earth

MDPI

Article

Using Public Participation GIS to Assess Effects of Industrial Zones on Risk and Landscape Perception: A Case Study of Tehran Oil Refinery, Iran

Mahdi Gheitasi [1,*], David Serrano Giné [2], Nora Fagerholm [3] and Yolanda Pérez Albert [1]

[1] GRATET Research Group, Department of Geography, Universitat Rovira I Virgili, 43480 Vila-Seca, Spain; myolanda.perez@urv.cat
[2] Department of Geography, Universidad Nacional de Educación a Distancia, 08016 Barcelona, Spain; dserrano@barcelona.uned.es
[3] Department of Geography and Geology, University of Turku, 20500 Turku, Finland; ncfage@utu.fi
* Correspondence: mahdi.gheitasi@urv.cat

Abstract: Petrochemical clusters are forms of industrialization that use compounds and polymers derived directly or indirectly from gas or crude oil for chemical applications. They pose a variety of short- and long-term risks to the environment and the people who live nearby. The aim of this study is to determine whether there is a correlation between the degree of perceived technological risk and the emotional value generated by the contemplation of the petrochemical industry landscape in order to try to establish strategic lines of action to mitigate the perception of risk and improve the emotional well-being of the population. This study uses manipulated pictures and a Public Participation Geographic Information System (PPGIS) survey to assess changes in perception and emotional response in residents in Teheran (Iran). Key findings show an insignificant relationship between technological risk and landscape value perception in both original and manipulated pictures. However, taking into account that, in general, in manipulated pictures, there is a more significant relationship, designing the landscape could help to mitigate the technological risk perception. This study contributes to the broader discussion about industrialization and its environmental and social consequences. It emphasizes the importance of considering public perception when planning and developing industrial areas, so as to balance industrial functionality and environmental and aesthetic considerations for long-term urban development.

Keywords: PPGIS; oil refinery; technological risk perception; landscape value perception; emotional perception

Citation: Gheitasi, M.; Serrano Giné, D.; Fagerholm, N.; Pérez Albert, Y. Using Public Participation GIS to Assess Effects of Industrial Zones on Risk and Landscape Perception: A Case Study of Tehran Oil Refinery, Iran. *Earth* **2024**, *5*, 371–387. https://doi.org/10.3390/earth5030021

Academic Editor: Charles Jones

Received: 4 July 2024
Revised: 29 July 2024
Accepted: 8 August 2024
Published: 16 August 2024

1. Introduction

The petrochemical industry refers to compounds and polymers derived from gas or crude oil used in the chemical industry [1]. Petrochemical clusters have a wide range of risks, for both the environment and the people living alongside them, on short- and long-term bases [2]. The report “Environment and Health Risks: A Review of the Influence and Effects of Social Inequalities” provided by the World Health Organization (WHO, 2010) points to seven environmental health challenges: air quality, housing and residential location, unintentional injuries in children, work-related health risks, waste management and climate change, social and gender-related inequalities, and children’s exposure to risks. The presence of industrial areas and petrochemical clusters raises concerns about their potential negative impacts on human health, the environment, and landscape perception and values. Therefore, it is essential to assess the effects of industrial clusters on landscape perception and people’s emotions in order to inform decision-making processes regarding their location and design.

Industrialization has also generated other types of landscape, primarily providing production facilities, rather than just recreation and entertainment [3]. Thus, the so-called industrial landscapes were born, dotted with numerous warehouses and production buildings, altering a territory's original appearance. The productive and social dimensions of these landscapes are intertwined and they take on a plurality of functions according to the use that local communities make of them [3,4].

Several studies have focused on landscape perception in industrial areas. For example, Tang, Wang, and Yao [5] used satellite images to examine landscape dynamics in the petroleum-based cities Houston and Daqing. In these cities, urbanization has led to the degradation and fragmentation of natural landscapes, while residential areas have expanded. The findings highlight the contrasting effects of urbanization on the environment and provide insights into the consequences of rapid urban growth. Soini et al. [6] focused on the perceptions of transmission lines in comparison with other landscape elements and explored the differences in perception between existing and new lines. Based on survey data from a community in southern Finland, the study found that transmission lines are viewed generally as negative elements in the landscape, regardless of when they were established. However, the perceptions among residents varied and were influenced by factors such as environmental attitudes, leisure activities, knowledge, and land ownership. Mirea [7] investigated the transformation of Bucharest's industrial landscape resulting from the transition to a market economy and revealed a lack of understanding of the conversion processes. Through the application of evaluation sheets across several industrial areas in the city, these changes impacted the urban fabric and communities, presenting both positive and negative outcomes. Khew, Yokohari, and Tanaka [8] used a questionnaire of 44 questions, plus one optional feedback question, to explore landscape perception and people's relationship with the petrochemical industry in Singapore, and they examined the role of ecological conservation in shaping perceptions. Masnavi, Amani, and Ahmadzadeh [9] addressed the ecological challenges faced in an industrial area in Iran. They spatially analyzed the structural relationships between landscape elements and patches, proposing strategies such as stormwater management, habitat protection, and phytoremediation to preserve mangrove communities and promote eco-tourism and sustainable development in the area. Djamel and Azzouzi [10] presented a study aimed at assessing the potential of the suburban space and defining a green structure for creating sustainable landscapes and environmental development in the city of Skikda (Algeria), since the city has been negatively impacted by uncontrolled urbanization, leading to aesthetic and physical pollution. The study utilized a qualitative estimation method based on a visual approach to assess the potential of the suburban space in the city of Skikda, which includes Jebel Mouadher and a portion of the Safsaf plain. Despite the wealth of data provided by these studies, a critical gap remains in understanding the discrepancies between objective measures of pollution and residents' perceptions. These studies often highlight a disconnection between measurable environmental impacts and subjective experiences. This discrepancy underscores the need to integrate both objective environmental data and subjective community perceptions in order to fully address the complexities of industrial landscape management and urban planning.

Some studies of people's feelings and emotions regarding landscape perception were conducted using a picture-based survey method. For example, Perovic and Folic [11] analyzed Niksic's public open spaces in Montenegro using subjective visual perception and empirical analysis. They aimed to develop objective criteria for designing desirable public spaces in the twenty-first century. Results indicate that multifunctional, dynamic, inclusive, and authentic spaces with natural elements achieve the desired visual effects. Maehr et al. [12] explored the emotional and physiological responses to the visual impacts of wind turbines compared to other structures like churches, pylons, and power plants. It used a novel psychophysiological approach, including skin conductance response measurements, to objectively quantify emotional reactions to these structures in various landscapes. The findings suggest that wind turbines are perceived as more pleasant than pylons and power plants but less calming than churches. Li, Nassauer, and Webster [13] explored the public perception of smart retention ponds in three American cities. They found that water-level manipulation by smart systems negatively affects perceptions of stormwater ponds, making them less attractive, neat, and safe. The effects were moderated by other design elements, with high water levels being more positive for ponds in greenspace and residential contexts. Luo, F al. [14] investigated how young adults in Changsha perceive forest landscapes and found that they appreciate forests more as personal and aesthetic spaces rather than for their ecological or social roles. This emphasizes the importance of raising public awareness about the forest's broader role and guiding diverse experiences in forest settings. Tasser, Lavdas, and Schirpke [15] investigated the influence of clouds on landscape pictures in people's preferences, concluding that there was no significant difference in preferences between pictures with or without clouds when the sky proportion was between 22% and 39%. Yan, J. al. [16] analyzed tourist photos of Huangshan Mountain to assess landscape perception and emotional response, revealing key patterns in photo focus, spatial distribution, and temporal emotional changes which demonstrates the significance and role of photographs in people's perceptions and landscape judgements.

