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URBAN TECHNICAL INFRASTRUCTURE IMPACT ASSESSMENT METHODOLOGY FOR PLANNING DECISIONS DEPENDING ON TURKISH LEGISLATIVE FRAMEWORK

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Abstract

Introduction. This article is positioned theoretically at the intersection of four keywords: urban planning, urban renewal, impact assessment, and technical infrastructure. Studies aiming to measure “impacts on technical infrastructure” are quite rare and tend to focus exclusively on national-level critical infrastructure, ignoring the local / urban scale. Filling this gap, **this article specifically aims** to propose an Urban Technical Infrastructure Impact Assessment (UTIIA) methodology to measure the impacts of changing planning decisions on drinking water, sewage, and rainwater systems, addressing a decision dichotomy (whether a planning decision constitutes a plan amendment or a plan revision) that is particularly common for urban renewal applications in the Turkish planning experience.

Keywords: urban technical infrastructure impact assessment; urban renewal; plan amendment; plan revision; technical infrastructure.

Introduction

Bridging Urban Planning, Technical Infrastructure and Impact Assessment

Today, 55.3 % of the world’s population lives in urban settlements. The UN predicts that this figure will reach 68.4 % by 2050 (UN, 2018).

Parallel to the spatial demands of such an exponentially increasing urban population, two simultaneous phenomena are observed: on one hand, densification of existing built-up areas, transformation / land-use change of unbuilt areas, and changes to urban social infrastructure areas within the existing urban fabric; on the other hand, urban spatial expansion beyond existing settlement boundaries.

In this context, while resource management of cities — where huge populations concentrate — becomes a major topic, the management of natural resources, public investments, and assets (including social and technical infrastructure facilities) emerges as related subtopics.

From the same perspective, urban sprawl is characterized and criticized in terms of inefficient use of urban technical infrastructure investments within the planning literature of various geographies. As an antidote, the keyword “urban compactness” is being informed by carrying capacity and life-cycle assessment arguments of existing infrastructure investments and facilities. Achieving enriched urban environments in terms of quality of life is only possible and depends on a measurable compatibility between impact assessment-driven decision-making processes and existing technical infrastructure investments. It is also worth mentioning that aiming for efficient use of urban technical infrastructures as public investments is the main idea of this article.

Departing from this idea and grounding it in the current Turkish planning system, this paper proposes an impact assessment methodology to measure the impacts of changing planning decisions on urban technical infrastructure systems. This methodological proposal reflects the major findings of a research project on a regulation proposal for infrastructure impact assessment, carried out for the Turkish Ministry of Development (Ağaçcıoğlu et al., 2017).

The keywords urban planning, urban renewal, technical infrastructure, and impact assessment each have a massive literature. Due to the subject and intention of this article, a literature review and gap analysis is carried out by examining double and multiple intersections of these keywords.

Zone 1: Urban Planning, Renewal and Impact Assessment Relation

When the urban planning literature is refined by intersecting urban renewal and impact assessment keywords (Fig. 1 — Zone 1), it is observed that studies under this subtopic show a fragmented nature in terms of their subject matter.

Chan (2017) investigates the social impact assessment of an urban renewal project from a “right

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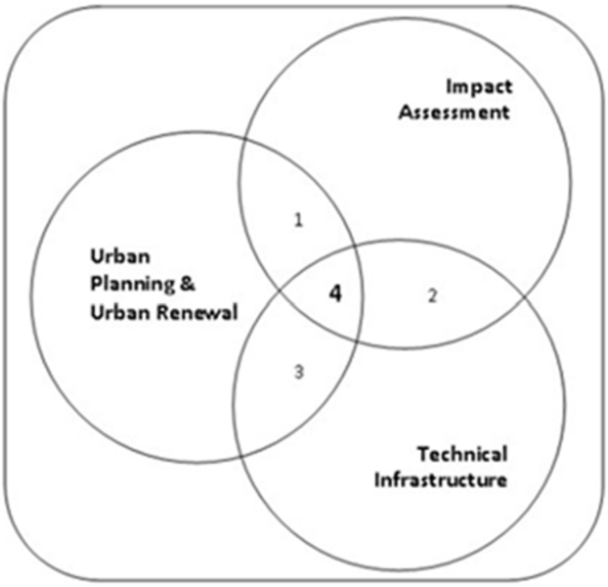

Fig. 1. Literature Review Fields

to the city" perspective, while Cheung and Leung (2008) try to clarify the effects of urban renewal on quality of life by considering subjective quality of life parameters, and Amis (2001) evaluates the impacts of a slum improvement project in India. Quite differently, linking the subject to mega-projects, Forouhar and Hasankhani (2018) examine local resident satisfaction with an urban renewal mega-project developed as a public-sector renewal intervention; Park et al. (2016) concentrate on risk factor evaluation of mega-projects; Lawanson and Agunbiade (2018) evaluate the social and environmental effects of a mega-project on indigenous communities; while Parkes, Lettieri, and Bogle (2016) propose an environmental impact assessment model based on an Olympic Park case study considering the construction, staging, and post-event phases of the mega-event. Consequently, it can be said that impacts of various projects of different scales and themes play a pivotal role in this literature.

Zone 2: Impact Assessment and Technical Infrastructure Relation

The relationship between impact assessment and technical infrastructure (Fig. 1 — Zone 2) hosts the widest and most diversified literature. From this perspective, Bonnel et al. (2002) aim to highlight the direct and indirect effects of transportation infrastructure investments in 13 European cities, while Chia et al. (2016) explore the linkages between environmental impact assessment and project process integration, professional governance, and public engagement in three transportation projects. El-Gafy et al. (2011) focus on environmental impact assessment of three plan alternatives for a transportation project, and Wu et al. (2014) measure the impacts of a highway project on landscape and ecosystems. Mahmood and Keast (2016) introduce a new methodology to measure the probable impacts and applicability of a large-scale (bridge) infrastructure project. Within the same literature, while Monzón et al. (2013) measure the spatial equity impacts of a high-speed railway investment using accessibility as a lens, Mottee and Howitt (2018) similarly focus on the social impacts of a new rail link, and Dimitriou et al. (2015) explore the economic impacts of a mega-infrastructure pipeline project.

