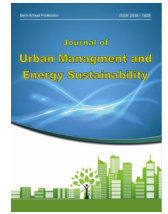


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CASE STUDY RESEARCH PAPER

Future Evolution of Environmental Justice in Tabriz City: Structural Analysis Through Identification and Presentation of Key Driving Factors

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ABSTRACT

Due to rapid urban expansion, environmental justice has become a major challenge in urban planning. Tabriz city in Iran, as a regional economic hub, faces unequal distribution of green space, noise and air pollution, and unequal access to environmental services. This research adopts a forward-looking approach to analyze the current situation and explore possible future pathways of environmental justice. The main objective is to identify and analyze the key driving factors affecting the evolution of environmental justice in Tabriz City. This applied, descriptive-analytical study involved urban management and local environment experts. Data were collected through library research and expert interviews. MAXQDA was used for qualitative coding, and MICMAC structural analysis was applied to determine the influence and dependence of factors and identify key drivers. The findings of the structural analysis showed that four axial codes were identified: challenges, strategies, key factors, and futures studies. The most important challenges included weak supervision, marginalization, and pollution. The most important strategy was culturalization. National policies, with an influence of 696, were identified as the most important external factor. Culturalization was the most comprehensive strategy (17 points), and pollution was the most critical challenge (13 points). The results shows that weak supervision and enforcement is the main challenge of environmental justice in Tabriz city. Culturalization is the key tool for transformation. Success requires simultaneous attention to national policies and local actions. The future of the city fluctuates between optimistic and pessimistic scenarios.

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INTRODUCTION

For over three decades, researchers and scholars have focused on the issue of environmental justice. Initially, academic research on environmental justice was primarily conducted in areas such as the environmental harms inflicted on disadvantaged groups due to the unregulated placement of landfills, toxic waste disposal sites, and other health-threatening facilities near their residential areas (Bullard, 2000). Justice, a longstanding societal necessity, entails meeting all members' basic needs; its absence widens social gaps and undermines creativity and cohesion (Pourahmad et al., 2023). Urban environmental justice means that citizens, regardless of their ethnic, linguistic, religious affiliations, or economic status, have the right to live in a clean, healthy, and safe environment and have fair access to workplaces, schools, recreational areas, and food resources, no matter where they reside in the city (Byrne, 2010). Sacrifice zones, which evolved from 1970s energy discourse to environmental justice, are sites where marginalized communities disproportionately bear environmental harms; the concept advances justice beyond distribution to "slow sacrifice"—concentrating death in some places to sustain life elsewhere (Juskus, 2023).

From Locke's perspective, justice is fundamentally about the protection of individuals' inalienable rights, including life, liberty, and property. According to Locke, legitimate government is established through the consent of the governed and exists primarily to safeguard these natural rights against unlawful encroachments. Justice, therefore, requires that the boundaries of individual freedom be respected, and that any transgression against these rights is considered unjust. This conception of justice provides a foundational framework for understanding the relationship between state authority and individual entitlements, emphasizing that public power must be constrained by the rights it is meant to protect (Locke, 2025). From the late 1960s, urban planning shifted toward social justice in order to reduce tensions and conflicts in Western societ-

ies. From the 1970s onward, these discussions became more serious in urban communities, leading to the publication of two seminal works: David Harvey's 'Social Justice and the City' and David Smith's 'Geography and Social Justice' (McWhirter & McWha-Hermann, 2021).

The concept of justice is multidimensional; concepts such as social justice, environmental justice, distributive justice, and spatial justice are both influenced by and indicative of this issue (Malekmohammadi et al., 2024). The emergence of the environmental justice movement began with the protests of community residents when veteran civil rights leaders and social justice advocates joined local grassroots efforts. From the early 1980s onward, these movements emerged in the United States and other countries such as India, South Africa, Nigeria, Mexico, etc., due to the pressures caused by environmental injustice. In this context, environmental justice advocates have emphasized local, regional, and national policies and laws that lead to environmental discrimination, arguing that many of the problems faced by poor and minority communities result from the use of violence and power by certain groups (Khorasani & Niazi, 2025). RAG combines retrieval with generative models to enhance accuracy in knowledge-intensive tasks, though scalability, bias, and ethics remain challenges (Gupta et al., 2024). AI, as a disruptive technology, impacts healthcare, sustainability, consumer adoption, and decision-making across multiple disciplines (Dwivedi et al., 2023). Tabriz faces major environmental justice challenges including industrial concentration, unequal green space distribution, pollution, and service disparities. These inequalities threaten quality of life and social stability. Addressing them requires futures studies to identify key drivers and possible scenarios. This research asks: What scenarios will shape environmental justice in Tabriz? Environmental justice, as a multidimensional concept, refers to the fair treatment and meaningful participation of all social groups in decision-making processes, policy-making, and the implementation of envi-

ronmental laws and programs. It ensures that no group regardless of race, color, ethnicity, or income level disproportionately bears the negative environmental consequences (Bullard, 2000). Environmental justice mapping tools have become essential instruments for identifying areas experiencing environmental injustices. These GIS-based digital maps integrate environmental, socioeconomic, health, and demographic data to guide investments toward disadvantaged communities. A review of 25 EJ mapping tools in the United States revealed that these tools vary widely in their indicators, resolutions, and coverage. However, gaps remain, particularly in the underrepresentation of certain regions and the limited inclusion of communicable diseases and climate impacts (Besse & Rojas-Rueda, 2025). Cumulative impact assessments should be integrated into EJ tools, incorporating a broad spectrum of indicators to capture the multifaceted nature of environmental injustices. Community engagement is also crucial in developing and updating EJ tools to ensure they accurately reflect community needs and conditions, thereby supporting broader environmental justice and health equity goals (Besse & Rojas-Rueda, 2025).

The assessment of environmental justice in a region is a qualitative matter and requires the definition of social impact assessment tools. This assessment is obtained, first, through processes that enable the inclusive participation of stakeholders, and second, through the systematic analysis of social patterns of impacts and benefits arising from projects (Walker, 2010). Justice is one of the criteria for quality of life, and based on it, any kind of benefit or harm is distributed among individuals: "from each according to his ability, to each according to his needs." Justice emphasizes those things that are considered the minimum basic necessities (Lynch, 1984). Environmental justice has broad meanings, almost all of which lead to the fair distribution of environmental effects, goods, and services within generations, between generations, and also between people and the natural world (Norman & Mitchell, 2012).

This concept entered development and planning literature around the 1980s, following protest movements regarding the establishment of polluting industries and thermal power plants near the residences of minorities and low-income classes. Initially, it sought the fair distribution of environmental burdens across geographic space (Kadree, 2009). Justice is one of the fundamental issues that humanity has long addressed and strived to establish. Although justice enjoys great popularity among people and policymakers, the interpretations and definitions of justice, as well as the methods of its implementation, are not only inconsistent but sometimes contradictory. Overall, no society can be found that shuns justice; upholding justice can be considered a guarantee of society's survival (Pourahmad et al., 2023).