Landscape perceptions have also been studied through Public Participation Geographic Information Systems (PPGISs) [17,18], which are spatially explicit methods and technologies for capturing and using spatial information in participatory planning processes [19–21]. Tulloch [22] defines PPGIS as a "field within geographic information science that focuses on ways the public uses various forms of geospatial technologies to participate in public processes, such as mapping and decision making". Korpilo et al. [23] presented a Multi-Sensory Public Participation GIS (PPGIS) method for integrating soundscape and landscape value mapping in Kalasatama (industrial case study) and Kuninkaantammi in Finland. The analysis revealed limited spatial overlap between landscape values and sound hotspots, indicating different perceptions of urban green and blue spaces. PPGIS provided a comprehensive understanding of diverse sounds and their relationship with landscape perception.

Image manipulation software such as Adobe Pictureshop, Affinity Picture, Paint Shop, and other image manipulation programs [24,25] offer a myriad of possibilities in landscape perception assessment studies. For instance, Barroso et al. [26] discussed the importance of Mediterranean landscapes for functions beyond production, such as conservation and recreation, and the need for knowledge to support decision-making. Their research demonstrated how picture-based surveys can effectively assess preferences in complex landscapes since controlled changes correlate with variations in landscape feature recognition.

The goal of this study is to assess technological risk and landscape values in an industrial cluster area by using manipulated pictures and PPGIS. Furthermore, this study aims at profiling participants' demographic characteristics for landscape value perception. The primary objectives are as follows:

- Assessing technological risk perception.
- Assessing landscape values by means of manipulated pictures.

By investigating the impact of an oil refinery on technological risk and landscape value perception in Tehran City, this study aims to contribute valuable insights to help policy makers and stakeholders to make informed decisions regarding the location and design of such clusters, ultimately minimizing negative impacts on landscape perception and human health.

2. Methodology

2.1. Study Area

The oil refinery in Tehran, located in the south of the city, is one of the most important centers of oil production in Iran. It was built between 1965 and 1968 and has been working since 1969 (south refinery) and 1973 (north refinery). The refinery manufactures a wide range of petroleum and chemical products, including liquid gas, regular gasoline, light and heavy naphtha, kerosene, gas oil, furnace oil, and mineral oil, accounting for approximately

12% of Iran's total refining capacity. One of the most significant environmental concerns in this refinery is air pollution, as it leads to the release of volatile organic compounds, nitrogen and sulfur oxides, and other harmful pollutants that pose health and environmental risks [27]. It also has a negative impact on the surrounding environment since the majority of the land has been converted into warehouses for petrochemical products, and residents in these areas lack adequate public spaces to engage in leisure and physical activities (Figure 1).

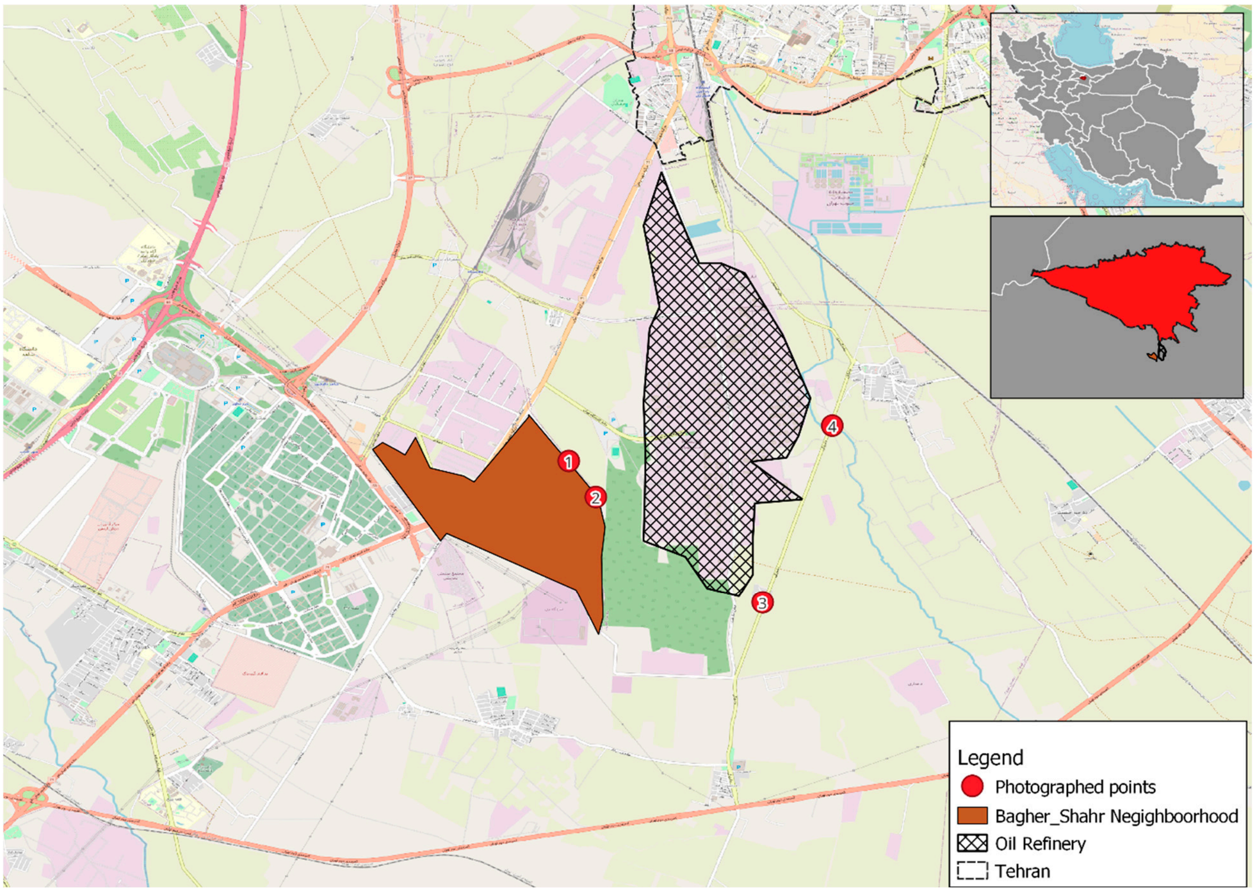

Figure 1. Case study location and surroundings.

Bagher-Shahr, a neighborhood near the oil refinery, has a population of approximately 65,000 people, according to Iran's statistical center [28]. The neighborhood has been impacted by issues related to the oil refinery. Before the Islamic Revolution, this neighborhood was a Bahá'í settlement, and since 1941, after the construction of some industrial areas nearby, it has become an economic center, accommodating many job-seekers. Between 1976 and 1986, the area's population increased significantly because of immigration from Afghanistan and other parts of Iran. Therefore, the construction of informal settlements in this area has increased since 1992 due to a lack of administrative rules and urban planning.

2.2. Design of the Survey

The survey (Figure 2) was 8 pages long and written in Farsi. It was designed to be conducted online using the Porsall https://porsall.com/ (accessed on 6 August 2023) platform, which facilitates efficient and organized data collection. To ensure the diverse representation of participants, the researchers distributed the questionnaire through various channels, including popular social media platforms such as LinkedIn, WhatsApp groups, and Telegram. Additionally, some surveys were filled out in person so that people without internet access were not excluded from this study.