In this bounded literature, "critical infrastructure" appears as a major keyword, referring to important infrastructure serving national and international scales. The fundamental ideas of these studies are risk assessment and precautionary actions / policies against natural threats (such as flooding, earthquakes, typhoons). Pant et al. (2018), for instance, propose a multi-dimensional infrastructure failure assessment methodology against flooding for national critical infrastructures (including electricity, airports, telecom masts, water towers, and wastewater treatment facilities) in the Thames catchment area. Very closely, while Emanuelsson et al. (2014) explore flood risk assessment for infrastructure networks, Neumann (2011) links urban planning to critical infrastructure in the context of sustainability.

In summary, this specific literature either concentrates on the impacts of infrastructure projects using tools such as environmental impact assessment (EIA) (El-Gafy et al., 2011; Chia et al., 2016; Paudel et al., 2025; Raafat et al., 2026), social impact assessment (SIA) (Mottee and Howitt, 2018), or economic impact assessment (Dimitriou et al., 2015), or shows a clustering around the "critical infrastructure" keyword (Pant et al., 2018) and deals with the resilience of technical infrastructures against natural risks (VROM, 2006) or related assessment methodologies (Emanuelsson, 2014).

Zone 3: Urban Planning, Renewal and Technical Infrastructure Relation

Starting in the late 1980s, the literature at the intersection of these keywords (Fig. 1 — Zone 3) mostly views technical infrastructure rehabilitation (and upgrading) as a tool component of urban renewal. For instance, Button and Pearce (1989) develop a cost-benefit analysis of infrastructure restoration for an urban revitalization project from an economic perspective. Similarly, Olanrewaju (2001) aims to evaluate the planning and implementation of infrastructure upgrading based on Urban Renewal Board studies in Badia (one of the low-income settlements in Lagos). From a different perspective within the same literature, Garrido-Jiménez, Magrinyà, and Consuelo del Moral-Ávila (2018) perform technical infrastructure calculations to assess economic outcomes in terms of municipal operating costs and revenues for diversifying urban patterns.

Partly similar to this article's point of view, while Hunt and Rogers (2005) explore a city center revitalization project solely in terms of its new water and energy demands considering sustainable solution options, Grimaldi et al. (2017) take the missing link between urban plans and water infrastructure planning as their departure point, comparing the relationships between regulatory and planning instruments. Neumann (2011) discusses the relationship between urban planning and infrastructure network planning through the lenses of life cycle / demand-capacity approach, demand management, and infrastructure demand assessment.

Very parallel to this last subset of articles, this study aims to propose an impact assessment methodology to systematically measure the impacts of planning decisions on urban technical infrastructure. However, beyond this general aim, the study introduces several original and innovative contributions that distinguish it from the existing body of literature.

First, it conceptualizes infrastructure not merely as an outcome of projects, but as a dynamic system that is directly shaped by planning decisions, thereby shifting the analytical focus from "impacts of infrastructure projects" to the largely neglected question of "impacts on infrastructure systems caused by spatial planning interventions". This reframing aligns with the "networked infrastructure" perspective of Graham and Marvin (2001), who argue that urban infrastructure is a dynamic socio-technological configuration reconfigured by planning and policy.

Second, the study develops a multi-dimensional and integrative assessment framework that simultaneously brings together urban renewal, impact assessment, and technical infrastructure within a single analytical model — an intersection that remains underexplored in current research. In this sense, the study occupies a distinct position in Zone 4 (Fig. 1), moving beyond fragmented approaches that typically address these domains in isolation. This integrated approach addresses what Tschupp et al. (2025) describe as the "siloed sector" problem, where a lack of cross-sectoral coordination leads to critical infrastructure bottlenecks during urban development.

Third, and more importantly, the proposed methodology introduces a novel operational mechanism based on the concept of "infrastructure tolerance / carrying capacity", which enables the quantification of whether a planning intervention can be accommodated within existing infrastructure systems or necessitates comprehensive plan revision. This capacity-based threshold approach transforms impact assessment from a descriptive or ex-post evaluation tool into a decision-support mechanism for ex-ante planning governance.

Furthermore, while the current literature predominantly focuses either on (i) the impacts of urban projects, mega-projects, and mega-events without explicitly addressing their consequences for infrastructure systems, or (ii) the impacts of infrastructure projects themselves — often at national or critical infrastructure scales — this study uniquely contributes by operationalizing impact assessment at the local / urban scale, where planning decisions and infrastructure capacities most directly interact. In doing so, it also bridges an important institutional and methodological gap between strategic-level assessments (such as SEA) and project-level assessments (such as EIA), which typically overlook local land-use planning processes. As noted by Partidário (2023), this "tiering" gap often leaves local planning decisions without a systematic assessment of their cumulative environmental and physical impacts.

Finally, the proposed UTIIA methodology is grounded in the specific legislative and planning context of Turkey, yet it offers a transferable analytical framework that can be adapted to other planning systems facing similar challenges of infrastructure capacity, urban renewal pressures, and fragmented decision-making.

Departing from these identified gaps and limitations in the existing literature, this article therefore not only proposes a new assessment methodology but also contributes a conceptual reframing, methodological innovation, and decision-oriented toolset for integrating infrastructure considerations into planning practice.

Changing Landscape of Impact Assessment and Positioning Infrastructure Impact Assessment within the Current Literature

After the wide-ranging use of project-level EIA, a growing number of assessment tools has been observed in the literature. Some relatively new assessment types that play a pivotal role include: Social Impact Assessment (Vanclay, 1999; Vanclay, 2002), Post-Disaster Impact Assessment, Demographic Impact Assessment, Economic Impact Assessment, Equality Impact Assessment, Gender Impact Assessment, Climate Impact Assessment, Cultural Impact Assessment, Cultural Heritage Impact Assessment, Cumulative Impact Assessment, Health Impact Assessment, Human Rights Impact Assessment, Socio-economic Impact Assessment, Sustainability Assessment, and Transportation Impact Assessment (Glasson et al., 2012; Morgan, 2012; Özügül, 2023).

