeted solutions for each identified root cause. Prioritize solutions: Use a prioritization matrix to decide which solutions to implement first.	Zimmerman, 2001 RHNTC, 2019

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2.4. Reviewing and evaluating problem-solving case studies

This section examines how problems are identified in case studies, using selected projects as examples. These case studies represent a range of urban contexts and planning conditions, thereby supporting the methodological triangulation employed in this study. These projects were analysed at micro, meso, and macro levels, and the actions have been classified into three categories: what, why, and how. Table 4 provides a detailed breakdown of each case study.

2.4.1. What – Problem identification

Micro-scale case studies use public input, site observations, and historical data reviews to address local issues effectively. However, it may lack structured techniques and rely on quantitative data. Meso-scale cases, such as field observations and surveys, may not engage diverse stakeholders or address urban challenges. Macro-scale cases, such as context analysis and consultations, provide a broader understanding but may lack local sensitivity and community involvement.

2.4.2. Why – Problem analysis

micro-scale case studies methods like interviews, workshops, and "SWOT" analysis provide detailed insights into underlying causes, relying on qualitative approaches. Meso-scale cases involve consultation, "SWOT" analysis, and contextual reviews, but may lack local engagement. Macro-scale cases often utilize high-level stakeholder engagement and data analytics, but may overlook broader social or cultural impacts, focusing instead on quantifiable data.

2.4.3. How – Developing solutions

micro-scale case studies solutions focus on flexible programming and phased implementation, lacking long-term monitoring and institutional support. Meso-scale ones use integrated zoning, expert input, and participatory approaches, but may face affordability and timeline delays. Macro-scale cases employ long-term, systemic strategies with comprehensive goals, but may lack detailed implementation strategies and measurable progress indicators.

Table 4. Reviewing and evaluating problem-solving case studies

Scale	City	Problem-solving steps: What? Problem Identification	Problem-solving steps: Why? Problem Analyzation	Problem-solving steps: How? Problem Resolution	Evaluation: What?	Evaluation: Why?	Evaluation: How?
Micro-Scale	Town Square Park, Anchorage, Alaska (Municipality of Anchorage Parks and Recreation Department, 2019)	By public input (online surveys to gather perceptions about the park), observation (site analysis) method, and historical data review. The park faces challenges related to public safety, lack of identity, and underutilization.	By stakeholder engagement (interviews and roundtable meetings), workshops, and data analysis (survey results). Illegal activity in urban areas, poor infrastructure, outdated amenities, limited connectivity and interaction, and lack of consistent programming	By collaborative workshops, best practices case studies, and community-driven design (integration of public preferences and use of advisory groups) • Design solutions modify landscaping, introduce flexible-use areas, and update hardscape • Programming enhancements Expand year-round activities and family-friendly and inclusive programming • Management strategies adopt a sustainable management model involving public and private partnerships. • Community involvement Engage stakeholders and residents through workshops and surveys • Implementation phase-based execution with regular monitoring	Strengths: Important issues are supported by statistics and public participation. Weaknesses: insufficient comparative context with other urban park issues to offer a more comprehensive viewpoint.	Strengths: effectively identifies underlying reasons Weaknesses: relies heavily on qualitative feedback; limited quantitative analysis, and insufficient exploration of the long-term impacts.	Strengths: proposes actionable and comprehensive solutions Weaknesses: Some strategies may be too ambitious without assurance of long-term support
	Gharani &HorAmeli Street, Mashhad, Iran (Ministry of Roads and Urban Development, 2020)	By initial observations or context analysis, quantitative data disorganized land use, traffic congestion, and poor access, insufficient pedestrian and green spaces.	By data analysis, SWOT analysis, and GIS-based mapping	By the development of proposed solutions and the creation of an implementation framework • Define vision, objectives, and goals. Enhance zoning regulations, improve pedestrian pathways, reduce traffic congestion, and preserve historical and cultural landmarks. • Define policies • Alternative solutions and evaluation Redesigning zoning for different spaces, improving public transportation, and revitalizing underutilized buildings. • Implementation plan	Strengths: clearly defines the main challenges Weaknesses: Some issues are mentioned without adequate supporting quantitative data	Strengths: The document employs tools like SWOT Weaknesses: The analysis does not fully explore the main problem	Strengths: proposed solutions are actionable and align with identified problems Weaknesses: detailed plans for monitoring and evaluating the impact of the solutions are missing