Environmental justice, as a multidimensional concept, refers to fair treatment and meaningful participation of all social groups in decision-making processes, policy development, and implementation of environmental laws and programs, such that no group, regardless of race, color, national origin, or income level, disproportionately bears negative environmental consequences (Bullard, 2000; Schlosberg, 2004). Within this framework, citizens are entitled to equitable access to fundamental urban life opportunities, including workplaces, education, recreational spaces, food services, and a healthy, safe, and clean environment (Agyeman et al., 2016). In other words, it can be said that the concept of environmental justice is based on the general principle that all people have the right to be protected against specific environmental issues such as pollution and climate change, and to have access to services such as green spaces, social services, and transportation in the urban environment. Environmental justice supports the tools, values, laws, regulations, and policy decisions needed to create healthy and sustainable communities, where people can interact with each other with the assurance that their environment is safe, nurturing, and productive. This type of justice is achieved when

people can utilize their highest potential without experiencing sexism, racism, or class prejudice (Khorasani & Niazi, 2025). Environmental justice theory addresses three key topics: environmental capacities, inequality types, and methodological approaches to measuring inequality. A critical urban quality is inclusiveness—spaces where diverse social groups coexist tolerantly—closely linked to environmental justice (Geropanta & Cornelio-Marí, 2022). Today, discussing the process of forming public places and their evolution from a governmental political space to a public realm, and their transformation toward achieving favorable living conditions, is one of the goals of contemporary humanity. The public realm is a normative process that, based on Habermas's theories, can be a speech act aimed at securing the goals of active and passive urban actors. The public sphere potentially possesses the capacity to involve all residents of a city in playing a role in the formation of an inclusive city (Alves & Daitx, 2021). Caselli et al. (2024), in an article titled "Increasing Access to Public Spaces and Inclusivity in Residential Neighborhoods: A Methodological Framework and Pilot Application," concluded that their findings included the identification of professions and critical aspects of nodes and axes for the reconstruction of urban space in the suburbs of medium and large cities. Alves & Daitx (2021), in an article titled "Observations on Inclusivity, Equality, and Justice in the Urban Space of the City of São Paulo," concluded that if inclusivity, equality, and urban justice (considering their differences) are a major concern of our time, then attention must be directed toward their opposites, namely the forms of urban segregation and exclusion. By revealing the aspects of capital reproduction, power relations, and their social responses (whether positive or negative), it can be assessed whether more inclusive, equal, or just cities are being created (or even attempted to be created). The question is then raised: to what extent are political discourses, urban policies, and interventions related to urban (re)production characterized by the intensification of social

and spatial segregation in order to increase urban inequality? Can this movement be reversed in an era in which heightened individual freedoms, high competitiveness, and a lack of security, trust, and hope (in institutions, in the future, and in oneself) are increasingly on the rise?

Nygren & Quesada (2020), in a study titled "Imagining Inclusive Cities: Formulating Spaces of Justice," concluded that urban theory must be revisited to consider cities as spaces that redefine "politics" in relation to urban renewal, the right to the city, justice, and alternative urbanisms. This study emphasizes the structural aspects of urban policy and planning, including the intersection of large-scale development projects with disruptive practices of social appropriation and efforts to depoliticize institutional control. At the same time, the study highlights tactics that reinterpret hierarchical governance practices and create initiatives to enhance justice through claims-making, negotiation, improvisation, everyday acts of resistance, and organized opposition. Emanuel (2017), in a study titled "Combating Social Exclusion Through Public Space Design," showed that the results indicate that political discourses and national policy priorities have a direct impact on urban design recommendations and interventions. This study also emphasizes the active role of urban planners and designers in the implementation of social policies, introducing urban design as an effective tool for achieving justice and social cohesion.

MATERIALS AND METHODS

The present research is applied in purpose and mixed (qualitative-quantitative) in method, investigating the evolution of environmental justice in Tabriz using a futures studies approach and structural analysis to identify driving factors, outline strategic scenarios, and provide solutions. The statistical population comprised two groups. The qualitative population included documents, interviews, and opinions of experts, professors, and urban managers. The Delphi panel consisted of 15 experts selected purposefully based on ex-

pertise in environmental justice, urban management, and futures studies. Data collection tools included semi-structured interviews, documents and records (Tabriz detailed plans, environmental laws, Environmental Protection Organization reports, and previous studies), and a Delphi questionnaire for gathering expert opinions on inter-relationships between indicators and key factors. In the qualitative section, grounded theory with the Strauss and Corbin approach was employed through three coding stages. Open coding broke raw data into meaning units and extracted initial codes. Axial coding categorized open codes into axial categories based on similarities and semantic relationships, yielding four main axial codes: challenges and barriers to environmental justice, strategies and strategic actions, key influential factors, and futures studies—forming the conceptual core. Selective coding identified relationships between categories and drew the paradigm model.

In the quantitative section, pairwise comparisons prioritized the main categories. Pearson correlation matrices examined relationships between axial categories. A heat matrix analyzed relationships between strategies and challenges, indicating the degree of appropriateness and coverage of each strategy. MICMAC software identified key variables and ranked them based on influence and dependence. From the open coding process, 21 sub-components were extracted. With 15 experts, the degree of influence of each indicator was collected and consensus reached through Delphi. A cross-impact matrix was calculated over two iterations to achieve stability and consistency. The MDI (Mean Direct Influence) index was calculated, indicating causal relationships. Variables were classified into four categories: drivers, bi-directional variables, results, and independent variables. The Delphi consensus threshold was set at a minimum of 70% agreement. Structural analysis via MICMAC used a cross-impact matrix over 2 iterations, with stabilization requiring convergence of direct and indirect influences in the second iteration such that variations remained

below 5%, confirming reliability. The P (Possible relationships) category in MICMAC represents latent influences not observable in direct analysis but detectable through chains of indirect effects, enriching scenario analysis. To ensure trustworthiness, triangulation was applied through multiple data sources: semi-structured interviews, official documents, and previous studies. Theoretical saturation was achieved after the 12th interview, with three additional interviews confirming no new codes emerged. Regarding inter-coder reliability, coding was conducted solely by the author; therefore, Cohen's Kappa was not calculated. However, rigor was enhanced through audit trail, peer debriefing with two academic peers, member checking with four Delphi participants, and reflexivity through a reflective journal. MAXQDA software and the 70% Delphi consensus threshold further supported coding consistency and validity.

Pearson correlation was used as an exploratory measure to identify patterns of linear association between axial categories, with frequencies treated as quantitative approximations. All correlations were cross-checked with non-parametric Spearman's rank correlation, yielding similar patterns and confirming consistency.