Such a diversification and specialization trend can be seen as a result of demand for a more comprehensive scope, better integration, and a more extensive scale both in practical and theoretical grounds. The model presented in this article, parallel to some recent studies (Wang et al., 2020), summarizes the implementation guideline of a new and special type of assessment not currently found in the literature and focuses on an urban-scale “infrastructure impact assessment”.

Hamada (2015) conceptualizes urban infrastructure facilities as lifeline systems supporting the protection and sustainability of human life in cities and classifies these systems under four subtopics:

1. Water supply and purification systems: including water, sewage, and river facilities.
2. Energy systems: including electric power, gas and liquid fuels, and local cooling / warming.
3. Information and communication systems: including telephone, information, and broadcast facilities.
4. Transportation systems: including roads, railroads, ports, and airports.

A similar categorization is accepted as a starting point, and evaluation of the impacts of planning decision changes on sanitation, sewage and rainwater systems, transportation systems, and electricity infrastructure is aimed for the proposed model.

Transforming Planning Agenda in Turkey

Since 1993, the mainstream assessment route of Turkey has been dominated by project-based EIA practices. Just after the approval of a new regulation on Strategic Environmental (Impact) Assessment (SEA) in 2017, plans, policies, and programmes became subject to an obligatory impact assessment process. Under this regulation, the plans covered are strategic and sectoral plans (tourism master plan, transportation plan, etc.), management plans (watershed and river basin management plan, etc.), and socio-economic and mezzo-scale spatial plans (regional plans, environmental master plan, etc.)[1]. Within this context, local plans that define land uses, population, densities, and spatial rules fall outside the coverage of assessment systems. Departing from this point, local spatial plan assessment appears as a clear gap and grey area between the scopes of SEA and project-led EIA.

To clarify the relationship between planning and impact assessment practices, it would be better to define the (hierarchy of) the current comprehensive planning system of Turkey on one hand, and the contradictory nature of planning decisions — which becomes more visible in current discussions on transforming planning trends (such as urban renewal, mega-projects, etc.) also causing uncertainties — on the other.

Contours of the Current Planning System

According to the current legislative context, Turkey’s planning system has a hierarchical structure starting from the national level (Table 1). As upper-level instruments, National Development Plans (macro-scale socio-economic plans defining sectoral policies and investments within a five-year period) and National Spatial Strategy Plans (orienting spatial strategies, infrastructure, transport, and other spatially relevant investments and decisions) are foreseen. These national plans are to be complemented by regional-level plans, namely: Regional Plans (which are not obligatory and are supposed to combine national-level aims, objectives, and policies with regional strategies and decisions) and Territorial Spatial Strategy Plans (which can be prepared at varying regional scales and reflect decisions at the regional territory) (OECD, 2017; Özügül et al., 2017).

Functioning as mezzo-scale plans, Land Development Plans have the same geographical scope as Territorial Spatial Strategy Plans. These plans are used to guide lower-level land-use plans in terms of defining main decisions about settlement, development zones, and sectoral relations.

At the local (urban) level, there are two types of land-use plans. Being the first type, Master (Land Use) Plans’ conformance to Land Development Plans is a legal obligation. Master (Land Use) Plans organize the location and growth directions of settlements and main urban functions (residential, commercial, industrial zones, urban facilities, urban technical infrastructure, etc.) and the spatial

Table 1. **Plan Hierarchy in Turkish Planning System**

Level	**Plans**	**Scale**	**content**	**Institution**
National	National Development Plan	No scale	Socio-economic	Presidency of Strategy & Budget
	National Spatial Strategy Plan	1/250,000; 1/500,000 or more	Spatial	
Regional	Regional Plans	No scale	Socio-economic	Presidency of Strategy & Budget Regional Development Agencies Ministry of Environment and Urban
	Territorial Spatial Strategy Plan	1/100,000; 1/50,000	Spatial	
Sub-regional (city and its	Land Development Plans	1/100,000; 1/50,000; 1/25,000	Spatial	Ministry of Environment and Urban Planning
Urban	Master (Landuse) Plans	1/10,000; 1/5,000	Spatial	Metropolitan City Municipalities (Provincial) Governorships
	Implementation Plans	1/1,000	Spatial	Local Municipalities

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[1] http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=7.5.23492&MevzuatIliski=0&sourceXmlSearch=Stratejik%20%C3%87evresel%20De%C4%9Ferlendirme%20Y%C3%B6netmeli%C4%9F.

distribution of population density. Determining the spatial reflections (both 2D and 3D) of general decisions of Master / Land Use Plans, Implementation Plans (as the second type of local plan) must show conformance to them.

In addition to this top-down legally binding hierarchical planning structure — which is the main route of planning for the Turkish case — a paradigmatic shift toward strategic planning has been observed since the 2000s. As a result of this shift, sectoral and special plans such as Tourism Master Plans, Agriculture Master Plans, Coastal Zone Management Plans, Transportation Master Plans, Watershed Management Plans, Earthquake Risk and Mitigation Plans, etc., have emerged within the planning agenda as non-obligatory strategic types of plans (İbişoğlu and Özügül, 2022; Yılmaz and Alkan, 2024; Yılmaz et al., 2023).

From "Urban Planning" to "Urban Renewal"; Growing Infrastructure Uncertainties

The above-mentioned urban land-use plans, which are prepared by local municipalities, must be holistic and consistent due to the current Turkish legislative system. On the other hand, besides sectoral and special plans, most urban mega-projects (mostly decided by the central government) and urban renewal projects (central government or local municipality projects) can be major drivers of deformation of the integrity and consistency of these local plans.

Within the scope of this study, the integrity and consistency problem will be examined through the impacts of planning decisions on urban technical infrastructure (including sanitation, sewage and rainwater systems, transportation systems, and electricity infrastructure). As is well known, urban technical infrastructure systems are planned and designed in accordance with the projections of a given urban system's future demands, and local (urban) plans are the base documents for these projections. While master plans direct urban space primarily through density and land-use decisions, implementation plans convert these decisions into built environment values (floor area ratio, total construction area, building heights, etc.). Considering the interdependent nature of local plans and infrastructure investments, unless urban mega-projects and renewal projects are developed in an integrative manner (in terms of land-use and density conformity between these projects and their vicinity), great infrastructure uncertainties will be created. From this perspective, Fig. 2 represents the hypothetical uncertainty patches in a holistic urban plan.