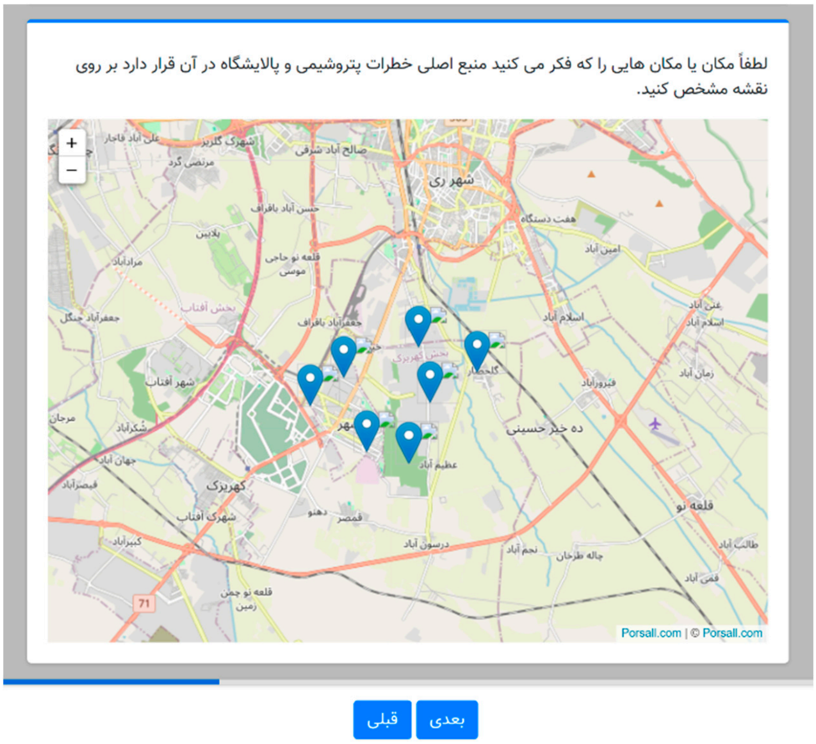

Figure 2. A screenshot of the online survey (translation of the texts in picture: please indicate which locations you think are the source of the technological risk caused by the oil refinery in the industrial area).

The PPGIS Survey had some social–demographic questions, some based on pictures, and some place-based questions, which asked for inputs on three maps: the first concerned the location of technological risk sources in Tehran, the second the location of areas affected by technological risk sources, and the third the location of residences. However, in this study, the question on residence location was only used to assess technological risk perception.

Throughout the data collection process, utmost consideration was given to ethical guidelines, ensuring the confidentiality and privacy of the participants. Clear instructions and explanations were provided to the respondents, and any queries or concerns raised by the participants were addressed promptly.

The survey included three distinct sections:

(a) The first section focused on technological risk perception, investigating how participants perceive risk associated with the presence of the oil refinery complex. Participants were asked about technological risks such as noise, oily waste, and fire and explosion associated with the oil refinery. In the section dedicated to risk perception, participants were prompted to assess their perceived level of risk, choosing from options such as “very low”, “low”, “neutral”, “high”, “very high”, or “ prefer not to say”.

(b) In the second section, participants were asked about their perceptions of landscape values using both original and edited pictures. This section was based on a previous work conducted by Svobodova et al. [29], where the authors selected pictures based on the visibility of the oil refinery and people’s awareness.

The pictures were captured from four carefully selected locations (Figure 3) chosen for their representativeness. Two of these locations were on the border between the Tehran Oil Refinery and the Bagher-Shahr neighborhood, while the other two were to the east of the refinery. In this section, three pictures (pictures 1, 3, and 4) were manipulated to reduce the impact of oil refineries and industrial areas, while picture 2 was manipulated by adding some negative elements to increase the impact of oil refineries and industrial zones.

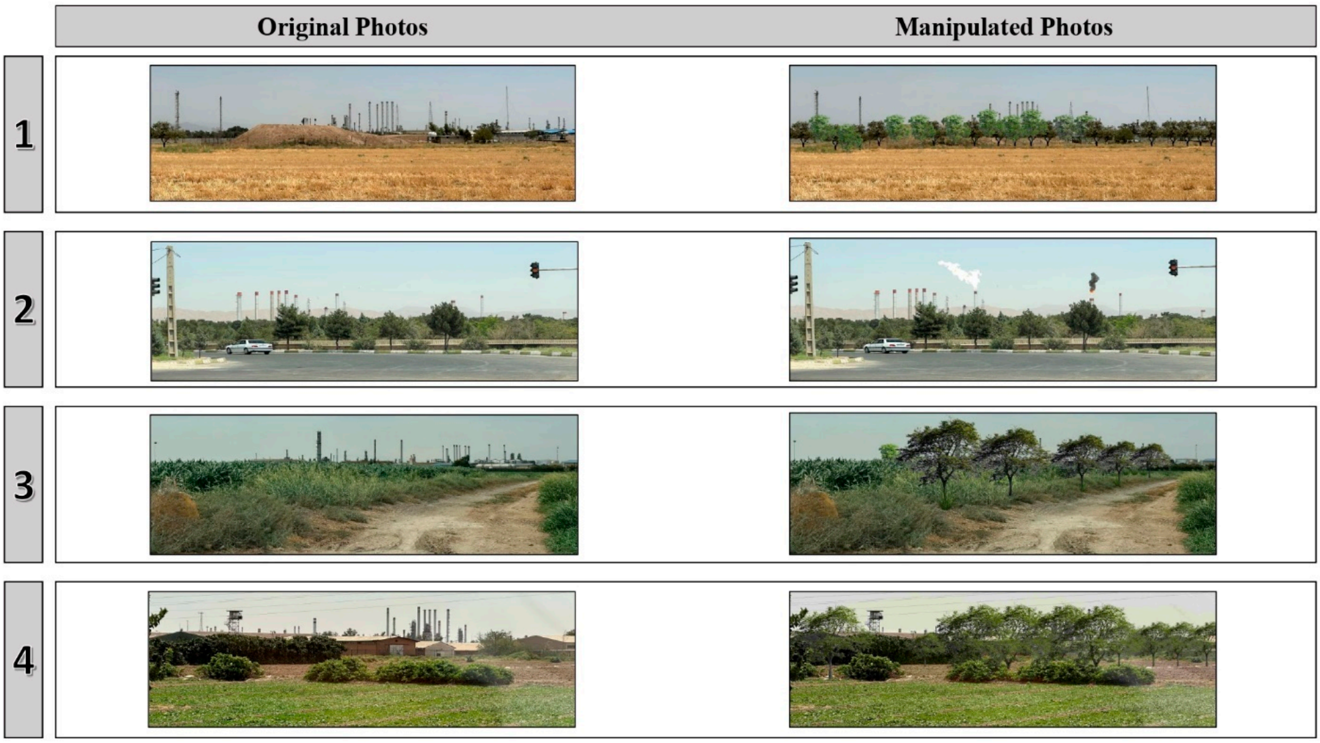

Figure 3. Pictures captured at selected points.

Following that, the perception of landscape values was assessed using pictures, and all participants were asked to use a set of adjectives for both the original and manipulated pictures. Participants were asked how they felt about the pictures while undertaking activities such as sports, reading, or walking in those areas. The adjectives used were according to the following three groups (Table 1):

- Anxious/Serene;
- Restless/Tranquil;
- Tense/Calm.

Table 1. Adjectives description (Source: [30]).

Adjectives	Description	Adjectives	Description
Anxious	Feeling or showing worry, nervousness, or unease about something with an uncertain outcome.	Serene	Peaceful and calm; worried by nothing.
Restless	Unwilling or unable to stay still or to be quiet and calm, because you are worried or bored.	Tranquil	Calm and peaceful and without noise, violence and worry.
Tense	Nervous and worried and unable to relax.	Calm	Peaceful, quiet, and without worry.

(c) Finally, the survey included a demographic and social section to gather essential information about participants. This section included details such as age, gender, place of residence, level of education, and income. In this section, the respondents' place of residence was asked based on a text box question, and in order to analyze these data, the authors created a location map based on their responses.

Table 2 displays the concepts of technological risk perception and landscape value, as well as operational definitions, parameters, and indicators associated with the Operationalization Framework for Survey Concepts.

Table 2. The Operationalization Framework for Survey Concepts.

Concept	Operational Definition	Indicators
Technological Risk Perception	Perception of risks related to an oil refinery	Risk types: noise, oily waste, and fire and explosion
Landscape Value Perception	Emotional and aesthetic responses to visual representations of landscapes	Emotional adjectives
Demographics	Basic participant information	Age, gender, place of residence, education, and income

2.3. Data Analysis

The data underwent a cleaning process where one response was eliminated due to an error in selecting points for participatory mapping questions that pertained to a different city. In the social–demographic section, percentages were calculated for each category to reflect the proportion of total respondents. Subsequently, each category was broken down considering social–demographic criteria (age, education level, income level, gender).