Case Study

The city of Tabriz, as one of the most populous cities in Iran and the capital of East Azerbaijan Province, with a population exceeding one and a half million people, is situated within the geographical coordinates of 46° 17' to 46° 28' east longitude and 37° 55' to 38° 03' north latitude. As the industrial hub of northwestern Iran, Tabriz has consistently faced environmental challenges such as air pollution, lack of green space, water crisis, and waste management. The unequal distribution of environmental amenities across different urban districts has led to the formation of environmental inequalities. The study area of this research encompasses all urban districts of Tabriz and, with an emphasis on the dimensions of environmental justice, analyzes the current

situation and engages in future-oriented plan-

ning of improvement strategies.(Fig. 1)

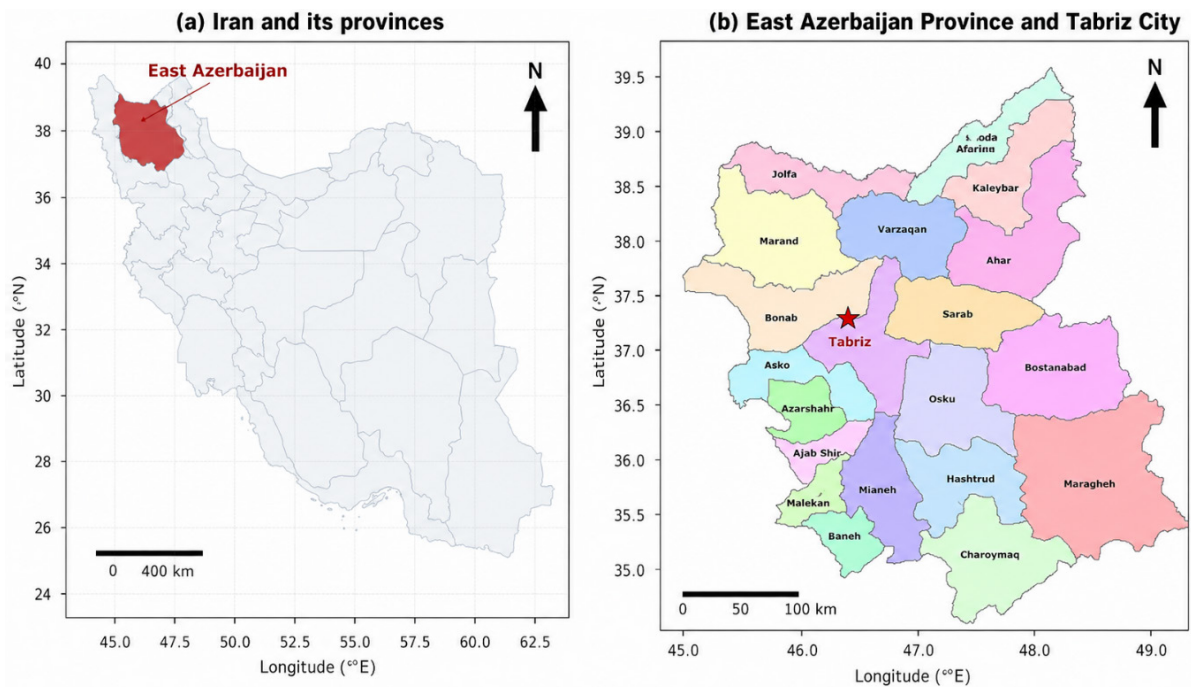


Figure 1: Geographical location of the study area, (a): Iran and provinces, (b): East Azerbaijan province and Tabriz city

RESULTS AND DISCUSSION

Analysis of the axial codes of the research

The results of axial coding in MAXQDA software show that the data analysis process has led to the identification of four main axial codes that form the conceptual core of the research. These four axial codes encompass a total of 21 open codes, indicating the comprehensiveness and depth of the research in covering various dimensions of the issue of environmental justice in the city of Tabriz. The axial code “challenges and barriers to environmental justice” with nine open codes has the highest frequency, indicating the research’s focus on identifying and analyzing the existing obstacles and problems in the path of achieving environmental justice. This suggests that researchers have primarily examined this field from the perspective of existing challenges and barriers. The axial code “strategies and strategic actions” with six open codes ranks second, indicating significant attention to providing practical solutions and strategies to overcome the identi-

fied challenges. The axial codes “key influential factors” and “futures studies,” each with three open codes, indicate attention to systemic and external factors affecting environmental justice as well as the forward-looking perspective of the research. The distribution of open codes among the axial codes shows that the present research has a balanced approach in which both problem diagnosis and solution provision have been addressed, although greater weight has been given to identifying challenges. This approach is common in futures studies because before presenting strategies, the current situation must be properly identified. Table 1 is presented below.

Table 1: Axial codes and the number of subordinate open codes

Row	Axial Code	Number of Open Codes
1	Strategies and Strategic Actions	6
2	Challenges and Barriers to Environmental Justice	9
3	Key Influential Factors	3
4	Futures Studies	3

Analysis of open codes within the category of strategies and strategic actions

The results of open coding within the category of strategies and strategic actions indicate six main solutions identified for achieving environmental justice in the city of Tabriz, which have been repeated a total of twenty-seven times in the data. Culturalization, with a frequency of twelve, has the highest repetition, indicating the strong emphasis by researchers and experts on the importance of education, awareness-raising, and changing social attitudes as the primary foundation for achieving environmental justice. This suggests that without citizen participation and cooperation, no policy or program alone can lead to sustainable change. Energy, with a frequency of six, ranks second, indicating the importance of energy resource management, reducing dependence on fossil fuels, and developing clean energy in improving urban environmental quali-

ty. Increased budget and transportation development, each with a frequency of three, indicate the need for greater financial resource allocation and improvement of public transportation infrastructure to reduce pollution and enhance all citizens' access to urban services. Public participation, with a frequency of two, and inter-organizational coordination, with a frequency of one, indicate the importance of active citizen participation and cooperation among various institutions in achieving environmental justice goals. Overall, these findings show that the proposed strategies encompass a combination of cultural, economic, infrastructural, and institutional actions. This comprehensive approach confirms the necessity of simultaneously addressing various dimensions of the issue. Table 2 presents the open codes within the category of strategies and strategic actions along with their frequencies.

Table 2: Open codes within the category of strategies and strategic actions and their frequencies

Row	Open Code	Frequency
1	Culturalization	12
2	Energy	6
3	Increased budget	3
4	Transportation development	3
5	Public participation	2
6	Inter-organizational coordination	1

Results of pairwise comparison and Pearson correlation matrix between axial categories

The results of the pairwise comparison indicate the prioritization of the four main categories of the research based on assigned scores. The category of "challenges and barriers to environmental justice" with a score of 54 has the highest priority in the research, indicating that the main focus of the study is on identifying and analyzing existing

obstacles and problems in the path of achieving environmental justice in the city of Tabriz. The category of "key influential factors" with a score of 30 ranks second, indicating the importance of identifying external and systemic factors affecting the state of the urban environment. The category of "strategies and strategic actions" with a score of 27 ranks third, reflecting attention to providing practical solutions and strategies to

overcome the identified challenges. The category of “futures studies” with a score of 18 has the lowest priority, indicating the forward-looking perspective of the research, although this category is of lesser importance.