Consequently, once an urban mega-project or a renewal project is introduced into the land-use plan of a given territory, three probable paths emerge for the adaptation of these external and individual projects to the current plan: first, making a new plan (if an essential change in the planning problematic is observed); second, revising the existing holistic land-use plan in accordance with these projects (if the main aims and objectives of the existing plan remain but the holistic calculations must be revised to sustain the quality of urban space); and third, making partial amendments to the existing plans (if the effects are minor). Also, depending on the related national legislative documents, the proposed model particularly aims to calculate the magnitude of the effect caused by the planning decision on the

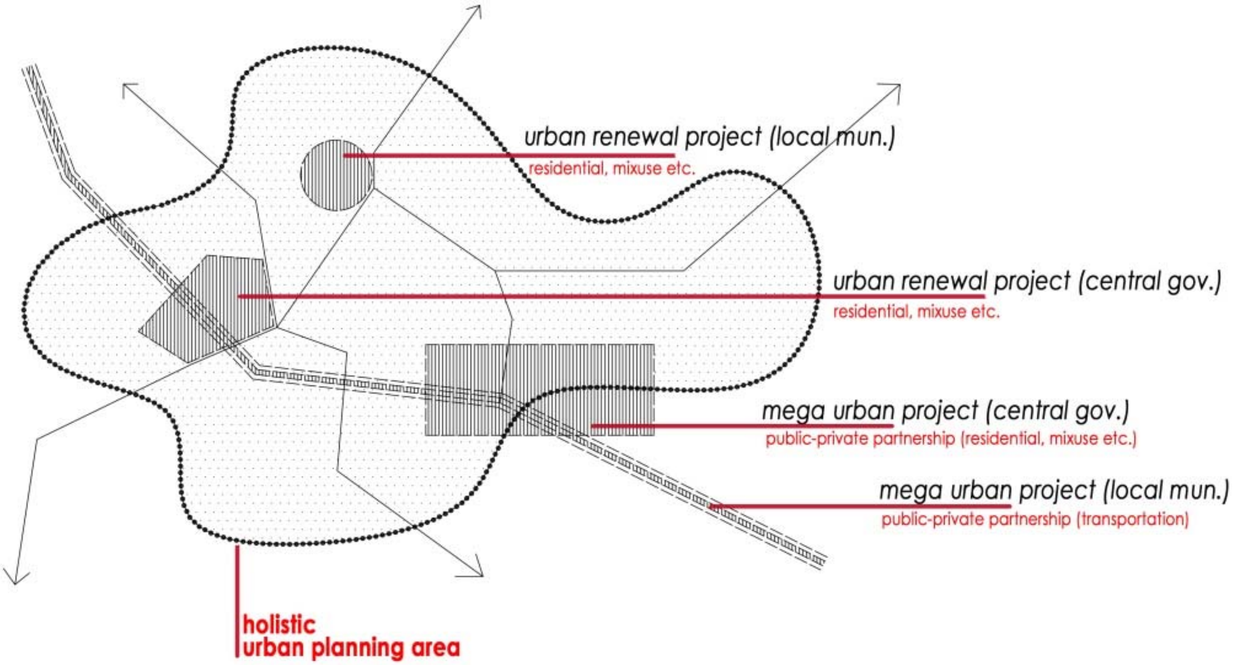


Fig. 2. Uncertainty Patches in a Holistic Urban Plan

existing technical infrastructure on the one hand, and to serve in deciding the correct path on the other.

Methodology

The method used in developing the impact assessment model proposed in this article is the focus group. A focus group is a "non-standard technique for information gathering based on an apparently informal discussion among a group of people selected on the basis of specific characteristics, outlined according to the cognitive purposes of the research" (Acocella and Cataldi, 2021). What makes the focus group technique — in which qualitative data is obtained through group discussions — unique is its ability to generate data and information that is difficult to access outside the interaction and participation environment used in this technique (Morgan, 2019). First used in the behavioral sciences, the technique has been used for almost 100 years in a wide range of scientific fields such as education, sociology, communication, health sciences, organizational behavior, program evaluation, psychotherapy, social psychology, gerontology, political science, policy research, sociology, anthropology, information systems, management, and marketing (Stewart and Shamdasani, 2015).

Although it is stated that a group size of 6–8 people is generally optimal (Bloor et al., 2001), 2–5 experts can also be used in "mini focus group" type applications consisting of high-level experts (Ochieng et al., 2018).

In developing the impact assessment model that is the subject of this article, the focus group technique was used in two main research stages. The first stage involved identifying the possibilities and limitations of planning, the impact of urban renewal on technical infrastructure, and the "current state" of the impact assessment system in Turkey. The second stage was the "strategic decision and model generation" stage, where the structure and parameters of the infrastructure impact assessment model were determined.

A total of seven participants from the following disciplines took part in regular weekly focus group meetings for one year: Drinking Water, Sewage and Rainwater (three expert participants), Energy and Communication (one expert participant), Urban and Regional Planning (two expert participants), and Transport (one expert participant). Furthermore, two focus group meetings were conducted with representatives of two directly relevant public institutions, namely the Istanbul Water and Sewerage Administration (ISKI) and Ilbank Inc. (ILBANK). The findings of the aforementioned meetings are presented in the section titled "Model Abstraction" of this paper, while the conclusions regarding the model parameters are outlined in Table 2. It presents only those parameters identified for the categories of drinking water, sewage, and rainwater infrastructure, which fall within the scope of this paper. The parameters predicted to have direct and significant effects on the implementation detail of the model are taken as the basis for further consideration.

Urban Technical Infrastructure Impact Assessment Model Proposal (UTIIA)

Model Abstraction

Before introducing the proposed model, basic related concepts need to be explored. Conceptually, any change that does not contradict main plan decisions, deform plan holisticity, or cause urban infrastructure deficiencies (in the existing plan) could be defined as a "plan amendment" (minor changes in a plan without a major revision). On the other hand, if an external plan decision causes a major negative impact regarding the three above-mentioned threats, "plan revision" (by which a major revision of the whole plan is meant) appears as the major plan instrument.