In the spatial section, data on participants' technological risk perceptions were extracted and spatially analyzed using QGIS' kernel density tool. Kernel density analyses [31] were conducted using participants' technological risk perceptions and residential locations in Tehran. To create these data, the authors first extracted the respondents' locations from the social–demographic section, then applied this information to the map and classified it based on each participant's technological risk perceptions.

In the picture-based questions, the data extracted from landscape perception were analyzed in Excel to determine the relationship between landscape values and technological risk perception. Each picture, both original and manipulated, was assessed for emotional content using three scales: Anxious/Serene, Restless/Tranquil, and Tense/Calm. Subsequently, the percentages represented the proportion of respondents or sentiment analysis tools that assigned a specific emotion (e.g., Anxious, Restless, Tense) or its inverse (Serene, Tranquil, Calm) to each picture. Finally, the analysis revealed the impact of manipulation on emotional perception by comparing the emotional perception of each picture's original and manipulated versions.

IBM SPSS statistical software version 27 was used to analyze the link between risk perception and emotional landscape values. First, the Spearman correlation coefficients were used to identify the correlation between variables. The ordinal regression model was also used for the regression model because the acquired data contained ordinary data.

3. Results

3.1. Social–Demographic Findings

A total of 220 participants took part in the participatory process. Females made up 52.27% of all respondents, while males averaged 45.45% (Table 2). The 25–34 age group has the highest representation (31.36%), followed by the 18–24 and 35–44 age groups. The data also show a drop in participation among respondents aged 45 and over.

Many of the respondents are university-educated (Table 3). The majority (23.15%) of females hold Masters or PhDs, followed by "Graduates" (19.44%). Males are also overrepresented in the Master/PhD category (21.76%), followed by "Graduates" (12.96%). While the percentages in these categories are slightly lower than for females, there is still a significant presence of well-educated males. According to the data, both genders have significant representation in higher education categories ("Graduates" and "Master/PhD").

Regarding income levels (Table 3), females are well represented at all income levels, with the highest percentage in the less than 5 MT category, from 5 MT to 10 MT, and from 10 MT to 15 MT, with each one being 11.87%. According to the distribution, a sizable proportion of females have financial experience. Males have a more diverse distribution of income levels. The category "More than 15 MT" has the highest percentage (15.53%), indicating a significant presence of males with significant income levels in MT. In general, approximately 58 percent of participants have significant income levels above 10 MT, 20.55 percent have income levels from 5 to 10 MT, and 17.35 percent have income levels less than 5 MT.

Table 3. Informant characteristics.

	Female	Male	N/A	Total
Age group				
N/A	8.18%	9.09%	1.36%	18.64%
18–24 years old	14.55%	7.73%	0.45%	22.73%
25–34 years old	16.82%	14.55%	0.00%	31.36%
35–44 years old	7.27%	10.00%	0.00%	17.27%
45–54 years old	2.73%	1.82%	0.45%	5.00%
More than 55 years old	2.73%	2.27%	0.00%	5.00%
	52.27%	45.45%	2.27%	100.00%
Educational level				
N/A	1.39%	1.85%	0.93%	4.17%
Without studies	0.46%	0.46%	0.00%	0.93%
Primary education	1.39%	0.46%	0.00%	1.85%
Secondary education	1.39%	1.85%	0.00%	3.24%
High School	5.56%	5.56%	0.00%	11.11%
Degree studies	19.44%	12.96%	0.93%	33.33%
Master/PhD	23.15%	21.76%	0.46%	45.37%
	52.78%	44.91%	2.31%	100.00%
Income levels				
N/A	8.68%	5.94%	0.00%	14.61%
Less than 5 MT *	11.87%	5.02%	0.46%	17.35%
From 5 to 10 MT	11.87%	7.76%	0.91%	20.55%
From 10 to 15 MT	11.87%	11.42%	0.46%	23.74%
More than 15 MT	7.76%	15.53%	0.46%	23.74%
	52.05%	45.66%	2.28%	100.00%

* Million Tomans: The Toman and Rial both are the currencies of Iran. One Toman is equivalent to ten Rials. While the Rial is the official currency of Iran, the Toman is commonly used in everyday transactions.

3.2. Risk Perception Findings

General Risk Perception

Table 4 summarizes the findings, categorizing respondents' perceptions of the petrochemical industry and refinery dangers. A small proportion of respondents believe that the petrochemical industry and refineries are extremely dangerous. This could indicate a subset of people who are convinced that these industries have negative health and mental health consequences. A larger proportion of respondents, but still less than a fifth, believe that the risks are high. This implies that a sizable proportion is aware of significant dangers, though perhaps not to the extreme level perceived by the "very high" group. The greatest proportion is classified as medium risk. This could represent a sizable proportion of respondents who see the risks as moderate, expressing balanced concern about the potential health and mental well-being consequences. A sizable but relatively small proportion of the population believes that the risks are low. These respondents may believe that the petrochemical and refinery industries pose only minor risks to their physical and mental health. A smaller proportion considers the risks to be very low, indicating that respondents are less concerned about the potential risks associated with the petrochemical industry and refineries. A sizable percentage did not respond or were unsure about the perceived risks. This could be due to respondents' ignorance, apathy, or uncertainty.

Furthermore, in Table 4, the total percentages show that females perceive risk at various levels compared to males, making up 52.27% of the total, compared to 45.45% in males. These data suggest that females have a broader range of risk perception or are more capable of identifying risk at various levels. The analysis of perceived risk levels shows that females perceive higher levels of risk than males in most categories. Females are more likely to identify both high and low risk levels, indicating potentially increased sensitivity or awareness of risk factors. Males, on the other hand, perceive a higher level of risk but have a lower overall risk perception percentage than females. Understanding these differences in risk perception can help us to tailor risk communication and management strategies to gender-specific concerns and attitudes toward risk.

Table 4. Risk perception and gender.

Risk Levels	Male	Female	Total
Null	5.45%	8.64%	14.09%
Very High	4.09%	2.27%	6.36%
High	7.73%	10.45%	18.18%
Medium	14.09%	13.64%	29.09%
Low	7.73%	10.00%	18.64%
Very Low	6.36%	7.27%	13.64%
Total	45.45%	52.27%	100%

In terms of perceived risk among participants, Figure 4 shows that people who live near the Tehran Oil Refinery perceive the most significant risk. The very high level was only displayed in the Bagher-Shahr neighborhood, which is close to Tehran's oil refinery (to the southwest of the oil refinery area). Furthermore, as this analysis shows, people from the east of Tehran perceived a moderate-to-high level of risk. In the eastern region of Tehran, despite the absence of a petrochemical industry, there are multiple sources of potential hazards. The eastern region of Tehran is primarily residential; however, it also hosts an industrial facility or warehouse that handles hazardous materials. Additionally, there are military installations in the vicinity that are involved in the production of these dangerous products. Presumably, this influences the population's choice of this particular area.