The differences obtained from the pairwise comparisons show the gaps between the categories. The largest difference is between challenges and futures studies, with a value of 36, indicating a significant gap between the current situation and the forward-looking perspective in the research. This suggests that the main focus of the research is on the current situation and existing challenges rather than on future predictions. A difference of 27 units between challenges and strategies indicates that solutions have not received as much attention as challenges, which may reflect the diagnostic priority of the research. A difference of 24 units between challenges and factors also indicates the greater importance of barriers compared to influential factors. The smallest difference is related to the comparison between factors and strategies, with a value of 3, indicating the proximity of these two categories in terms of research priority. Overall, this comparison shows that the present research adopts a problem-solving approach in which identifying challenges is the first priority, followed respectively by factors, strategies, and futures studies.

The results of the Pearson correlation matrix between the axial categories of the research show different relationships among the four main categories, providing important insights into the conceptual structure of the study. The correlation between the category of “challenges and barriers to environmental justice” and the category of “strategies and strategic actions” with a coefficient of 0.72 shows the strongest relationship, indicating a close connection between diagnosing challenges and proposing solutions in the

research. This suggests that the proposed strategies have been designed directly to address the identified challenges. The correlation between the category of “challenges and barriers” and the category of “key influential factors” with a coefficient of 0.68 also shows a strong positive relationship, indicating that the identified key factors are well aligned with the raised challenges and that these factors act as root causes of the challenges. The correlation between the category of “key factors” and the category of “futures studies” with a coefficient of 0.62 indicates a strong positive relationship, reflecting that future scenarios are influenced by the identified key factors.

The correlation between the category of “strategies” and “key factors” with a coefficient of 0.55 is at a moderate level, indicating a significant but not complete relationship between the proposed solutions and the influential factors. This suggests that some strategies have been proposed independently of the key factors. The correlation between the category of “challenges” and “futures studies” with a coefficient of 0.45 is at a moderate level, indicating that future scenarios are influenced by current challenges, although this relationship is not as strong as the others. The weakest correlation is between “strategies” and “futures studies” with a coefficient of 0.38, which is at a weak level and shows that the proposed strategies are not directly related to future scenarios and are likely more focused on the current situation. Overall, this correlation matrix indicates that the conceptual structure of the research has good coherence and that the main categories are interconnected, although the relationship between strategies and futures studies needs to be strengthened. Table 3 presents the Pearson correlation matrix between the axial categories of the research.

Table 3: Pearson correlation matrix between axial categories of the research

Category	Challenges & Barriers	Strategies	Key Factors	Futures Studies
Challenges & Barriers	1	0.72	0.68	0.45
	-	Strong	Strong	Moderate
Strategies	0.72	1	0.55	0.38

	Strong	-	Moderate	Weak
Key Factors	0.68	0.55	1	0.62
	Strong	Moderate	-	Strong
Futures Studies	0.45	0.38	0.62	1
	Moderate	Weak	Strong	-

Based on the results of the coding performed, the present research provides a comprehensive picture of the state of environmental justice in the city of Tabriz by identifying five main categories and twenty-two sub-codes. The category of "challenges and barriers to environmental justice," with a total frequency of 111, has the largest share of the findings, indicating the research's focus on identifying existing problems and obstacles. Among these, "weak supervision" with a frequency of 16 has been identified as the most important challenge, reflecting a deep gap between policy-making and the proper implementation of environmental laws in Tabriz. This is followed by "marginalization" with a frequency of 11 and "pollution" with a frequency of 10, which represent two fundamental problems of Tabriz: unbalanced urban development and the environmental quality crisis. "Insufficient budget" with a frequency of 8 and "climate change" with a frequency of 9 are other major challenges, indicating financial resource constraints and regional environmental threats. "Spatial-social inequality" with a frequency of 7, "high land prices" and "population density" each with a frequency of 2, and "revision of urban plans" with a frequency of 2 are other identified barriers. Additionally, "concentration of facilities and services in the city center" with a frequency of 3 indicates the unjust distribution of urban resources across different districts of Tabriz.

The category of "strategies and strategic actions," with a total frequency of 43, constitutes the second most important category of the research. In this section, "strategies and strategic actions" with a frequency of 15 is presented as the main focus of the solutions. "Culturalization and awareness-raising" with a frequency of 12 is recognized as the second most important

solution, indicating the importance of changing social attitudes and behaviors in achieving environmental justice. "Clean energy development" with a frequency of 6, "budget increase" and "public transportation development" each with a frequency of 3, "public participation" with a frequency of 2, and "inter-organizational coordination" with a frequency of 1 are among the other proposed solutions. These findings indicate that researchers believe a combination of cultural, economic, and infrastructural actions is necessary to improve the state of environmental justice.

The category of "futures studies," with a total frequency of 33, outlines the temporal perspective of the research. The "pessimistic scenario" with a frequency of 9 and the "optimistic scenario" with a frequency of 8 are almost balanced, indicating high uncertainty regarding the future of environmental justice in Tabriz. This suggests that the city's fate depends on today's decisions and actions. "Current trend" with a frequency of 1 and "futures studies" with a frequency of 15 define the research's temporal framework.

The category of "key influential factors," with a total frequency of 30, demonstrates the role of external and systemic factors in the state of environmental justice. "National policies" with a frequency of 14 is the most important external influential factor, indicating the strong dependence of Tabriz's environmental situation on national decisions and policies. "Political factors" with a frequency of 1 also indicates the importance of the political environment in achieving environmental justice. The category of "interaction and influence of factors," with a frequency of 15, emphasizes the complex relationships between various variables and the necessity of a systemic approach to the issue. In

summary, the results of this research show that weak supervision and enforcement is the most important factor in creating environmental justice challenges in Tabriz, and culturalization has been identified as the key tool for transformation. Furthermore, success in achieving environmental justice requires simultaneous attention

to national policies and local actions, and the city's future fluctuates between optimistic and pessimistic scenarios, which doubles the importance of today's decision-making. Figure 2 presents the frequency distribution of the categories and codes identified in the research. (Fig. 2)