The main function of the proposed UTIIA model is to orient decision-makers to differentiate planning amendments from planning revisions. To distinguish planning amendments from planning revisions using this model, "tolerance level" must be calculated as the measurable threshold of a planning amendment. In other words, the tolerance level is limited by the carrying capacity of the planned urban technical infrastructure systems. Any plan decision tolerated

Table 2. **Parameters derived from focus group findings**

Infrastructure category	Parameters	
	Direct & Significant	**Indirect & Ignorable**
Drinking Water Infrastructure	Current land-use type, planned land-use type, population density and FAR (Floor Area Ratio) as basic determinants of population	Climate, socio-economic structure, losses and leakages, water consumption per capita, fire flow, emergency needs, type of water distribution (topography, pumping)
Sewage Infrastructure	Current land-use type, planned land-use type, population density and FAR as basic determinants of population	Slope of terrain and road, climate and underground water level, socio-economic structure, size of drainage basin
Rainwater Infrastructure	Size of drainage area, BCR (Building Coverage Ratio), vegetation, ground permeability, slope, population, current land-use type, planned land-use type	Socio-economic structure, distance to the discharge point

by the planned infrastructure capacity could be accepted, while any excessive planning decision implies a plan revision.

The proposed model works in a stepwise manner, and the outline of the steps is presented below (Fig. 3).

Step 1: “Determination of the planned infrastructure capacities” due to population and land use.

Step 2: “Determination of the proposed change in master land-use plan and / or related implementation plan”. The main question in this step to answer is: what changes in the holistic (original) plan / plans according to proposal?

Step 3: “Determining technical infrastructure impacts of the proposed changes”. Within this step, the proposal’s content and technical infrastructure categories are related in terms of predicted impact types (no impact, indirect impact, direct impact).

Step 4: “Calculating impacts of the proposal on each technical infrastructure category in detail”. In this step, after the related additional technical infrastructure loads are calculated, a comparison is carried out between the planned capacity and the additional loads to determine whether the carrying capacities are exceeded or whether the planned capacities can tolerate the proposal.

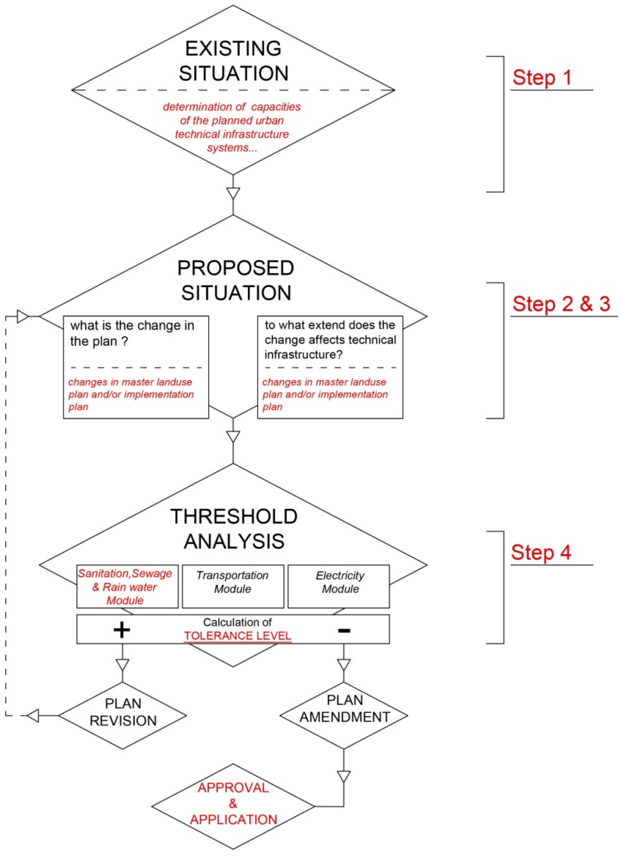


Fig. 3. The Main Structure of the Proposed Model

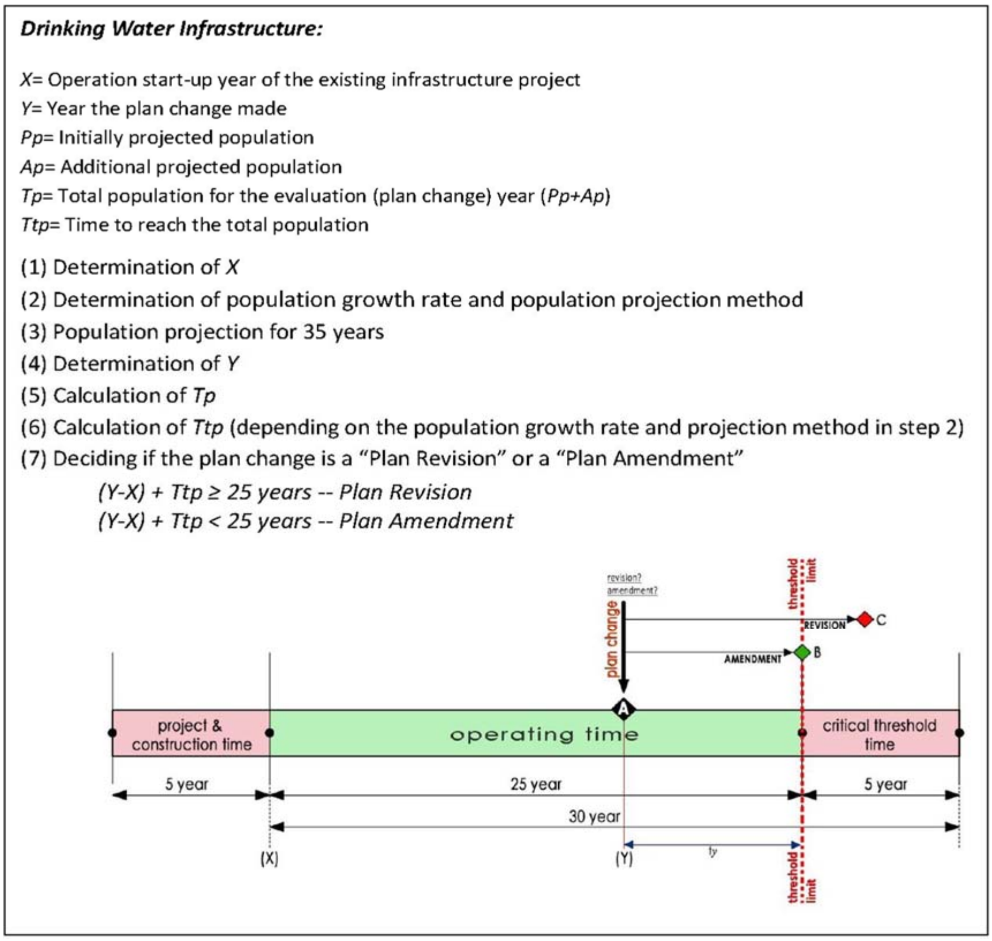
In the following section, impact calculation details (which are the tools to measure the magnitudes of the impacts) are presented for drinking water, sewage and rainwater systems.