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Scale	City	Problem-solving steps: What? Problem Identification	Why? Problem Analyzation	How? Problem Resolution	Evaluation: What?	Why?	How?
Meso-Scale	Hammarby Sjostad district, Stockholm, Sweden (Gaffney et al., 2007)	By initial site analysis and policy review. Environmental pollution from industrial use, rising urban housing demand, and lack of infrastructure integration	Through stakeholder consultation and historical research, policy impact analysis. Inefficient land use and pollution were the results of historical industrialization.	By public engagement and integrated planning • Design approach Create a sustainable, low-impact urban environment • Social and environmental goals Equity, sustainability, and social interaction • Stakeholder collaboration Partnership among municipal, private, and national actors • Implementation process Detailed description of the planning phases • Specific design approaches Compact urbanism, green infrastructure, and water-sensitive design	Strengths: comprehensive site analysis, focus on urban housing needs, strategic urban positioning Weaknesses: Various urban challenges heavily influenced the problem identification	Strengths: detailed research into historical and policy context Weaknesses: Lack of practical methods and techniques, limited resident engagement	Strengths: successfully implemented a Hammarby model and phased development Weaknesses: Implementation delays and affordability goals not met
	The District Surrounding the Holy Shrine of Imam Reza, Mashhad, Iran (Ministry of Roads and Urban	By Field observations, site visits, surveys, and feedback from stakeholders, zoning, transportation, and land use concerns near Imam Reza's holy shrine.	By using focus groups, collaboration, interviews, consultations, and SWOT analysis.	By stakeholder workshops and meetings, scenario modeling, and the use of goal-setting frameworks • Define objectives and goals Develop a balanced urban system • Alternative solutions and evaluation Enhancing public transit options and pedestrian pathways • Implementation plan Create phased and zoning plans to guarantee that solutions are implemented gradually.	Strengths: identifies urban challenges clearly by using different methods and documents	Strengths: Analyse problems by using different methods and opinions. Comprehensive analysis Weaknesses: Lack of practical methods to enhance engagement	Strengths: Actionable strategies and an implementation plan Weaknesses: lacks detailed mechanisms for tracking progress or assessing the success of implementation
Macro-Scale	Charlotte, North Carolina, USA (City of	By data analysis, geospatial mapping, and stakeholder feedback Charlotte faces a significant public	By data analysis, stakeholder engagement, and community input human error (speeding, distracted driving,	By phased implementation planning, collaborative engagement, and educational campaigns • Proposed solutions: -Engineering: Redesigning streets to improve safety -Education: creating community ambassador programs	Strengths: Clearly defines the problem of traffic-related fatalities and injuries and focuses on vulnerable road users	Strengths: Identifies root causes and uses stakeholder engagement	Strengths: proposes comprehensive solutions and focuses on systemic change

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Scale	City	Problem-solving steps			Evaluation		
		What? Problem Identification	**Why? Problem Analyzation**	**How? Problem Resolution**	**What?**	**Why?**	**How?**
		safety issue due to traffic-related fatalities and serious injuries.	and failure to yield), infrastructure issues, and equity concerns (vulnerable populations)	-Enforcement: data-driven enforcement targeting high-risk areas -Engagement and equity: continued involvement of the community • Implementation plan: -Regular updates to the action plan based on data and progress. -Multi-year benchmarks from 2020 to 2030 to track progress in sidewalk construction, bike lane improvements, and policy updates.	Weaknesses: lacks comparison with national or global trends, and insufficient exploration	Weaknesses: Limited examination and insufficient detail	Weaknesses: lacks detailed funding strategies
	Ludwigsburg, Germany (Kuhla von Bergmann and Dieterle, 2019)	By observations and context analysis. Identified key urban challenges such as rising temperatures, air pollution, and housing shortages.	By data collection and analysis, stakeholder engagement, SWOT analysis, and comparative research car-centric planning, pollution, and reduced urban efficiency, while high land and construction costs limit housing development	By using the SMAC framework and scenario development • Define objectives and measurable goals sustainable mobility, enhanced housing, and increased green spaces • Generate and evaluate alternative solutions • Engage stakeholders for validation Used co-creation workshops to ensure solutions are inclusive and adaptable • Create an implementation plan Involves the phased execution of a dynamic master plan, incorporating pilot projects and real-time feedback, and utilizing monitoring frameworks to track progress and adjust solutions as needed.	Strengths: Comprehensive data collection and clear articulation of symptoms and their interconnections. Weaknesses: limited emphasis on specific demographic impacts and geographic focus on central Ludwigsburg	Strengths: Effective use of stakeholder consultations and robust systemic analysis Weaknesses: Lack of deep exploration of social parameters and limited discussion on governance or policy barriers	Strengths: Practical solution, useful framework (SMAC), and long-term adaptability in scenarios Weaknesses: Limited metrics or KPIs for tracking the success of interventions, and limited funding

