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Evaluating the Impact of Oil Refinery on Landscape Values Perception and Mental Health: A Case Study of Tehran

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Abstract: Petrochemicals and oil refineries are industrial processes that use compounds and polymers derived directly or indirectly from natural gas or crude oil for chemical purposes. They have posed a number of short- and long-term risks to the environment and the people who live nearby. The study aims to determine how the presence of industrial areas, such as oil refineries, affects the local population's perception of their surroundings. The investigation centers on the Tehran Oil Refinery, a major refinery hub, and its perceived environmental impact. For this purpose, a Geographic Information System for Public Participation (PPGIS) covering three basic sections has been designed: socio-demographic information of the participants; self-perceived health; and landscape valuation before and after an intervention. The main observations show a complex interaction between industrial presence and the perception of landscape values. Participants' reactions to the manipulated Photographs reveal important details about the psychological impact of visual elements on emotional perception. There is also a direct relationship between the level of stress and emotional perception in the manipulated and original photos. This research adds to the larger debate about the effects of industrialization on the environment and society. It emphasizes the importance of considering public perception when planning and developing industrial projects. The goal is to strike a balance between industrial operational needs and environmental quality preservation, resulting in long-term urban growth.

Keywords: participatory process; industrial clusters; landscape perception; stress

1. Introduction

The petrochemical industry, as a kind of industrialization, refers to compounds and polymers derived directly or indirectly from gas or crude oil which are utilized in the chemical industry [1]. Petrochemical clusters entail a wide range of risks either for the environment or the people living alongside them, both on a short-term and a long-term basis [2]. The report "Environment and Health Risks: A Review of the Influence and Effects of Social Inequalities" curated by the World Health Organization points to six 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 these petrochemical clusters raises concerns about their potential negative impacts on the environment, human health, and landscape perception and values.

Industrial complexes located near residential zones can expose the nearby population to harmful emissions, thereby increasing their health risks [3]. Research indicates that proximity to petrochemical industries is linked with higher mortality rates due to various cancers including brain,

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bladder, lung, leukemia, non-Hodgkin's lymphoma, multiple myeloma, and lymphohematopoietic cancers—compared to populations in control areas [4–7]. Beyond physical health, the mental well-being of individuals residing close to these complexes may suffer as well, as pollutants like particulate matter (PM) and nitrogen dioxide (NO2). Known emissions from these facilities, have been associated with brain oxidative stress and inflammation, potentially impacting mental health [8–10]. Stress, a significant contributor to both mental and physical health problems [11], often results from the body's negative reactions to threatening environments. This increased stress is linked to various physical illnesses [12] and mental health conditions such as anxiety and depression [13–15].

Today, stress is regarded as one of the most important factors related to ill-health in modern society. Stress reactions may be reduced with exercise, which rids the body of some of the fighting and wakefulness hormones. Exposure to daylight may reduce stress reactions by adjusting hormone levels, especially cortisol and melatonin. Moreover, the design of the environment itself may signal danger or safety [16].

Understanding the relationship between the urban environment and health, particularly the benefits of the outdoors for mental health, is becoming increasingly important [17–19]. This is why it is crucial for urban planners and architects to consider the impact of the built environment on stress levels. By incorporating landscape values such as green spaces, natural light, and opportunities for physical activity, they can help create environments that promote relaxation and well-being.