Calculation Details and Components of the Model

While calculating the impacts of a plan proposal on the drinking water system, the evaluation basically depends on an examination of whether the additional load of the proposal remains within the operating time of the existing infrastructure (which is 25 years) or not.

Here, the time to reach total population (T_{tp}) and additional projected population generated by the proposal (A_p) play a pivotal role. Within this evaluation process, the operation start-up year of the existing infrastructure project (X), population growth rate and projection method, a 35-year population projection, and the year the plan change was made (Y) are needed and should be determined as baseline information. Total population is the sum of the initially projected population (P_p) of the given area for which the drinking water infrastructure was constructed and the additional projected population (A_p) generated by the plan change. Time to reach total population should be calculated according to population growth rate and projection method assumptions given in the national regulations on drinking water and wastewater systems. To decide whether the plan change should be accepted as a “plan revision” or a “plan amendment”, the duration calculated by the formula (Y–X) + T_{tp} (see Table 2 for stepwise calculation details) must be compared with the effective operating time (25 years) of the given site’s infrastructure. If the calculated duration is more than 25 years, the plan change could be accepted as a plan revision. Otherwise, the given case is a plan amendment where the impact on drinking water is tolerable and no additional public investment is needed (Fig. 4).

Impacts on sewage infrastructure should be evaluated in two main steps. The first step is the same calculation process as that carried out for drinking water infrastructure. The only difference is that the process proceeds to the second step if the calculated duration ((Y-X) + Ttp) is found to be less than 25 years (otherwise, the plan proposal is a plan revision). Within the second step, an additional verification emerges to determine whether the sewage channel can tolerate the additional load. To execute this step, the existing fill rate (He) and the diameter of the sewage channel (Dc) must be known. The fill rate of the sewage channel can be calculated as a function of these components ($Fr = He/Dc$), where 50 % of the channel fill rate is the critical threshold (Ht). As a result, if the sewage channel fill rate exceeds 50 %, the case can be



Drinking Water Infrastructure:

X= Operation start-up year of the existing infrastructure project
Y= Year the plan change made
Pp= Initially projected population
Ap= Additional projected population
Tp= Total population for the evaluation (plan change) year (*Pp+Ap*)
Ttp= Time to reach the total population

(1) Determination of *X*
(2) Determination of population growth rate and population projection method
(3) Population projection for 35 years
(4) Determination of *Y*
(5) Calculation of *Tp*
(6) Calculation of *Ttp* (depending on the population growth rate and projection method in step 2)
(7) Deciding if the plan change is a "Plan Revision" or a "Plan Amendment"

$(Y\text{-}X) + Ttp \geq 25$ *years -- Plan Revision*
$(Y\text{-}X) + Ttp < 25$ *years -- Plan Amendment*

Fig 4. Components and Calculation Details of Impacts on Drinking Water Infrastructure (Adapted from Ağaçcıoğlu et al., 2017)

designated as a plan revision; if not, the given plan proposal is a plan amendment (Fig. 5).

To calculate the infrastructure impacts of a plan proposal on the rainwater system, land-use decisions must be considered to find the average surface run-off coefficient of the urban environment. In the national "Regulation on Rainwater Collection, Storage and Discharge System", surface run-off coefficients are given for different land-use types. The higher these coefficients are, the lesser the additional load on the existing rainwater channel will be. Departing from existing land-use proportions, the average surface run-off coefficient and rainwater flow and fill rate of the rainwater channel, the calculation of the difference generated by the plan proposal on the same components will be performed for the given urban environment. At this point, it is worth mentioning that existing conditions must be determined because it is assumed that not all land-use coverage is changed by the plan proposal. Within this impact evaluation category, the fill rate of the rainwater channel (considering the plan proposal effects) (F_{rr}) is calculated by dividing the existing rainwater level (H_{erl}) by the channel diameter (D_{cr}). The obtained fill rate must be compared with the threshold level (given as 90 % in the same national regulation) to decide whether the plan proposal is a plan revision ($F_{rr} \geq H_{tr}$) or a plan amendment ($F_{rr} < H_{tr}$) (Fig. 6).

As a conclusive remark for this section, it is important to highlight that the proposed UTIIA model works as a stepwise process for each of the three given infrastructure impact categories. In other words, if the plan proposal implies a plan revision for any of the above-mentioned impact assessment categories, then the holistic result should be considered a plan revision by the planning authority.