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3. Methodology

This study employs a comprehensive three-phase methodological approach to identify urban problem-solving frameworks, utilizing both qualitative and quantitative research methods (Figure 2). The research methodology follows a systematic process to develop the urban problem-solving framework.

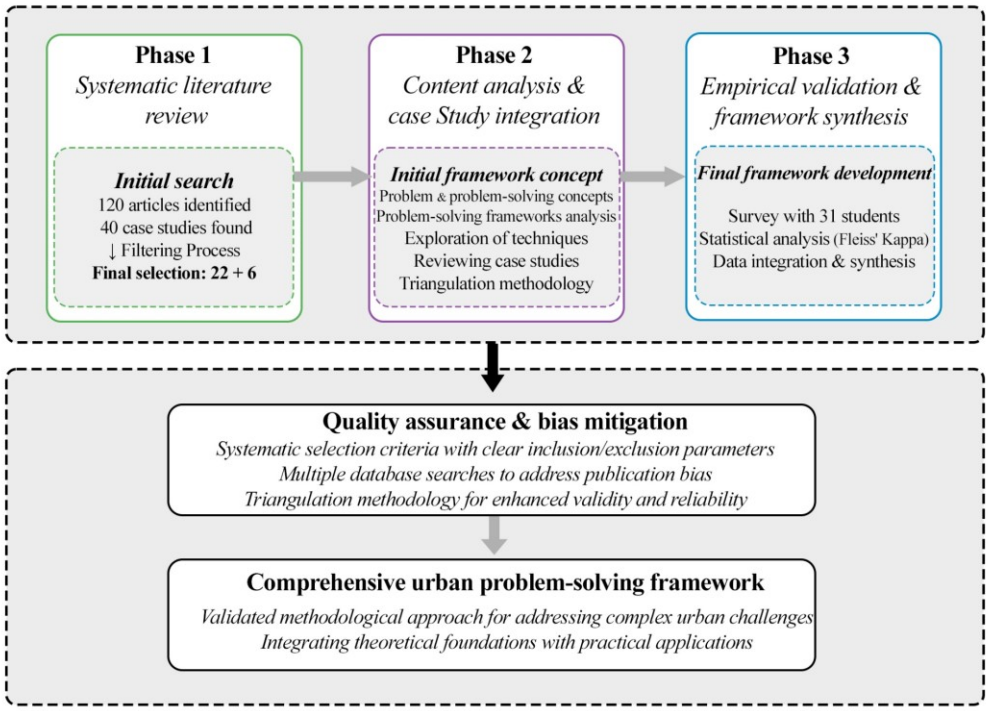

Figure 2.Methodological framework for urban problem-solving analysis

3.1. Phase 1: Systematic literature review

A systematic literature review was conducted using Google Scholar, Web of Science, and Scopus. The methodological review is based on Sandelowski and Barroso's (2007) meta-analysis approach ,which systematically synthesizes existing research. One hundred twenty articles and forty case studies were identified from databases. The list was eliminated based on inclusion and exclusion criteria. The inclusion criteria included studies of urban problem-solving, planning tools, clear goals, conceptual or methodological frameworks, published in adequate journals, and real-world application of techniques in urban planning. Exclusion criteria included unrelated titles, studies lacking methodological transparency or academic quality, indicators without established frameworks, or publications outside the scope of the study. Finally, 22 peer-reviewed articles and six relevant case studies were selected for final analysis. The systematic selection of articles and case studies was accurate; however, potential biases, such as publication bias favoring certain journals, the exclusion of non-English sources, and subjective judgments, were addressed (Figure 3).