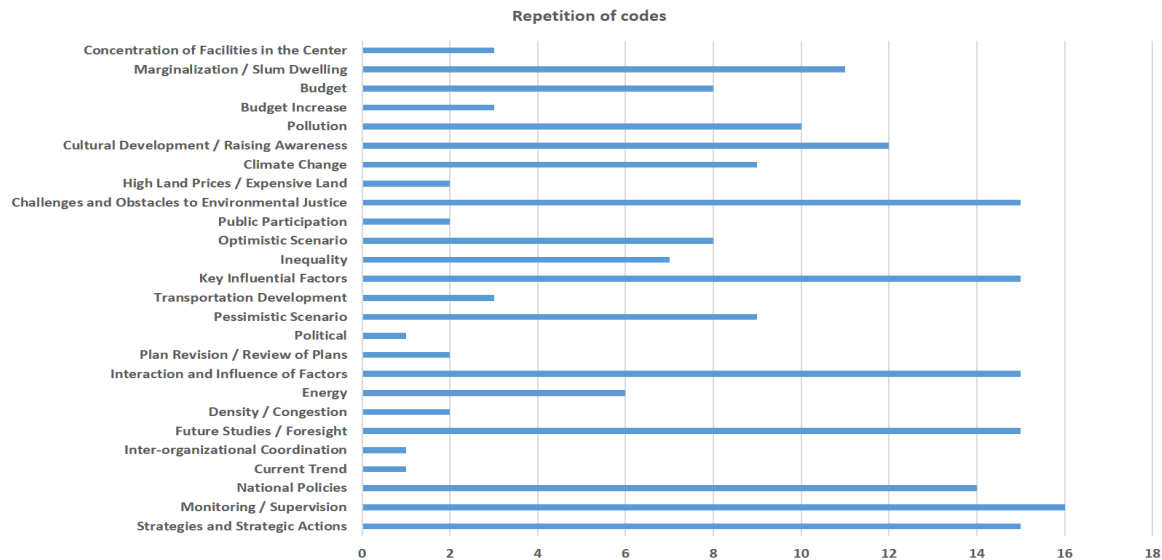


Figure 2: Frequency distribution diagram of the categories and codes identified in the research

Results of the co-occurrence matrix of categories in MAXQDA software

The results of the co-occurrence matrix of categories in MAXQDA software show that the five main categories of the research are unevenly distributed across the six stages of the research process. The category of "strategies and strategic actions," appearing in four stages (1, 3, 4, and 6), has the highest frequency, indicating the research's focus on providing solutions and strategies throughout the research process. The category of "challenges and barriers to environmental justice" appears in three stages (2, 3, and 6), reflecting the researcher's attention to identifying obstacles at different stages as well

as returning to this issue in the final stages of the research to relate challenges to solutions. The category of "key influential factors" is coded in two stages (2 and 3), indicating the identification of these factors in the initial and middle stages of the research. The category of "futures studies" appears only in the fifth stage, and the category of "interaction and influence of factors" appears only in the fourth stage. A noteworthy point is that the first and fifth stages lack coding for some categories, which may indicate differences in the intensity of the research's focus across different stages or methodological limitations. Table 4 presents the co-occurrence matrix of categories across the research stages.

Table 4: Co-occurrence matrix of categories across the research stages

	1	2	3	4	5	6
Strategies and Strategic Actions	0	0	1	1	0	1

Futures Studies	0	0	0	0	1	0
Interaction and Influence of Factors	0	0	0	1	0	0
Key Influential Factors	0	1	1	0	0	0
Challenges and Barriers to Environmental Justice	0	1	1	0	0	1

Results of the weighted code analysis in MAXQDA software

The results of the weighted code analysis in MAXQDA software indicate the prioritization of topics raised in the interviews and research documents based on their coverage and importance. According to this analysis, the category of "challenges and barriers to environmental justice," with the highest frequency and weight, constitutes the most important part of the findings. Among these, "concentration of facilities in the city center" with a weight of 139 and coverage of 31.10% has been identified as the main challenge, indicating severe inequality in the distribution of urban services and facilities between the central and peripheral areas of Tabriz. "Heavy traffic and resulting pollution" with a weight of 81 and coverage of 25.47%, "inequality in access to parks and open spaces" with a weight of 76 and coverage of 25.68%, and "temperature inversion phenomenon and the geographical location of Tabriz" with a weight of 70 and coverage of 22.51% are other major challenges, reflecting the environmental and urban crises of Tabriz. Furthermore, "lack of precise implementation of detailed plans," "municipality budget shortage," "marginalization," and "class disparity" are high-priority challenges, each with a weight exceeding 50 and coverage above 17%.

In the section on "key influential factors," "national policies" has been identified as the most important external factor, with a weight of 147 and coverage of 22.43%, indicating the strong dependence of the environmental justice situation in Tabriz on national policies in the areas of housing, transportation, energy, and the environment. "Managerial stability and political will of managers" with a weight of 35 and coverage of 11.82%, and "private investment

and climate change" with a weight of 49 and coverage of 10.96% are among other key factors. In the section on "strategies and strategic actions," "requiring managers to submit annual reports on sustainable urban indicators" with a weight of 63 and coverage of 21.65%, "attracting investors and selling municipal bonds for green projects" with a weight of 58 and coverage of 20.21%, and "making managers independent from political changes" with a weight of 62 and coverage of 20.95% have been proposed as the most important solutions. "Culturalization and education," with multiple weights across various sections, has been recognized as a key tool for transformation. In the section on "futures studies," optimistic and pessimistic scenarios have been presented in a balanced manner, indicating high uncertainty regarding the future of environmental justice in Tabriz. The pessimistic scenario includes items such as "failure to achieve sustainability," "worsening air quality," "increase in social tensions," "water crisis," and "environmental collapse," while the optimistic scenario includes "integrated management," "sustainable income," "managerial stability," and "public transportation development." In the section on "interaction and influence of factors," the complex relationships between various variables are shown, including the impact of fossil fuels on pollution, the impact of welfare policies on spatial distribution, and the impact of media on changing public attitudes. Overall, this analysis shows that the state of environmental justice in Tabriz requires integrated management, increased budget, widespread culturalization, and serious attention to national policies. Figure 3 presents the weighted code analysis diagram of the main research categories with the coverage index. (Fig. 3)

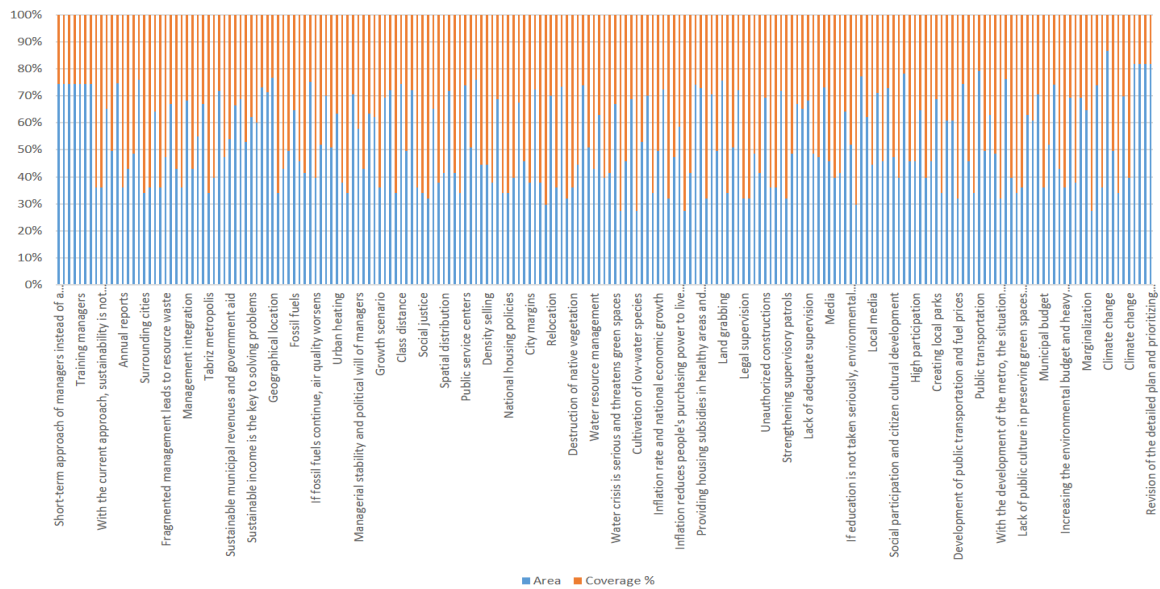


Figure 3: Weighted code analysis diagram of the main research categories with the coverage index