Discussion and Conclusion

Parallel to neo-liberal critiques, the socio-economic and environmental impacts of urban (renewal) projects and mega-projects have been central discussions in the current urban policy and management literature throughout the last three decades. Starting in the 2000s, the impacts of infrastructure projects and, more recently, impacts on critical infrastructure have also been widely researched issues (Neumann, 2011; Emanuelsson et al., 2014; Pant et al., 2018). Recalling the relevant literature, Batouli and Mostafavi (2017) addressed the sustainability of infrastructure systems using

Sewage Infrastructure:

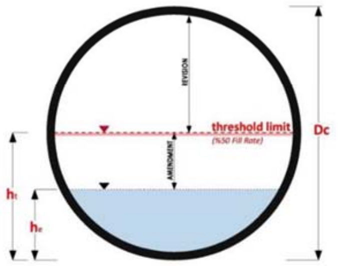
X= Operation start-up year of the existing infrastructure project
Y= Year the plan change made
Pp= Initially projected population
Ap= Additional projected population
Tp= Total population for the evaluation (plan change) year (*Pp+Ap*)
Ttp= Time to reach the total population
Ht= Threshold fill rate of a channel which is 50% [*]
He= Existent fill rate of a channel
Dc= Diameter of sewage channel
Fr= Fill rate of sewage channel (*He/Dc*)

1sth Step: Verification of Operating Time of the Project

(1) Determination of *X*
(2) Determination of population growth rate [**] and population projection method [*]
(3) Population projection for 35 years
(4) Determination of *Y*
(5) Calculation of *Tp*
(6) Calculation of *Ttp* (depending on the population growth rate and projection method in step 2)
(7) Deciding if the plan change is a "Plan Revision"
    (Y-X) + Ttp ≥ 25 years -- Plan Revision
    (Y-X) + Ttp < 25 years -- 2^{nd} Step

2nd Step: Verification of Channel Fill Rate

(1) Determination of *He & Dc*
(2) Calculation of *Fr* (*He/Dc*)
(3) Deciding if the plan change is a "Plan Revision" or a "Plan Amendment"
    Fr ≥ Ht (50%) -- Plan Revision
    Fr < Ht (50%) -- Plan Amendment



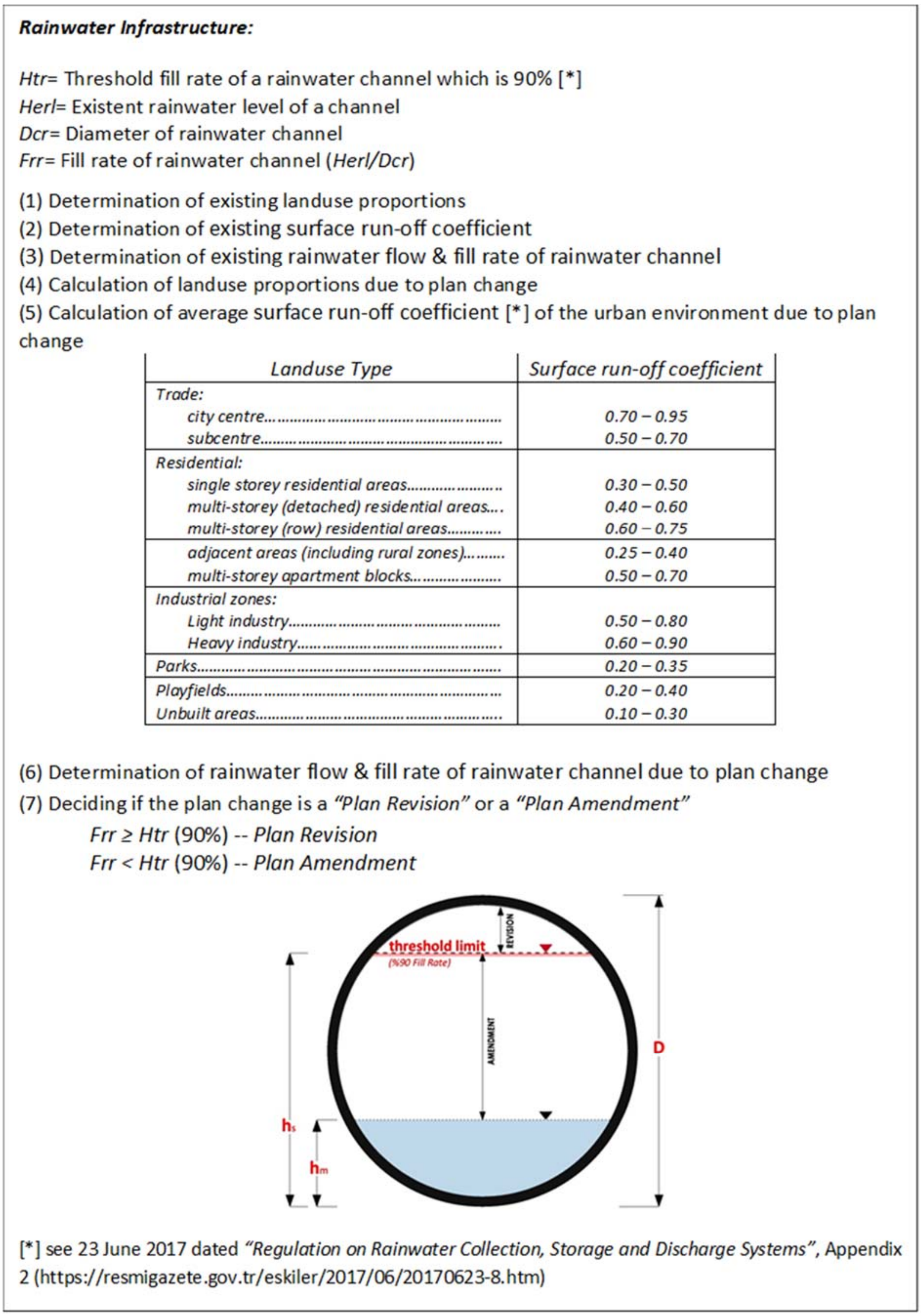
[*] see 06 January 2017 dated *"Regulation on Wastewater Collection and Removal Systems"*, Appendix *"1.3.2.1. Future Population"* (https://resmigazete.gov.tr/eskiler/2017/01/20170106-1.htm)
[**] see 12 October 2017 dated *"Regulation on Drinking And Using Water Supply and Distribution Systems"*, Appendix 1 (https://resmigazete.gov.tr/eskiler/2017/10/20171012-1-1.pdf)

Fig. 5. Components and Calculation Details of Impacts over Sewage Infrastructure, (Adapted from Ağaçcıoğlu et al. (2017)

a case study on roads and a model called "Service and Performance Adjusted Life Cycle Assessment" (SPA-LCA). In their literature review on the use of multi-criteria decision-making methods in sustainable infrastructure design, Navarro, Yepes, and Martí (2019) identified several methods, including AHP, TOPSIS, and PROMETHEE. In contrast to the model proposed in this paper, the above-mentioned studies do not emphasize the interconnection between impact assessment and urban renewal. Upon examination of the literature on urban renewal in relation to impact assessment, it becomes evident that studies have been conducted on various aspects, including social impacts (Yung et al., 2015; Glasson and Wood, 2009), impacts on quality of life (Eni and Abua, 2014), health impacts (Bacigalupe et al., 2010), and economic impacts (Bello and Nwosu, 2011). However, there is a paucity of studies on impacts on technical infrastructure.