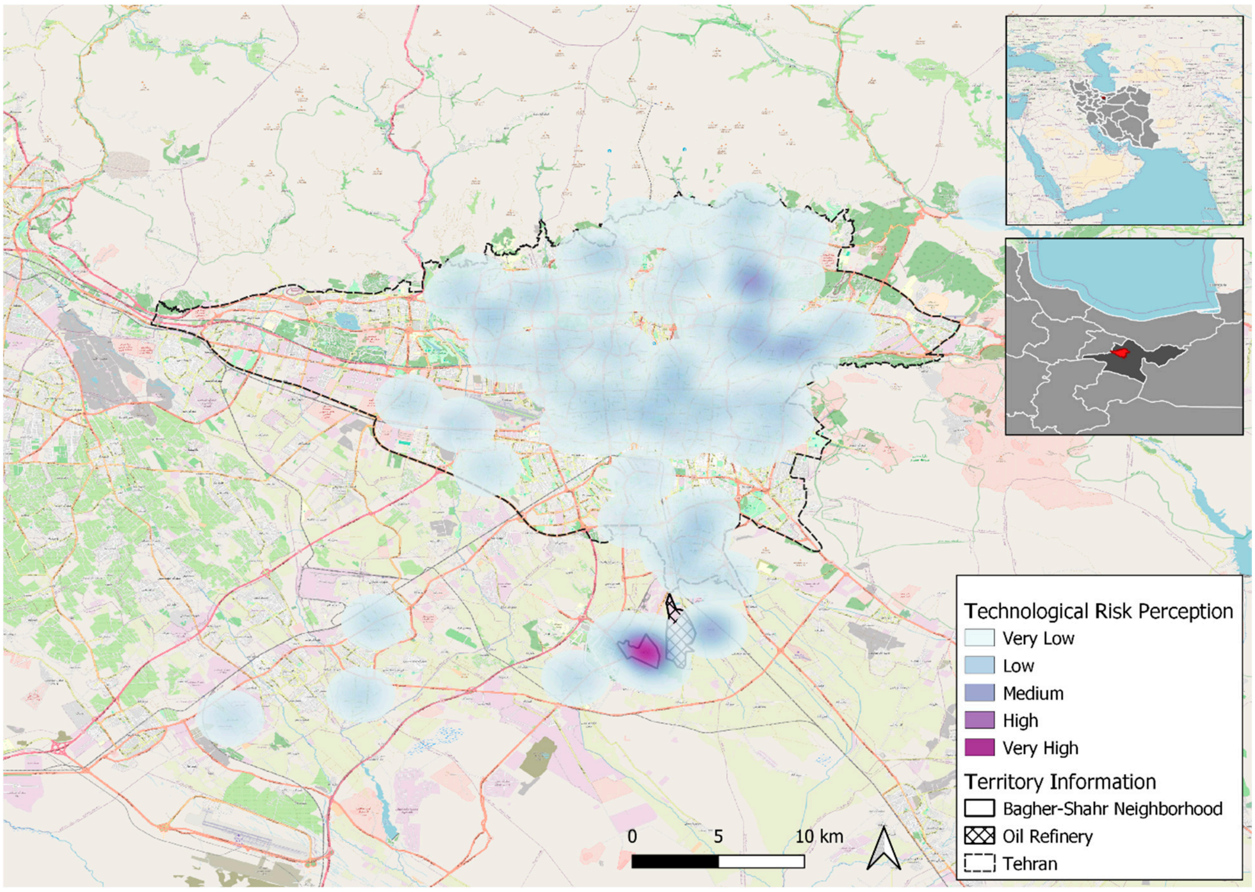

Figure 4. Level of technological risk perception among Tehran-based participants.

3.3. Emotional Landscape Value Perception Findings

All 220 participants were asked to make observations on both original and manipulated pictures. People's preferences for manipulated pictures tended to slightly modify the original attribution given to the pictures (Table 5). For pictures 1 and 4, the manipulated version led to lower negative opinions than the original pictures, whereas in picture 3, people expressed much more positive opinions, and in picture 2, negative opinions were prevalent because of the fog and fire added to the torch.

Table 5. Summary of people's perception of and emotions toward the landscape.

	Picture One		Picture Two		Picture Three		Picture Four	
	Original	Manipulated	Original	Manipulated	Original	Manipulated	Original	Manipulated
Anxious/ Serene	Anxious (50.45%)	Anxious (39.09%)	Anxious (48.40%)	Anxious (49.55%)	Anxious (53.18%)	Serene (45.45%)	Anxious (46.82%)	Anxious (35%)
Restless/ Tranquil	Restless (35.35%)	Tranquil (37.73%)	Restless (45%)	Restless (49.55%)	Restless (31.82%)	Tranquil (56.36%)	Restless (40.91%)	Tranquil (44.55%)
Tense/Calm	Tense (52.73%)	Tense (43.18%)	Tense (48.64%)	Tense (50%)	Tense (51.82%)	Calm (34.55%)	Tense (45.91%)	Tense (38.64%)

Note: The green color's transparency reflects positive opinions, with dark green having significantly more positive opinions in manipulated pictures than original pictures and displaying a range of positive opinions from very low (light green color) to very high (dark green color). Grey indicates that the manipulated pictures have more negative opinions than the original pictures.

3.4. Relationship between Technological Risk and Emotional Landscape Value Perception

3.4.1. Analyzing the Correlation (The Spearman Correlation Coefficients)

Normally, the Spearman correlation coefficients are used for the non-parametric and nonlinear variables that do not meet the Pearson correlation coefficients. Table 6 shows that the correlations between emotional landscape values and risk perceptions are weak and not statistically significant (high p-values). Many p-values (Sig) are >0.05, indicating that the correlations are statistically insignificant. The notable exception is the Anxious/Serene rating for picture 3 (Original), which has a statistically significant but minor positive connection (p = 0.015). However, the low correlation value (0.164) indicates that this is not a major influence.

Table 6. Correlation between emotional landscape value perception and perception of risk.

Pictures	Adjectives	Original Picture		Manipulated Picture	
		Correlation Coefficient	Sig. (Two-Tailed)	Correlation Coefficient	Sig. (Two-Tailed)
1	Anxious/Serene	0.026	0.696	0.004	0.956
	Restless/Tranquil	0.033	0.630	−0.026	0.700
	Tense/Calm	0.051	0.455	0.018	0.787
2	Anxious/Serene	0.034	0.621	0.004	0.957
	Restless/Tranquil	−0.017	0.798	0.016	0.811
	Tense/Calm	−0.041	0.548	0.040	0.553
3	Anxious/Serene	0.164	0.015	0.065	0.341
	Restless/Tranquil	−0.002	0.973	0.050	0.458
	Tense/Calm	0.027	0.689	0.017	0.798
4	Anxious/Serene	0.079	0.243	0.034	0.612
	Restless/Tranquil	0.091	0.177	0.002	0.975
	Tense/Calm	0.047	0.485	0.043	0.522

3.4.2. Logistic Regression Analysis Results

Although there is no correlation between emotional landscape values and risk perception variables in the Spearman correlation coefficients, the authors used ordinal logistic regression analysis to check for other possibilities and find the relationship. Ordinal logistic regression is a statistical analysis method that can be used to model the relationship between an ordinal response variable and one or more explanatory variables [32]. The following analysis examines the relationship between emotional landscape values in each picture, based on each adjective, and the level of risk perception. For each combination of picture and emotional values, Table 7 provides several key pieces of information.

Table 7. Logistic regression analysis results.