The paradigmatic model based on the Strauss and Corbin approach illustrates the research structure for environmental justice in Tabriz. Causal conditions including factor interactions, national policies, pollution, and climate change drive the central phenomenon of "environmental justice and sustainable development." Contextual conditions (marginalization, budget constraints, facility concentration in the city center, and high land prices) shape the environment in which this phenomenon occurs. Intervening conditions (culturalization, energy, public participation, and inter-organizational

coordination) act as accelerating or inhibiting tools. Strategic actions—culturalization, energy management, budget increase, transportation development, and public participation respond to the central phenomenon and overlap with intervening conditions. Outcomes are summarized in three scenarios: optimistic, pessimistic, and current trend, reflecting uncertainty and the dependence of results on today's decisions. The model demonstrates logical integration across all categories and provides a comprehensive framework for understanding environmental justice in Tabriz (Fig. 4).

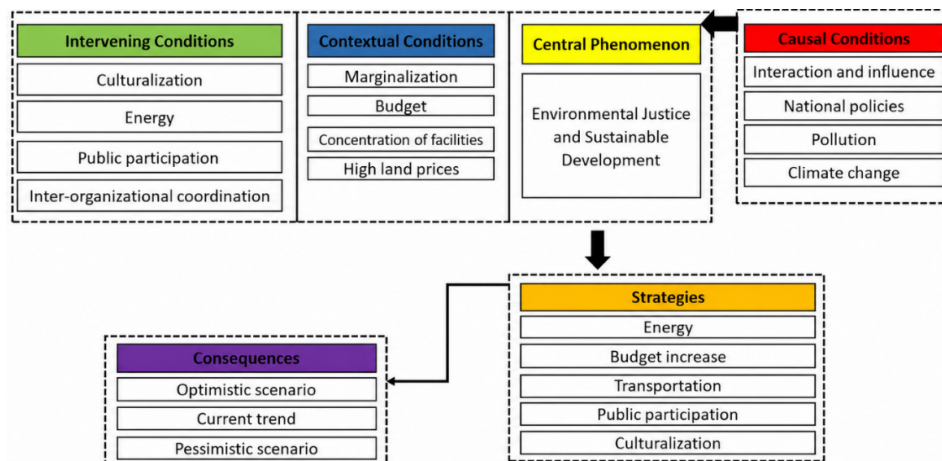


Figure 4: Diagram of the paradigmatic model of the research

Heat matrix of strategies and strategic actions versus challenges and barriers to environmental justice

The total number of relationships in the matrix is 72. The strategy of "culturalization" with a score of 12 has the highest frequency, and the challenge of "pollution" with a score of 13 ranks first among the challenges. The highest numerical intersection is recorded between the strategy of "culturalization" and the challenge of "marginalization" with a value of 4. The strategy of "culturalization," with a total score of 17, is the most comprehensive strategy and has been able to cover all 9 challenges. The strategy of "energy," with a score of 14, ranks second, with its focus primarily on pollution and climate change. The strategy of "budget increase," also with a score of 14, is on par with energy and focuses on inequality and marginalization. The strategy of "transportation development," with a score of 13, has good coverage in the areas of pollution and density. The strategy of "public participation," with a score of 8, is more limited but targeted, and the strategy of "inter-organizational coordination," with only 6 points, has the lowest coverage and requires serious strengthening. The challenge of "pollution," with a score of 13, is the most critical and high-risk challenge and has a direct relationship with public health. The challenge of "marginalization," with a score of 12, ranks second and requires special attention. The challenge of "budget," with a score of 11, is recognized as the main constraint on the

implementation of strategies. The challenge of "climate change," with a score of 10, is a global challenge with local impacts. The challenge of "inequality," with a score of 8, is considered the most fundamental issue. The challenges of "concentration of facilities" and "density" each have 5 points, and the challenges of "revision of plans" and "high land prices" each have 4 points, indicating less attention to these issues. The highest numerical relationship is recorded between the strategy of "budget increase" and the challenge of "inequality" with a value of 5. The strategy of "culturalization" has a relationship of 4 with the challenge of "marginalization." The strategy of "energy" has a relationship of 4 with the challenge of "pollution." The strategy of "transportation development" has a relationship of 4 with the challenge of "pollution" and a relationship of 3 with the challenge of "density." The matrix identifies "culturalization" as the most central strategy, while "pollution" and "marginalization" are the top-priority challenges. "Inter-organizational coordination"—critical for implementation—is notably weak, reflecting a fundamental executive weakness. "Revision of plans" and "high land prices" received the least strategic attention. Priorities should be: (1) culturalization in deprived neighborhoods to address marginalization, (2) fair resource allocation to reduce inequality, (3) clean fuel replacement to reduce pollution, and (4) strengthening inter-organizational coordination to remove implementation barriers (Tab. 5).

Table 5: Analysis of the heat matrix of environmental justice strategies and challenges

Strategy	MARGINALIZATION	POLLUTION	CLIMATE CHANGE	BUDGET	INEQUALITY	CONCENTRATION OF FACILITIES IN THE CENTER	DENSITY	REVISION OF PLANS	HIGH LAND PRICES	TOTAL
Culturalization	4	3	2	1	3	1	1	1	1	17
Energy	1	4	5	2	1	0	1	0	0	14
Budget increase	2	1	0	5	1	2	0	1	2	14
Transportation development	1	4	3	0	1	1	3	0	0	13
Public participation	3	1	0	1	2	0	0	1	0	8
Inter organizational coordination	1	0	0	2	0	1	0	1	1	6
Total	12	13	10	11	8	5	5	4	4	72

After completing the coding process in MAXQ-DA software and identifying twenty-one main components within four axial categories, MICMAC software was used to analyze the causal relationships between these components and to identify key variables. The components in question were extracted from the open coding process, including nine components in the category of challenges and barriers, six components

in the category of strategies, three components in the category of key factors, and three components in the category of futures studies. This analysis enables the classification of variables based on their degree of influence and dependence and identifies critical and key variables. Table 6 presents the research variables and codes in MICMAC software.