Several studies have focused on landscape values and stress. Grahn and Stigsdotter [16] investigated how city landscape planning could affect residents' health. They found statistically significant associations between the use of urban open green spaces and self-reported stress experiences, regardless of the informant's age, gender, or socioeconomic status. The study found that the more often a person visits urban open green spaces, the less likely he or she is to report stress-related illnesses. Skärbäck [20] explored the balance between nature and landscape values in development planning, focusing on measures to mitigate negative impacts. This research aimed to raise awareness among the public, developers, and politicians about improving health as a parameter for sustainable development. Ward Thompson et al. [21] discovered that salivary cortisol can be used as a biomarker to assess stress levels associated with green space exposure. Their research discovered significant links between self-reported stress, cortisol secretion patterns, and green space quantity in the living environment. The percentage of green space in the living environment significantly predicted the circadian cortisol cycle and self-reported physical activity. Van den Berg et al. [22] explored the potential of green space to mitigate the negative health effects of stressful life events. They found that respondents with more green space were less affected by stressful life events. Stigsdotter et al. [23] investigated the associations between green space and health, health-related quality of life and stress, respectively. They found that respondents living one kilometer away from green spaces report poorer health and quality of life, and they have1.42 times more chances of experiencing stress compared to those living closer. Grahn and Stigsdotter [24] found a relationship between sensory perception of natural environments and human health. They identified eight perceived sensory dimensions: Serene, Space, Nature, Rich in Species, Refuge, Culture, Prospect, and Social. People generally prefer Serene, followed by Space, Nature, Rich in Species, Refuge, Culture, Prospect, and Social. Refuge and Nature were found to be most strongly correlated with stress, suggesting the need for restorative environments. Lottrup, Grahn, and Stigsdotter [25] investigated the relationship between access to green outdoor environments at work and employees' perceived stress and attitude towards the workplace. Data showed significant relationship between physical and visual access to greenery, and a positive workplace attitude and decreased stress for male respondents. Female respondents showed a similar relationship but not between access and stress. Vujcic et al. [26] found that green spaces are suitable settings for running and jogging, and may alleviate self-reported nervous problems and medication use. Shu et al. [27] investigated the restorative effects of virtual nature on anxiety, depression, and stress in patients with depression. It found that landscape type, viewing distance, and permeability significantly influence these effects. Studies showed that environments with higher openness, green elements, blue sky, and sunshine exposure had higher restorative levels. Grassland landscapes with higher viewing distances showed

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more restorative impacts. Ha et al. [28] investigated the relationship between urban green space and mental health in Chicago, focusing on the spatial distribution of green spaces. They found that residents reported less psychological distress in urban landscapes with small-sized water bodies and greater distances between forested areas. However, psychological distress levels were lower in landscapes with disaggregated distribution of green spaces, suggesting that the configuration of urban green space may be as important as the amount of green space.

There are various methods for analyzing landscape values and stress level. For example, one of the most recent participatory methods is public participation geographic information (PPGIS), systems which were used on various landscape value studies [29–33]. In addition, participatory methods were used in various stress and well-being studies on an urban scale [34,35].

This study employs an online participatory survey combined with PPGIS to investigate participants' perceptions of landscape values in areas near the oil refinery and industrial complex. This study's primary objectives are as follows:

1. To assess landscape values perception at the Tehran oil refinery.
2. To examine the relationship between landscape values perception and stress levels at the Tehran oil refinery.

By investigating the impact of oil refineries on landscape values perception in Tehran City, this study hopes to provide policymakers and stakeholders with valuable insights into the location and design of such clusters, thereby reducing negative impacts on human health.

2. Materials and Methods

The Tehran Oil Refinery (Figure 1), located south of Tehran, is one of Iran's most important oil production facilities. This oil refinery was built between 1965 and 1968, and it operated from 1969 (south refinery) to 1973 (north refinery). The refinery produces 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. The Tehran refinery produces 11% gasoline, 34% gas oil, 21% furnace oil, and 2% other products, accounting for approximately 12% of Iran's total refining capacity [36]. Air pollution is a major environmental concern at this refinery because it emits particulate matter, volatile organic compounds, NOx, SOx, and other harmful pollutants that endanger both human health and the environment.