Pictures	Adjectives	Level of Risk Perception (Dependent Variable)	Original Picture				Manipulated Picture			
			Std. Error	B	Sig	Exp(B)	Std. Error	B	Sig	Exp(B)
1	Anxious/Serene	Null or very low	1.5109	−0.431	0.775	0.650	1.2289	−0.795	0.518	0.452
		Low	1.4971	−0.601	0.688	0.548	1.1287	−1.274	0.259	0.280
		Medium	1.5093	−0.352	0.816	0.703	1.1328	−1.135	0.316	0.321
		High	1.5514	−0.357	0.818	0.700	1.1447	−1.260	0.271	0.284
		Very High *		0	.	1		0	.	1
	Restless/Tranquil	Null or very low	0.6449	−0.931	0.149	0.394	0.8538	−1.508	0.234	0.221
		Low	0.5125	−0.581	0.257	0.559	0.4801	−1.570	0.206	0.208
		Medium	0.5246	−0.916	0.081	0.400	0.4574	−1.660	0.187	0.190
		High	0.5299	−0.685	0.196	0.504	0.4488	−1.395	0.273	0.248
		Very High *		0	.	1		0	.	1
	Tense/Calm	Null or very low	0.7377	0.036	0.962	1.036	0.6713	0.105	0.908	1.111
		Low	0.6969	−0.268	0.701	0.765	0.5088	0.263	0.766	1.301
		Medium	0.7433	0.692	0.352	1.998	0.5351	0.191	0.837	1.211
		High	0.7540	−0.210	0.780	0.810	0.5484	0.464	0.616	1.591
		Very High *		0	.	1		0	.	1
2	Anxious/Serene	Null or very low	1.5489	−0.323	0.835	0.724	1.4730	0.869	0.555	2.384
		Low	1.4959	−0.580	0.698	0.560	1.4555	0.390	0.789	1.477
		Medium	1.4991	−0.505	0.736	0.604	1.4617	0.561	0.701	1.752
		High	1.5483	−0.086	0.956	0.918	1.6882	2.605	0.123	13.537
		Very High *		0	.	1		0	.	1
	Restless/Tranquil	Null or very low	0.8074	−0.352	0.663	0.703	1.2680	−1.508	0.234	0.221
		Low	0.7060	−0.904	0.200	0.405	1.2416	−1.570	0.206	0.208
		Medium	0.7217	−0.863	0.232	0.422	1.2572	−1.660	0.187	0.190
		High	0.7393	−0.964	0.192	0.381	1.2714	−1.395	0.273	0.248
		Very High *		0	.	1		0	.	1
	Tense/Calm	Null or very low	0.6510	−0.075	0.908	0.928	0.9060	0.105	0.908	1.111
		Low	0.5613	−0.036	0.949	0.965	0.8843	0.263	0.766	1.301
		Medium	0.5868	0.097	0.869	1.101	0.9268	0.191	0.837	1.211
		High	0.6209	−0.565	0.363	0.568	0.9269	0.464	0.616	1.591
		Very High *		0	.	1		0	.	1

Table 7. *Cont.*

Pictures	Adjectives	Level of Risk Perception (Dependent Variable)	Original Picture				Manipulated Picture			
			Std. Error	B	Sig	Exp(B)	Std. Error	B	Sig	Exp(B)
3	Anxious/Serene	Null or very low	1.1118	−0.560	0.615	0.571	0.6279	0.269	0.668	1.309
		Low	1.0803	0.022	0.984	1.022	0.4321	0.322	0.456	1.380
		Medium	1.0970	0.263	0.811	1.300	0.4539	0.372	0.413	1.450
		High	1.1248	0.549	0.626	1.731	0.3853	0.116	0.762	1.124
		Very High *		0	.	1		0	.	1
	Restless/Tranquil	Null or very low	0.6828	−1.033	0.130	0.356	1.1032	1.672	0.130	5.325
		Low	0.5576	0.042	0.941	1.042	0.5052	−0.271	0.592	0.763
		Medium	0.5580	−0.077	0.891	0.926	0.4239	−0.595	0.160	0.551
		High	0.5644	−0.404	0.474	0.667	0.3366	−0.212	0.530	0.809
		Very High *		0	.	1		0	.	1
	Tense/Calm	Null or very low	0.7084	−0.723	0.307	0.485	0.5163	−0.375	0.468	0.687
		Low	0.6540	−0.353	0.589	0.703	0.3837	−0.046	0.904	0.955
		Medium	0.7011	−0.211	0.763	0.809	0.3960	−0.281	0.478	0.755
		High	0.6972	−0.685	0.326	0.504	0.3481	−0.282	0.418	0.754
		Very High *		0	.	1		0	.	1
4	Anxious/Serene	Null or very low	0.5289	−0.744	0.159	0.475	0.5491	−0.139	0.801	0.871
		Low	0.4976	−0.790	0.112	0.454	0.4324	−0.004	0.994	0.996
		Medium	0.5302	−0.539	0.309	0.583	0.4540	0.404	0.374	1.498
		High *		0	.	1	0.4825	0.036	0.940	1.037
		Very High						0	.	1
	Restless/Tranquil	Null or very low	1.0024	−0.278	0.781	0.757	0.6933	−0.641	0.355	0.527
		Low	0.9501	−0.601	0.527	0.548	0.5802	0.108	0.852	1.114
		Medium	0.9596	−0.233	0.808	0.792	0.5636	−0.113	0.842	0.893
		High	0.9661	−0.080	0.934	0.923	0.5425	−0.173	0.750	0.841
		Very High *		0	.	1		0	.	1
	Tense/Calm	Null or very low	1.1457	−1.110	0.333	0.330	0.5311	−0.087	0.870	0.916
		Low	1.1297	−1.438	0.203	0.237	0.4262	0.075	0.860	1.078
		Medium	1.1448	−0.752	0.511	0.472	0.5355	0.612	0.253	1.845
		High	1.1676	−1.318	0.259	0.268	0.4407	0.273	0.536	1.313
		Very High *		0	.	1		0	.	1

* Set to zero because this parameter is redundant. Green suggests that while no significant relationships exist between the variables, the manipulated pictures greatly improved the significant relationship between variables.

- Picture 1

Anxious/Serene

The coefficients (B) for different levels of risk perception range from −0.431 to −0.357 for the original picture and from −0.795 to −1.260 for the manipulated picture. Most coefficients suggest a decrease in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

Restless/Tranquil

The coefficients (B) range from −0.931 to −0.685 for the original picture and from −1.508 to −1.395 for the manipulated picture. Similar to "Anxious/Serene", most coefficients indicate a decrease in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

Tense/Calm

The coefficients (B) range from 0.036 to −0.210 for the original picture and from 0.105 to 0.464 for the manipulated picture. Unlike the previous two, here, there are some positive coefficients, indicating an increase in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

- Picture 2

Anxious/Serene

The coefficients (B) range from −0.323 to −0.086 for the original picture and from 0.869 to 2.605 for the manipulated picture. There is a mix of negative and positive coefficients. However, these effects are not statistically significant (Sig. > 0.05).

Restless/Tranquil

The coefficients (B) range from −0.352 to −0.964 for the original picture and from −1.508 to −1.395 for the manipulated picture. Similar to picture 1, most coefficients suggest a decrease in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

Tense/Calm

The coefficients (B) range from −0.075 to −0.565 for the original picture and from 0.105 to 0.464 for the manipulated picture. Similar to picture 1, some positive coefficients are observed, indicating an increase in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

- Picture 3

Anxious/Serene

The coefficients (B) range from −0.560 to 0.549 for the original picture and from 0.269 to 0.116 for the manipulated picture. There is a mix of negative and positive coefficients. However, these effects are not statistically significant (Sig. > 0.05).

Restless/Tranquil

The coefficients (B) range from −1.033 to −0.077 for the original picture and from 1.672 to −0.212 for the manipulated picture. There is a mix of negative and positive coefficients. However, these effects are not statistically significant (Sig. > 0.05).

Tense/Calm

The coefficients (B) range from −0.723 to −0.685 for the original picture and from −0.375 to −0.282 for the manipulated picture. Similar to pictures 1 and 2, some coefficients are positive, indicating an increase in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

- Picture 4

Anxious/Serene

The coefficients (B) range from −0.744 to −0.539 for the original picture and are not available for the manipulated picture. Similar to previous pictures, there are negative coefficients. However, these effects are not statistically significant (Sig. > 0.05).

Restless/Tranquil

The coefficients (B) range from −0.278 to −0.080 for the original picture and from −0.641 to −0.173 for the manipulated picture. Most coefficients suggest a decrease in the log-odds of perceiving risk at higher levels. However, these effects are not statistically significant (Sig. > 0.05).

Tense/Calm

The coefficients (B) range from −1.110 to −0.752 for the original picture and from −0.087 to 0.273 for the manipulated picture. Similar to previous pictures, some coefficients are positive. However, these effects are not statistically significant (Sig. > 0.05).