Table 6: Research variables and codes in MICMAC software

Number	Code	Variable Name	Axial Category
1	CH1	Marginalization	Challenges and barriers
2	CH2	Pollution	
3	CH3	Climate change	
4	CH4	Budget	
5	CH5	Inequality	
6	CH6	Concentration of facilities in the center	
7	CH7	Density	
8	CH8	Revision of plans	
9	CH9	High land prices	
10	RA1	Culturalization	Strategies
11	RA2	Energy	
12	RA3	Budget increase	
13	RA4	Transportation development	
14	RA5	Public participation	
15	RA6	Inter-organizational coordination	
16	FA1	Interaction and influence of factors	Key factors
17	FA2	National policies	
18	FA3	Political factors	
19	AF1	Pessimistic scenario	Futures studies
20	AF2	Optimistic scenario	
21	AF3	Current trend	

The output of MICMAC software is presented as a two-dimensional diagram. Table 7 shows the matrix.

Table 7: MICMAC matrix of direct influences between variables

	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	RA1	RA2	RA3	RA4	RA5	RA6	FA1	FA2	FA3	AF1	AF2	AF3
CH1	0	2	1	3	3	P	2	1	3	P	1	1	2	P	P	2	2	P	1	1	2
CH2	P	0	1	2	2	P	2	P	2	2	P	P	2	1	2	P	2	P	2	2	2

CH3	2	2	0	P	1	1	2	2	3	2	2	P	1	1	2	3	3	1	2	2	P
CH4	3	2	P	0	P	2	2	2	P	1	P	3	3	2	2	2	2	P	2	2	3
CH5	2	2	2	P	0	3	2	3	3	P	1	2	2	2	3	3	2	2	2	2	P
CH6	2	2	2	P	2	0	3	3	3	2	1	2	2	2	2	2	3	2	P	2	2
CH7	2	3	P	2	3	3	0	2	3	P	1	2	3	2	3	2	3	P	1	P	2
CH8	3	P	2	3	2	P	2	0	3	2	2	2	2	2	2	2	2	P	2	1	3
CH9	P	2	2	3	3	3	3	2	0	P	2	2	2	2	2	3	2	P	2	2	3
RA1	P	3	2	P	2	P	2	2	2	0	3	P	3	3	2	2	2	P	2	2	P
RA2	P	3	2	P	2	2	2	3	2	3	0	2	2	2	3	3	2	P	2	2	3
RA3	2	2	P	3	2	P	2	2	2	P	1	0	2	2	2	2	2	P	P	2	2
RA4	2	2	2	P	2	2	2	P	2	2	2	2	0	2	2	3	3	P	1	P	2
RA5	P	2	P	1	1	P	2	2	P	2	2	P	2	0	P	2	2	P	1	2	2
RA6	P	2	2	3	2	2	P	3	2	2	2	2	2	2	0	2	3	2	2	1	3
FA1	2	P	2	P	2	2	2	2	3	2	2	3	2	3	2	0	3	4	2	2	2
FA2	P	3	2	3	3	3	3	3	3	2	3	3	3	2	3	2	0	2	2	2	3
FA3	2	2	P	2	2	2	2	P	2	P	2	2	2	P	2	2	2	0	2	2	2
AF1	P	2	P	1	2	3	2	3	2	2	P	2	2	P	P	2	2	P	0	2	1
AF2	2	2	P	1	2	P	2	1	2	P	2	2	2	2	P	2	2	P	P	0	2
AF3	2	2	2	2	3	3	2	2	3	2	2	P	2	2	2	3	2	2	P	P	0

Following the identification of 4 main components and 21 sub-components, data on interrelationships were collected and consensus reached via Delphi with 15 experts. MICMAC cross-impact matrix calculations were performed over two iterations to achieve matrix stability and consistency. The first iteration recorded direct influences based on expert opinions; the second

iteration incorporated indirect effects and chain relationships. This ensures that indirect influences are captured and the matrix is not highly sensitive to minor input changes, enabling reliable identification of key factors for strategic scenario development and decision-making in Tabriz's environmental justice context (Tab. 8).

Table 8: Number of iterations of the cross-impact matrix calculation

ITERATION	INFLUENCE	DEPENDENCE
1	%95	%98
2	%100	%100

Based on the cross-impact matrix, the MDI (Mean Direct Influence) index was calculated

to measure the direct influence power of each variable on others. The matrix characteristics

are presented in Table 9, where the total number of relationships (441) equals the square of the matrix size (21×21). The fillrate of 95.24% indicates a densely populated matrix, confirming

the richness of the relationships identified by the expert panel. Table 9 presents the MDI direct influence values extracted from the software.

Table 9: Characteristics of MDI direct influences in MICMAC software

INDICATOR	VALUE
Matrix size	21
Number of iterations	2
Number of zeros	21
Number of ones	29
Number of twos	232
Number of threes	75
Number of P	84
Total	441
Fillrate	95.2381%

MICMAC structural analysis quantifies causal relationships through a relational matrix. Each variable's row sum indicates its influence on other components (active/driving role), while its column sum shows dependence on other factors (dependent/effect role). This distinction under-

pins the influence-dependence map. As shown in Table 10, "challenges and barriers" has the highest influence (309) and dependence (315), while "futures studies" has the lowest influence (92) and dependence (98). "Key factors" shows moderate dependence (103).

Table 10: Direct influence and dependence values of the components

N°	VARIABLE	TOTAL NUMBER OF ROWS	TOTAL NUMBER OF COLUMNS
1	Marginalization	27	26
2	Pollution	24	40
3	Climate change	32	24
4	Budget	33	29
5	Inequality	38	41
6	Concentration of facilities in the center	39	31
7	Density	37	41
8	Revision of plans	37	38
9	High land prices	42	45
	Total for challenges and barriers	309	315
10	Culturalization	32	26
11	Energy	40	31
12	Budget increase	30	32
13	Transportation development	33	43
14	Public participation	23	34
15	Inter-organizational coordination	39	36
	Total for strategies	197	202

16	Interaction and influence of factors	38	44
17	National policies	50	46
18	Political factors	32	13
	Total for key factors	120	103
19	Pessimistic scenario	28	28
20	Optimistic scenario	26	31
21	Current trend	38	39
	Total for futures studies	92	98
	Grand Total	718	718

The diagram in MICMAC software visually locates four main categories of variables in different zones (drivers, bi-directional variables, results, and independent variables). This allows the researcher to gain a deeper and more sys-

tematic understanding of the system's dynamics by analyzing the position of each factor, thereby achieving a comprehensive and strategic analysis of the data. Figure 5 shows the cross-impact map in MICMAC software. (Fig. 5)