Filling this gap would also serve to improve the efficiency of public resource use, which plays a pivotal role within the aims of most urban administrative authorities.

Such resource efficiency demands strong integration between infrastructure investments and holistic local-level urban plans. Any uncontrolled intervention in holistic plans would deteriorate the integration and the initially formed (healthy) plan-



Rainwater Infrastructure:

Htr= Threshold fill rate of a rainwater channel which is 90% [*]
Herl= Existent rainwater level of a channel
Dcr= Diameter of rainwater channel
Frr= Fill rate of rainwater channel (*Herl/Dcr*)

(1) Determination of existing landuse proportions
(2) Determination of existing surface run-off coefficient
(3) Determination of existing rainwater flow & fill rate of rainwater channel
(4) Calculation of landuse proportions due to plan change
(5) Calculation of average surface run-off coefficient [*] of the urban environment due to plan change

Landuse Type	*Surface run-off coefficient*
Trade:	
city centre...	*0.70 – 0.95*
subcentre...	*0.50 – 0.70*
Residential:	
single storey residential areas.....................	*0.30 – 0.50*
multi-storey (detached) residential areas....	*0.40 – 0.60*
multi-storey (row) residential areas............	*0.60 – 0.75*
adjacent areas (including rural zones).........	*0.25 – 0.40*
multi-storey apartment blocks.....................	*0.50 – 0.70*
Industrial zones:	
Light industry...	*0.50 – 0.80*
Heavy industry..	*0.60 – 0.90*
Parks...	*0.20 – 0.35*
Playfields..	*0.20 – 0.40*
Unbuilt areas...	*0.10 – 0.30*

(6) Determination of rainwater flow & fill rate of rainwater channel due to plan change
(7) Deciding if the plan change is a *"Plan Revision"* or a *"Plan Amendment"*

Frr ≥ *Htr* (90%) -- *Plan Revision*
Frr < *Htr* (90%) -- *Plan Amendment*

[*] see 23 June 2017 dated *"Regulation on Rainwater Collection, Storage and Discharge Systems"*, Appendix 2 (https://resmigazete.gov.tr/eskiler/2017/06/20170623-8.htm)

Fig. 6. Components and Calculation Details of Impacts on Rainwater Infrastructure
(Adapted from Ağaçcıoğlu et al., 2017)

infrastructure interdependence, as is frequently seen in Turkish planning practice. Such interventions are mostly observed as a consequence of a project-based partial decision-making process in the Turkish experience. Here, impact assessment could be conceptualized as an ex-ante evaluation tool to understand and measure the impact magnitude of plan decisions (which would otherwise remain uncertain) and to prevent the previously mentioned disintegration problem.

The proposed UTIIA methodology is such a potential tool to measure the impacts of plan changes for most Turkish metropolises where urban renewal, mega-projects, mega-events, etc., are major drivers of uncertainty patches. UTIIA would serve the topics briefly summarized below:

– Strengthening the integration of planning & impact assessment, infrastructure investments & planning decisions, and policy-plan-programme level SEA & project-led EIA;

– Aiding the planning authority to justify plan proposals and decide whether a planning change should be considered a plan revision (which necessitates new infrastructure investment) or a plan amendment (which can be tolerated by existing infrastructure);

– Clarifying how to implement current national regulations on Wastewater Collection and Removal, Drinking and Using Water Supply and Distribution, and Rainwater Collection, Storage and Discharge Systems;

– Understanding the sufficiency of existing urban technical infrastructure in a given area under a plan change probability and improving public resource efficiency through infrastructure investment duration optimization as a preliminary calculation for a more detailed cost-effectiveness examination.

As a result, the proposed UTIIA can be seen and developed as a specialized impact assessment type positioned within the diversifying impact assessment family on the one hand, and a useful decision-making process for a more rational planning practice in the Turkish case on the other.

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МЕТОДОЛОГИЯ ОЦЕНКИ ВОЗДЕЙСТВИЯ НА ГОРОДСКУЮ ТЕХНИЧЕСКУЮ ИНФРАСТРУКТУРУ ПРИ ПРИНЯТИИ ПЛАНИРОВОЧНЫХ РЕШЕНИЙ С УЧЁТОМ ТУРЕЦКОЙ ЗАКОНОДАТЕЛЬНОЙ БАЗЫ

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Аннотация

Введение. Данная статья расположена на пересечении четырёх ключевых теоретических понятий: городское планирование, реновация городской среды, оценка воздействия и техническая инфраструктура. Исследования, направленные на измерение «воздействия на техническую инфраструктуру», встречаются довольно редко и, как правило, фокусируются исключительно на критически важной инфраструктуре национального уровня, игнорируя локальный / городской масштаб. Восполняя этот пробел, **настоящая статья ставит своей целью** предложить методологию оценки воздействия на городскую техническую инфраструктуру (ОВГТИ) для измерения влияния изменяющихся планировочных решений на системы питьевого водоснабжения, канализации и ливневой канализации, а также обращается к проблеме дихотомии решений (является ли планировочное решение корректировкой плана или пересмотром плана), что особенно характерно для практик реновации городской среды в турецком опыте планирования.

Ключевые слова: оценка воздействия на городскую техническую инфраструктуру; реновация городской среды; корректировка плана; пересмотр плана; техническая инфраструктура.