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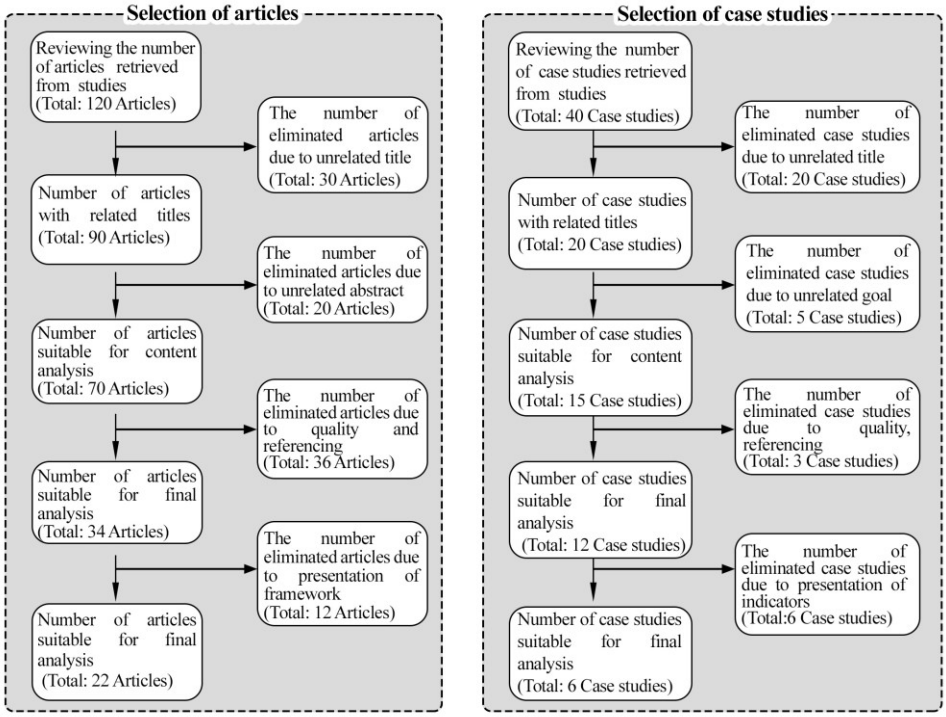

Figure 3. Selection process of sources

3.2. Phase 2: Content analysis and case study integration

Following this, a systematic review was conducted to analyze the structure and content of the literature, extracting key information. This phase systematically reviewed four key areas: (1) problem and problem-solving concepts specifically in urban contexts, (2) existing problem-solving frameworks and their theoretical foundations, (3) exploration and categorization of various problem-solving techniques, and (4) reviewing and evaluating real-world case studies to understand practical applications. The study included diverse case studies from different geographical, cultural, and planning contexts to support the triangulation methodology. Triangulation is a methodological approach that uses multiple data sources to improve the credibility and validity of research findings. It is particularly helpful in qualitative studies, which aim to understand complex social phenomena and multicultural environments. By embracing diverse perspectives, researchers can verify and validate their findings, leading to more comprehensive and reliable conclusions (Meydan and Akkaş, 2024). The findings from this phase provided the foundation for developing a structured urban problem-solving framework that would be empirically validated in the next phase.

3.3. Phase 3: Empirical validation and framework synthesis

Likewise, A questionnaire, designed with structured and semi-structured questions, was administered to 31 urban planning students to evaluate the practical effectiveness of problem-

solving techniques. These participants were deliberately chosen due to their extensive practical experience, having actively applied problem-solving techniques over several months in an urban planning studio. This hands-on engagement provided deep insights into the applicability and efficacy of these methods in addressing urban challenges. In contrast, urban policymakers and practitioners, who prioritize practical outcomes over structured problem-solving frameworks in real-world settings, often lack direct experience with these specific techniques, making students a more suitable sample for this study. Fleiss' Kappa coefficient was calculated to assess the reliability of binary-response items, and descriptive statistics were used to evaluate the effectiveness of techniques across three stages: problem identification, analysis, and solution development. Thematic analysis of open-ended responses identified key themes and student perceptions, further enriching the findings. Findings from all data sources were synthesized to propose a structured urban problem-solving framework that integrates insights from the literature, case study applications, and empirical validation results.