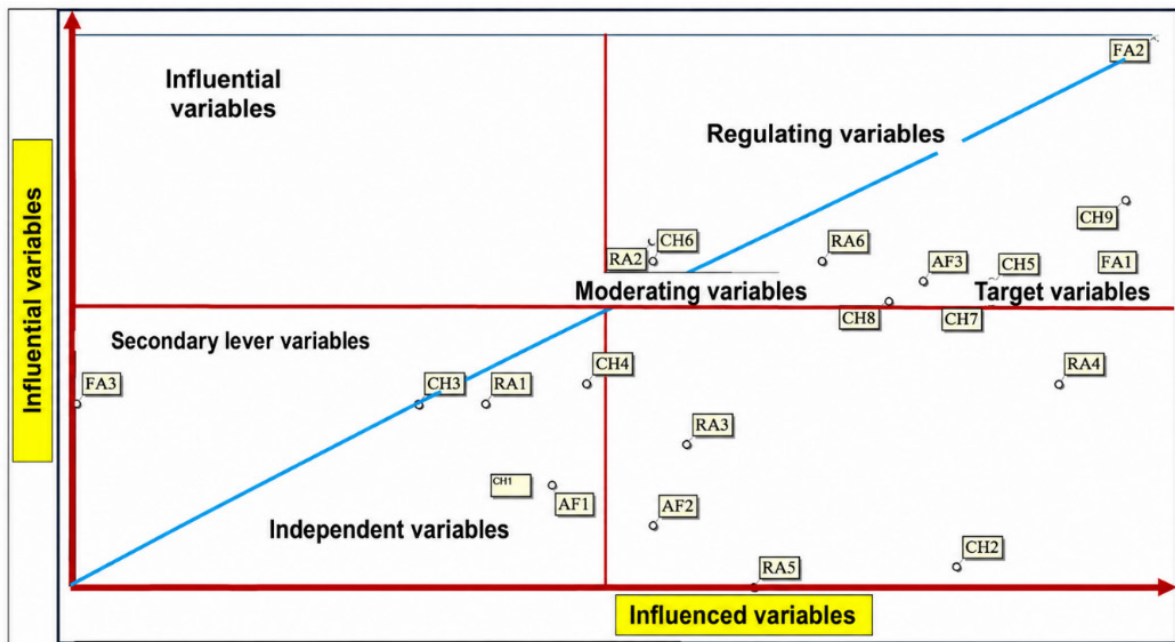


Figure 5: Cross-impact map in MICMAC software

In the continuation of the analysis process, the position of each component is evaluated and re-arranged based on direct and indirect influence and dependence indicators. This stage leads to the final ranking of the components according to their role in the system's dynamics. "National policies," with a direct influence of 696, has the greatest share in direct influence, and with an

indirect influence of 640, has the greatest share in indirect influence. Additionally, almost all of the identified key components in direct influence have been repeated, with slight shifts, in indirect influence as well. Table 11 presents the final list of key components affecting environmental justice in the city of Tabriz.

Table 11: Key components affecting environmental justice in the city of Tabriz

Direct Influence		Indirect Influence	
Component	Influence	Component	Influence
National policies	696	National policies	640
High land prices	584	High land prices	626
Energy	557	Interaction and influence of factors	612
Concentration of facilities in the city center	543	Transportation development	598
Inter-organizational coordination	543	Inequality	571

RESULTS AND DISCUSSION

The findings reveal several key mechanisms shaping environmental justice in Tabriz. National policies emerged as the most influential factor (**direct influence: 696**), reflecting Iran's centralized governance structure that concentrates environmental decision-making at the national level and limits local autonomy. This aligns with Pourahmad et al. (2023) on top-down planning in Iranian cities and Bullard (2000) on institutionalized environmental discrimination. Culturalization proved the most effective strategy, addressing all nine challenges through its grassroots nature, empowering citizens to demand rights and participate in environmental monitoring, thereby compensating for weak institutional oversight. Agyeman et al. (2016) and Schlosberg (2004) similarly emphasize shifting societal norms and community empowerment. Conversely, inter-organizational coordination showed the weakest performance due to fragmented governance, competing mandates, and managerial turnover, echoing Khorasani and Niazi (2025) on fragmented governance in Kashan. Urban marginalization and spatial inequality persist from historical development patterns concentrating facilities in the city center while peripheral areas suffer neglect, pushing low-income populations to informal settlements—consistent with Caselli et al. (2024) and Alves and Daitx (2021). The uncertain future reflects sensitivity to national policy changes, climate change, demographic pressures, and institutional weaknesses, as Nygren and Quesada (2020) argue regarding governance innovation for inclusive cities.

Achieving environmental justice in Tabriz requires simultaneous attention to national policies, institutional coordination, cultural transformation, and spatial planning interventions.

Future Research Directions

Based on the findings of this study, the following directions are proposed for future research on environmental justice in Tabriz and other Iranian metropolises:

1. Comparative Inter-City Studies

Comparative investigation of environmental justice status in Tabriz with other Iranian metropolises (Tehran, Isfahan, Mashhad) to identify common and specific patterns of environmental inequalities and to propose regional solutions.

2. Quantitative Research with Spatial-Geographic Approach

Utilization of Geographic Information Systems (GIS) and spatial analysis to more precisely measure the spatial distribution of pollutants, green spaces, and environmental services at the neighborhood level in Tabriz, and to identify critical hotspots with a spatial justice approach.

3. Study of Subjective Indicators of Environmental Justice

Design and implementation of field surveys to measure citizens' perception and satisfaction with environmental justice, and to identify the gap between objective and subjective conditions across different neighborhoods of Tabriz.

4. Analysis of Civil Institutions and Citizen Participation

Examining the impact of environmental non-governmental organizations, local media, and citizen

participation in environmental decision-making processes, and identifying barriers and capacities for popularizing environmental justice.

5. Dynamic Scenario Building and System Dynamics Modeling

Development of dynamic models (system dynamics) to simulate the impact of key variables (such as national policies, climate change, population growth) on the future of environmental justice, and to test the effectiveness of various strategies in the long term.

6. Institutional Analysis and Urban Governance

Investigating the institutional structure, laws, and regulations related to environmental justice in Tabriz, and identifying legal, administrative, and managerial barriers that hinder the implementation of equitable policies.

7. Interdisciplinary Studies of Environmental Justice

Integration of sociological, urban economic, political science, and environmental planning approaches to provide a more comprehensive analysis of the multiple dimensions of environmental justice and its linkage with social and economic inequalities.

8. Impact Assessment of National Policies on Local Environmental Justice

Research on how national policies (such as energy subsidies, housing policies, industrial development plans) influence the status of environmental justice at the city level, and proposing a framework for justice-oriented impact assessment of these policies.

Limitations of the Study

The study has several limitations. First, it is confined to a single-city case (Tabriz), limiting generalizability. Second, the Delphi panel comprised only 15 purposefully selected experts, which may not fully represent all stakeholder perspectives. Third, inter-coder reliability was not calculated as coding was conducted solely by the author, potentially introducing subjective bias. Fourth, the indicators rely primarily on software outputs (MAXQDA and MICMAC) without external val-

idation through independent empirical testing. Accordingly, findings should be interpreted as exploratory rather than definitive. Future research should expand the geographical scope, increase sample size, employ multiple coders, and validate factors through complementary methodologies.

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