4. Discussion

4.1. General Observations

Investigating visual perception and its impact in industrial zones is a vital component of urban planning and design, closely linked to the perception of technological risk. Gaining insight into how individuals perceive and interpret their environment in these areas enables urban planners and designers to make strategic choices aimed at reducing technological risk perception and enhancing safety. This process involves careful considering various factors, including the visual aesthetics of industrial zones, the clear visibility of potential hazards, and the general visual effect on the local community. Our research looks into how oil refineries affect perceptions of technological risk and landscape values in Tehran. This methodology uses Public Participation Geographic Information Systems (PPGISs) to assess aesthetic and emotional responses while also involving the local community in the data collection process, resulting in a more democratic and inclusive approach. Unlike previous research, our approach integrates technological risk perception with landscape value perceptions using advanced participatory mapping techniques, providing a comprehensive perspective aimed at minimizing negative impacts on both landscape perception and human health. Compared to other studies, this study provided significant insights into a variety of topics, including demographic participation, technological risk assessment, and the psychological impact of image manipulation, all of which have important implications in urban planning and management.

The observed engagement trends in social–demographics show a strong participation among the 25–34 age group, with a decline in participation among older age groups, particularly those aged 45 and above. This pattern indicates that younger generations are more likely to participate, whereas older generations show a lower preference for engagement. This could be due to limited internet access during the participatory process and the fact that a large proportion of the elderly did not know how to use their mobile phone to complete the survey. Furthermore, the decline in participation among older age groups could also be attributed to a lack of interest or motivation to engage with social media platforms. Older individuals may prioritize other activities or have different preferences when it comes to communication and information gathering. Additionally, the digital divide between generations may play a role, as younger individuals have grown up with technology and are more familiar with its usage compared to their older counterparts.

This study examined the emotional landscape perceptions of original and manipulated pictures. The findings reveal that visual alterations have a considerable impact on viewers' emotional perceptions, as illustrated by picture 3.

In relation to risk perception, according to Raymond and Brown [33], perceptions of climate change risk are influenced, in part, by the values people assign or hold for certain areas on the landscape. Biodiversity and intrinsic landscape values have a substantial geographical link with biodiversity loss risk, whereas recreation values are strongly associated with riparian floods, sea-level rise, and wave action threats. According to Johnson, Adams, and Byrne [34], linear regression and spatial cross-correlation results show that spatial perceptions of risk are closely related to landscape values. According to our results, in terms of risk perception, the analytical findings show that the majority of participants perceived a medium level of risk, followed by low and high levels. The prevalence of the high and very high risk perception categories (24.54%) varies across Tehran. The majority of participants in Tehran's south, particularly those near the oil refinery, perceived high-to-extremely high levels of risk. However, no significant link was observed between emotional landscape perceptions and risk perception levels, as indicated in Table 6. Although there are no significant relationships between these two variables, there is evidence that manipulating the pictures can influence participants' opinions and level of risk perception. According to Table 7, green suggests that while no significant relationships exist between the variables, the manipulated pictures greatly improved the significant relationship between variables. For example, pictures 1 and 2 provide excellent evidence for enhancing the significant link between variables in the manipulated picture compared to the original one.

It is important to mention that the lack of a statistical difference between manipulated and actual images may indicate a number of potential flaws. First, it implies that participants perceive the real and manipulated landscapes in the same way. This could imply that the manipulations were insufficiently distinct to change the overall perception of the landscape. Furthermore, it is possible that the specific changes introduced in the manipulated images have no significant impact on how people evaluate the landscape. This is critical because it may indicate a lack of understanding about the importance of green spaces. Furthermore, it could imply that the overall characteristics of the landscape have a greater influence on people's perceptions than specific altered details.

4.2. Implications for Planning

The findings of this study have significant implications for urban planning and design, particularly regarding the management and mitigation of technological risk perception in industrial areas. Engagement trends indicate a need for more inclusive and adaptable participatory methods that bridge the digital divide and ensure broader community participation in planning processes.

Urban planners and designers are encouraged to incorporate multifunctional, dynamic, and inclusive public spaces that are enhanced with natural elements in order to improve visual aesthetics and reduce perceived risks associated with industrial operations. The efficacy of image manipulation in changing emotional perceptions highlights the potential of visual media interventions for improving public well-being and shaping positive attitudes toward industrial zones.

5. Conclusions

This study emphasizes the effectiveness of targeted interventions for addressing demographic disparities, technological risks, and psychological effects associated with picture manipulation. It emphasizes the importance of using diverse communication strategies in urban planning to effectively engage different age groups, resulting in broad and meaningful public participation.

Furthermore, it emphasizes the importance of visual elements in shaping perceptions of risk and safety, and it advocates for the strategic use of visual design in urban development initiatives. This study also suggests that picture manipulation can have a positive impact on emotional responses to industrial settings, making it a promising avenue for improving public well-being and perception via visual media. These interventions are integrated by Public Participation Geographic Information Systems (PPGISs), which provides numerous benefits. For example, manipulated pictures can help with public advocacy efforts by providing visual evidence to back up community concerns or goals. By superimposing pictures of potential impacts or risks onto GIS maps, community advocates can effectively communicate their messages and rally support for their causes.

This study had several limitations that influenced its results. Restricted internet access in Iran during certain periods hampered participation, while low engagement among Bagher-Shahr neighborhood residents, many of whom were undocumented immigrants with limited literacy, further limited data collection efforts. Furthermore, the sample differs significantly from the general population in terms of age, education, and income, raising concerns about the generalizability of the findings. The higher proportion of younger respondents in the sample may skew findings about age-related differences in engagement or perceptions. Similarly, the sample's higher education and income levels may influence perceptions and responses, potentially obscuring the perspectives of those with lower education levels or incomes. As a result of these demographic imbalances, this study's findings, particularly those concerning age, education, and income, should be interpreted with caution.

These issues highlight the need for more inclusive and adaptable research methodologies in future studies. To improve technological risk perception, future research should prioritize advocating for safer technologies, strengthening regulatory frameworks, and raising public awareness. Investigating the underlying causes of high-risk zones, as well as the interaction between industrial operations and urbanization, is critical. Furthermore, evaluating the efficacy of current risk perception mitigation strategies and investigating advanced risk detection technologies will provide greater insight into urban safety and resilience.

Future research should investigate the relationship between participants' preferences for manipulated versus original photos, demographic factors, and their geographic location. Furthermore, future studies should strive for a more balanced sample that accurately represents the demographic composition of the target population. This can be accomplished through targeted recruitment or by weighting responses to reflect population statistics. Validation with a more representative sample, or additional studies, could help to corroborate the findings and provide a better understanding of the general population's perspectives.

Author Contributions: All authors contributed to the study design, data analysis, and interpretation of the results. M.G. drafted the article, and all authors critically revised the article. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by (1) Grant PID2020-114363GB-I00, funded by MICIU/AEI/10.13039/501100011033; (2) the GRATET Research Group, which is funded by the Catalan Government under code 2009-SG744; (3) the Agency for Management of University and Research (AGAUR, Generalitat de Catalunya, Spain) through the 2017-SGR-245 Grant; and (4) the Spanish Ministry of Science, Innovation, and Universities under a grant for predoctoral research training staff under code PRE-2021-098679.

Data Availability Statement: The original contributions presented in the study are included in the article material, further inquiries can be directed to the corresponding author.