4. Results

In this section, the questionnaire was designed to evaluate problem-solving techniques based on the opinions of 31 students. The participants were selected based on their expertise in using these techniques during their projects. The primary purpose was to gather students' insights into the applicability and effectiveness of these techniques in addressing urban challenges. The questionnaire consisted of two main sections.

4.1. Structured questions

In Structured Questions, respondents evaluated the effectiveness of 12 techniques across the three stages of problem-solving using a binary scale ("Yes" or "No"). Table 5 demonstrates a quantitative evaluation of techniques across the three stages of what, why, and how. The overall status shows that the average proportion of agreement (Pi) for all techniques is 0.89, indicating high response consistency. Moreover, the average proportion of 'yes' responses is 0.37, and 'no' responses are 0.63, indicating limited endorsement of the techniques at certain stages.

Analyze techniques based on their effectiveness:

- High effectiveness (80%-100% of yes): Five Whys (Why), Journalists (What), Discovery and action dialogue (How), Agreement certainty matrix (what), Mind map (What), Goal tree (How), Impact and effort matrix (How) and Causal loop diagram (Why), Problem tree (Why), World café(How), SWOT analysis (What), World café(What).
- Moderate effectiveness (50%-80% of yes): Fishbone analysis (Why), and Problem Tree (What).

Fleiss' Kappa is a statistical measure that assesses the agreement among more than two respondents, particularly in studies where responses are categorized, such as "Yes" or "No." The Kappa value of 0.77 indicates substantial agreement (Table 5) among participants regarding the effectiveness of different problem-solving techniques in urban studies. This agreement regarding their responses provides assurances of the dependability and validity of the collated data.

Table 5. Analysis of structured questions

Technique	Stage	Yes	No	Proportion Yes	Proportion No	Pi (Agreement) (Proportion Yes)^2 +(Proportion No)^2
The 5 Whys	What	0	31	0.00	1.00	1.00
	Why	31	0	1.00	0.00	1.00
	How	0	31	0.00	1.00	1.00
Fishbone analysis	What	5	26	0.16	0.84	0.73
	Why	24	7	0.77	0.23	0.65
	How	0	31	0.00	1.00	1.00
SWOT analysis	What	25	6	0.81	0.19	0.69
	Why	3	28	0.10	0.90	0.83
	How	3	28	0.10	0.90	0.83
Journalists	What	31	0	1.00	0.00	1.00
	Why	0	31	0.00	1.00	1.00
	How	0	31	0.00	1.00	1.00
Problem tree	What	24	7	0.77	0.23	0.65
	Why	26	5	0.84	0.16	0.73
	How	0	31	0.00	1.00	1.00
Goal tree	What	1	30	0.03	0.97	0.94
	Why	0	31	0.00	1.00	1.00
	How	29	2	0.94	0.06	0.88
World café	What	25	6	0.81	0.19	0.69
	Why	0	31	0.00	1.00	1.00
	How	26	5	0.84	0.16	0.73
Discovery & action dialogue	What	2	29	0.06	0.94	0.88
	Why	1	30	0.03	0.97	0.94
	How	30	1	0.97	0.03	0.94
The Impact and effort matrix	What	0	31	0.00	1.00	1.00
	Why	3	28	0.10	0.90	0.83
	How	29	2	0.94	0.06	0.88
Agreement certainty matrix	What	30	1	0.97	0.03	0.94
	Why	0	31	0.00	1.00	1.00
	How	1	30	0.03	0.97	0.94
Causal loop diagram	What	2	29	0.06	0.94	0.88
	Why	29	2	0.94	0.06	0.88
	How	1	30	0.03	0.97	0.94
Mind map	What	30	1	0.97	0.03	0.94
	Why	2	29	0.06	0.94	0.88
	How	1	30	0.03	0.97	0.94
Average				0.37	0.63	0.89
Po (observed agreement) = average (Pi Column)						0.89
Pe (expected agreement) = (average proportion yes)^2+(average proportion no)^2						0.53
Fleiss' Kappa = (Po–Pe) ÷ (Pe -1)						0.77

4.2. Semi-Structured questions

This section presents participant insights and suggestions for improvement. Based on Table 6, the semi-structured questions provide a qualitative evaluation of problem-solving techniques in urban projects. According to the findings, most respondents reported significant improvements in their ability to solve problems, particularly in reducing complexity and enhancing the quality of their decisions.

Table 6. Analysis of semi-structured questions

Semi-structured questions	Summary of results
Impact of techniques in the problem-solving process	Yes: 23 people (74%) Somewhat: 8 people (26%)
Impact of techniques on reducing complexity	Yes: 21 people (68%) Somewhat: 7 people (23%) No: 3 people (9%)
Most effective techniques in urban projects	SWOT analysis (21 mentions), 5 Whys (21 mentions), Mind map (12 mentions)
Combination of techniques for greater effectiveness	Suggested combinations: 5 Whys + SWOT analysis (12 times) 5 Whys + Goal tree + SWOT analysis (11 times) 5 Whys + Problem tree + Mind map (10 times)
Techniques for teaching students	SWOT analysis (18 times), 5 Whys (17 times), Mind map (10 times), Problem tree (9 times), World café(8 times)

The finding indicates that problem-solving techniques are effective in solving urban challenges. The five whys are identified for their ability to enhance decision-making. The agreement in participant responses (Kappa value: 0.77) supports the reliability of the findings. These results support an integrated, adaptable approach to urban problem-solving.

5. Discussion

Based on the data extracted from the results, Table 7, "Urban problem-solving framework," outlines a structured approach to addressing urban challenges. It organizes the problem-solving process into four stages: problem identification, problem analysis, solution development, and evaluation and feedback. Each stage emphasizes objectives, tools, techniques, and expected outcomes. For example, tools like SWOT analysis and GIS-based mapping are suggested to ensure comprehensive problem definitions and analyses. This structured methodology balances quantitative methods (e.g., data analytics) and qualitative approaches (e.g., stakeholder engagement).

Table 7. Urban problem-solving framework

Problem-solving process	What? Problem identification	Why? Problem analysis	How? Solution development	Evaluation and feedback
Objective	Define comprehensive, clear problems by considering different perspectives and contexts.	Investigate root causes and system interconnections to understand why the problem exists.	Generate inclusive solutions that consider creative approaches, feasibility, phased implementation, and stakeholder impact.	Develop pilot programs to evaluate the effectiveness of proposed solutions.
Tools, Techniques	SWOT, Journalists, Mind map, World café, Agreement Certainty matrix	The 5 Whys, Problem tree, Fishbone analysis, Causal loop diagram	World café, Discovery & action dialogue (DAD), The Impact and effort matrix, The Goal tree, Agreement certainty matrix	
	Using stakeholder and public input, GIS analysis, and spatial data analysis	Integrate quantitative methods (such as data analytics and GIS-based mapping) with qualitative approaches.	Scenario modelling for predictive analysis conducts regular public and stakeholder engagement, community consultations, and educational campaigns.	
Outcomes	A complete and accurate problem definition that considers stakeholder concerns and the spatial context into account	A comprehensive recognition of the problem, root causes, and interdependencies	Their effectiveness and practicality sort out a varied collection of possible solutions.	Validated and evaluated solutions using data-driven analysis regarding their potential for success.

Table 8, "Problem types and solution techniques framework," examines techniques and methods for addressing various types of problems, including simple, complex, ill-defined, social, ethical, and wicked problems. Each category encompasses "What" (problem identification), "Why" (problem analysis), and "How" (solution development), with specific techniques tailored to the complexity and nature of the issue. This part employs cognitive epistemic purposes (e.g., description, explanation, understanding, and change) in conjunction with structured problem-solving stages (what, why, how) to align specific techniques with urban problem types, utilizing questionnaire data, case study analysis, and theoretical literature.