Acknowledgments: We extend our appreciation to Sayeh Soltanpour for her invaluable support in carrying out fieldwork and interviews in Tehran and the surrounding area of the oil refinery.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

References

1. Matar, S.; Hatch, L.F. *Chemistry of Petrochemical Processes*, 2nd ed.; Gulf Professional Publishing: Boston, MA, USA, 2001.
2. World Health Organization. *Environment and Health Risks: A Review of the Influence and Effects of Social Inequalities*; WHO Regional Office for Europe: Geneva, Switzerland, 2010.
3. Talento, K.; Amado, M.; Kullberg, J.C. Landscape—A Review with a European Perspective. *Land* **2019**, *8*, 85. [CrossRef]
4. Cipriani, L. *Cipriani: Vita e Morte Del Paesaggio Industriale*; Università degli Studi di Trento: Trento, Italy, 2012.
5. Tang, J.; Wang, L.; Yao, Z. Analyses of Urban Landscape Dynamics Using Multi-Temporal Satellite Images: A Comparison of Two Petroleum-Oriented Cities. *Landsc. Urban Plan.* **2008**, *87*, 269–278. [CrossRef]
6. Soini, K.; Pouta, E.; Salmiovirta, M.; Uusitalo, M.; Kivinen, T. Local Residents' Perceptions of Energy Landscape: The Case of Transmission Lines. *Land Use Policy* **2011**, *28*, 294–305. [CrossRef]
7. Mirea, D.A. Industrial Landscape—A Landscape in Transition in the Municipality Area of Bucharest. *Forum Geogr.* **2011**, *X*, 295–302. [CrossRef]
8. Khew, J.Y.T.; Yokohari, M.; Tanaka, T. Public Perceptions of Nature and Landscape Preference in Singapore. *Hum. Ecol.* **2014**, *42*, 979–988. [CrossRef]
9. Masnavi, M.R.; Amani, N.; Ahmadzadeh, A. Ecological Landscape Planning and Design Strategies for Mangrove Communities (Hara Forests) in South-Pars Special Economic Energy Zone, Asalouyeh-Iran. *Environ. Nat. Resour. Res.* **2016**, *6*, 44. [CrossRef]
10. Djamel, F.; Azzouzi, A. A Green Structure Into Account the Landscape and Environmental Factors of a Suburban Space in a City on the Southern Shore of the Mediterranean Basin. *Int. J. Res. Methodol. Soc. Sci.* **2019**, *5*, 14. [CrossRef]
11. Perovic, S.; Folic, N.K. Visual Perception of Public Open Spaces in Niksic. *Procedia Soc. Behav. Sci.* **2012**, *68*, 921–933. [CrossRef]
12. Maehr, A.M.; Watts, G.R.; Hanratty, J.; Talmi, D. Emotional Response to Images of Wind Turbines: A Psychophysiological Study of Their Visual Impact on the Landscape. *Landsc. Urban Plan.* **2015**, *142*, 71–79. [CrossRef]

13. Li, J.; Nassauer, J.I.; Webster, N.J. Landscape Elements Affect Public Perception of Nature-Based Solutions Managed by Smart Systems. *Landsc. Urban Plan.* **2022**, *221*, 104355. [CrossRef]
14. Luo, F.; Wang, C.; Lei, H.; Xiao, Z. Young Adults' Perception of Forests Using Landscape-Image-Sketching Technique: A Case Study of Changsha, Central China. *Int. J. Environ. Res. Public Health* **2023**, *20*, 2986. [CrossRef]
15. Tasser, E.; Lavdas, A.A.; Schirpke, U. Assessing Landscape Aesthetic Values: Do Clouds in Photographs Influence People's Preferences? *PLoS ONE* **2023**, *18*, e0288424. [CrossRef] [PubMed]
16. Yan, J.; Yue, J.; Zhang, J.; Qin, P. Research on Spatio-Temporal Characteristics of Tourists' Landscape Perception and Emotional Experience by Using Photo Data Mining. *Int. J. Environ. Res. Public Health* **2023**, *20*, 3843. [CrossRef] [PubMed]
17. Fagerholm, N.; Torralba, M.; Moreno, G.; Girardello, M.; Herzog, F.; Aviron, S.; Burgess, P.; Crous-Duran, J.; Ferreiro-Domínguez, N.; Graves, A. Cross-Site Analysis of Perceived Ecosystem Service Benefits in Multifunctional Landscapes. *Glob. Environ. Chang.* **2019**, *56*, 134–147. [CrossRef]
18. Garcia-Martin, M.; Fagerholm, N.; Bieling, C.; Gounaridis, D.; Kizos, T.; Printsmann, A.; Müller, M.; Lieskovský, J.; Plieninger, T. Participatory Mapping of Landscape Values in a Pan-European Perspective. *Landsc. Ecol.* **2017**, *32*, 2133–2150. [CrossRef]
19. Brown, G.; Fagerholm, N. Empirical PPGIS/PGIS Mapping of Ecosystem Services: A Review and Evaluation. *Ecosyst. Serv.* **2015**, *13*, 119–133. [CrossRef]
20. Rambaldi, G.; Kyem, P.A.K.; McCall, M.; Weiner, D. Participatory Spatial Information Management and Communication in Developing Countries. *Electron. J. Inf. Syst. Dev. Ctries.* **2006**, *25*, 1–9. [CrossRef]
21. Sieber, R. Public Participation Geographic Information Systems: A Literature Review and Framework. *Ann. Assoc. Am. Geogr.* **2006**, *96*, 491–507. [CrossRef]
22. Kemp, K. *Sage Reference—Encyclopedia of Geographic Information Science*; Sage: Newcastle upon Tyne, UK, 2008. Available online: https://sk.sagepub.com/reference/geoinfoscience/n165.xml (accessed on 31 May 2023).
23. Korpilo, S.; Nyberg, E.; Vierikko, K.; Nieminen, H.; Arciniegas, G.; Raymond, C.M. Developing a Multi-Sensory Public Participation GIS (MSPPGIS) Method for Integrating Landscape Values and Soundscapes of Urban Green Infrastructure. *Landsc. Urban Plan.* **2023**, *230*, 104617. [CrossRef]
24. Gyncild, B. *Adobe Photoshop Cs6 Classroom in a Book, Photoshop 13.1 Update for Creative Cloud Members, 1/E*; Adobe Press: Berkeley, CA, USA, 2012.
25. Thakur, R.; Rohilla, R. Recent Advances in Digital Image Manipulation Detection Techniques: A Brief Review. *Forensic Sci. Int.* **2020**, *312*, 110311. [CrossRef]
26. Barroso, F.L.; Pinto-Correia, T.; Ramos, I.L.; Surová, D.; Menezes, H. Dealing with Landscape Fuzziness in User Preference Studies: Photo-Based Questionnaires in the Mediterranean Context. *Landsc. Urban Plan.* **2012**, *104*, 329–342. [CrossRef]
27. Sadeghian, A.; Sahba, M. Investigating the Environmental Effects of Refineries and Providing Solutions to Reduce the Effects. 2011. Available online: https://www.sid.ir/paper/815031/fa (accessed on 7 August 2024).
28. Markaz Amar Iran Markaz Amar Iran. Available online: https://www.amar.org.ir (accessed on 11 March 2024).
29. Svobodova, K.; Sklenicka, P.; Molnarova, K.; Vojar, J. Does the Composition of Landscape Photographs Affect Visual Preferences? The Rule of the Golden Section and the Position of the Horizon. *J. Environ. Psychol.* **2014**, *38*, 143–152. [CrossRef]
30. Cambridge Free English Dictionary and Thesaurus. 7 February 2024. Available online: https://dictionary.cambridge.org/dictionary/ (accessed on 12 February 2024).
31. Ebdon, D. *Statistics in Geography Second Edition: A Practical Approach*; Blackwell Publishing: Malden, MA, USA, 1985.
32. Luers, B. Ordinal Logistic Regression Models and Statistical Software: What You Need to Know. 2020. Available online: https://cscu.cornell.edu/wp-content/uploads/91_ordlogistic.pdf (accessed on 6 May 2024).
33. Raymond, C.M.; Brown, G. Assessing Spatial Associations between Perceptions of Landscape Value and Climate Change Risk for Use in Climate Change Planning. *Clim. Chang.* **2011**, *104*, 653–678. [CrossRef]
34. Johnson, M.S.; Adams, V.M.; Byrne, J. Identifying Relationships between Landscape Values, Spatial Perceptions of Risk, and Physical Assets. *Res. Sq.* **2024**. *preprint*. [CrossRef]