Table 8. Problem types and solution techniques framework

Type of problem	What (epistemic purpose + technique	Why (epistemic purpose + technique)	How (epistemic purpose + technique)
Simple or well-defined problems	Description: Mind map (83% agreement): organizes problem components visually, particularly in micro-scale projects.	Explanation 5 Whys (100% agreement): identifies root causes and is highly effective in the Micro-scale studies.	Evaluation Impact-Effort matrix (88% agreement): Prioritizes feasible solutions efficiently.
Complex problems	Description & exploration: Mind map + SWOT analysis (70% agreement): Explores systemic factors, especially in a micro-scale project	Explanation 5 Whys+ Problem tree (73% agreement): Identifies hierarchies of causes and effects for better clarity, especially in a micro-scale project	Evaluation & change Impact-effort matrix+ Goal tree (88% agreement): Breaks complex objectives into actionable steps. Collaborative idea generation and exploration

Type of problem	What (epistemic purpose + technique	Why (epistemic purpose + technique)	How (epistemic purpose + technique)
Ill-defined problems	Description & exploration: Mind map+ SWOT analysis+ Journalists (100% Agreement): Frames unclear problems with structured narratives, especially in a micro/meso-scale project	Explanation & understanding 5 Whys+ Problem tree+ Fishbone analysis (65% agreement): analyzes indirect causes, especially in micro- and meso-scale studies.	Evaluation& Change Impact-effort matrix+ Goal tree+ Discovery & action dialogue (94% agreement): Encourages participatory resolution of ethical challenges. Highly effective in micro/meso-scale studies.
Social problems	Description & Exploration& prediction: Mind Map+ SWOT analysis+ Journalists+ Stakeholder engagement: Identifies the problem through collaborative input, highly effective (Table 4). Meso-scale	Explanation& understanding 5 Whys+ Problem tree+ Fishbone analysis Causal loop diagram (88% agreement): Examines policy and social interconnections	Evaluation& Change Impact-effort matrix+ Goal tree+ Discovery & action dialogue+ World café (73% agreement): Generates inclusive strategies with broad stakeholder input.
Ethical or moral problems	Description, exploration & prediction: Mind map+ SWOT analysis+ Journalists	Explanation& understanding 5 Whys+ Problem tree+ Fishbone analysis Causal loop diagram	Evaluation& Change Impact-effort matrix+ Goal tree+ Discovery & action dialogue+ World Café
Wicked problem	Description & exploration& prediction Mind map+ swot analysis+ journalists+ World café(70% agreement): fosters understanding of stakeholder priorities Agreement certainty matrix (94% agreement): balances technical and adaptive approaches. Problem tree (65% agreement): maps complex issues Stakeholder engagement: Identify problems from a wide perspective. Visualization tools and techniques (e.g., system diagrams): illustrate relationships	Explanation& understanding& evaluation 5 whys+ Problem tree+ Fishbone analysis Causal loop diagram	Evaluation & change & impact assessment Impact-effort matrix+ Goal tree+ Discovery & action dialogue+ World café+ Scenario modelling: develops dynamic, long-term strategies.

6. Conclusion

Urban environments show complex challenges that require creative and multidimensional problem-solving approaches. This research highlights the importance of structured problem-solving processes, encompassing the entire spectrum from problem identification to solution implementation and evaluation. The results emphasize that effective urban problem-solving should use balanced technical accuracy. The framework developed in this study is based on a systematic literature review, case study analysis, and data from students with hands-on experience in planning studios. The analysis of case studies, ranging from micro-scale, showed that projects employed creative strategies; however, the use of problem-solving techniques

remained limited, uncreative, and often unstructured. Many interventions relied on singular methods without a clear connection between the problem types and the selected tools. This gap highlights the need to develop a framework that categorizes problems and aligns them with epistemic purposes and appropriate techniques, informed by data from questionnaires and case analysis. SWOT analysis, Fishbone diagrams, Mind mapping, and World café were selected based on their effectiveness scores and flexibility across urban contexts. These techniques help to have a better understanding, enhance creativity, and provide suitable solutions. Notably, the use of both qualitative and quantitative methods is essential. Tools and techniques, such as GIS mapping and scenario modeling, are combined with stakeholder workshops and public engagement to enhance the acceptance and adoption of these approaches. In conclusion, the problem-solving framework enhances understanding and serves as a practical tool for tackling urban challenges. While the suggested urban problem-solving framework could be useful, cities with different governance systems, varying resource availability, and distinct contexts require sensitivity to their unique contexts. Other administrative or stakeholder engagement strategies could impact the effectiveness of the framework. As a result, a successful application depends on contextual adaptation and awareness of local conditions. Future studies should examine specific adjustments and approaches to identify these obstacles, guaranteeing the framework's adaptability and applicability in urban contexts.

Disclosure statement

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