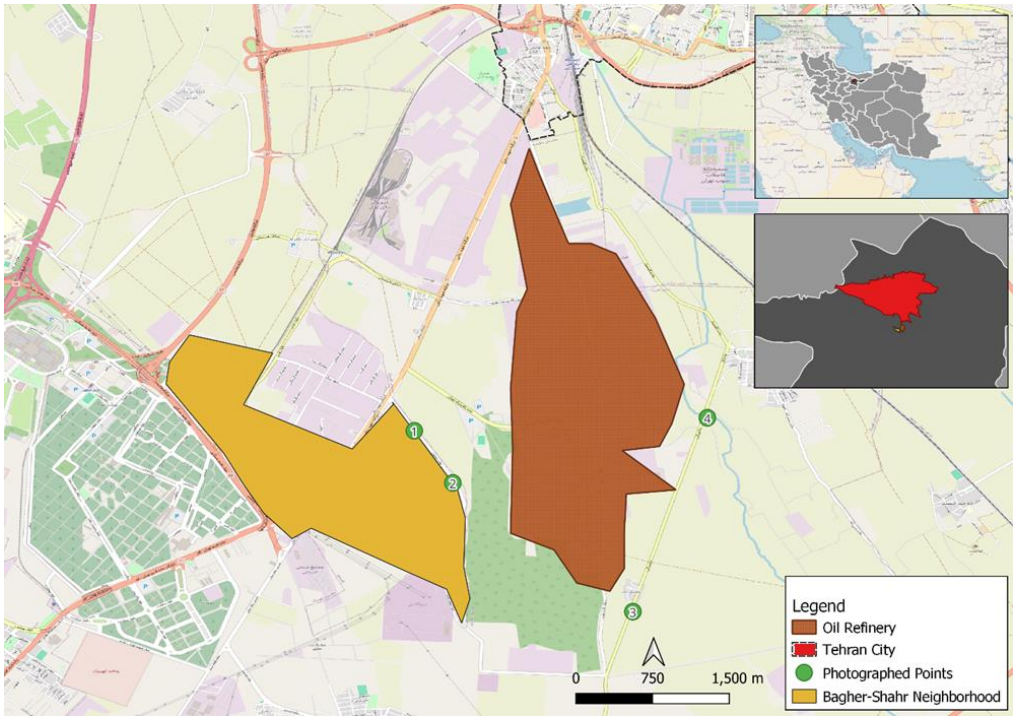

Figure 1. Case study Location and surroundings.

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Design of the Survey

The survey was 8 pages long, written in Farsi language, and designed to be completed online. It was conducted online using the Porsall (https://porsall.com/) platform, which allowed for efficient and organized data collection. To ensure a diverse sample of participants, the researchers distributed the questionnaire via a variety of channels, including popular social media platforms such as LinkedIn, WhatsApp groups, and Telegram channels. Furthermore, some surveys were completed in person, ensuring that people who had difficulty accessing the Internet were not excluded.

The first section of survey focused on mental health, specifically exploring how participants perceived stress arising from the presence of Oil Refinery. The level of stress was designed based on the Perceived Stress Scale provided by Cohen and colleagues [37]. The Perceived Stress Scale (PSS) is a well-known stress assessment tool. While the tool was created in 1983, it is still a popular choice for helping understand how different situations affect feelings and perceived stress. This scale's questions inquire about people's feelings and thoughts. In this paper, the short version of the PSS, which is known as PSS-4, was used, and participants were enquired about their feelings over the last month n [38].

In each case, participants will be asked how frequently they felt or thought a certain way. Although some of the questions are similar, there are differences, and they should be treated separately. Each question is scored from 0 (Never) to 5 (Very often) with a total possible score range of 0 to 16. A higher score indicates a high level of stress [37]. In order to evaluate the score, it should reverse the score from 4 to 0 for questions 2 and 3 (PSS-2, PSS-3). The questionnaire asked the following items:

1. How often have you felt that you were unable to control the important things in your life?
2. How often have you felt confident about your ability to handle your personal problems?
3. How often have you felt that things were going your way?
4. How often have you felt difficulties were piling up so high that you could not overcome them?

The best strategy to answer the questionnaire is to respond quickly. That is, rather than attempting to count the number of times you felt a certain way, indicate the alternative that appears to be a reasonable estimate.

In the second section, participants were asked about their perceptions of landscape values using both original and edited photographs (figure 2). This section was conceived considering a previous work conducted by Svobodova et al. [39], where the authors selected photographs based on the visibility to an oil refinery and people's awareness.

Figure 2. A screenshot of the online survey. (Translation: what is your feeling when you are going to study, listen to music or do physical activity in this certain place?).

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

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

1. Anxious/Serene
2. Restless/Tranquil
3. Tense/Calm

Table 1. Adjectives description (Source: Cambridge Free English Dictionary and Thesaurus, 2024).

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.

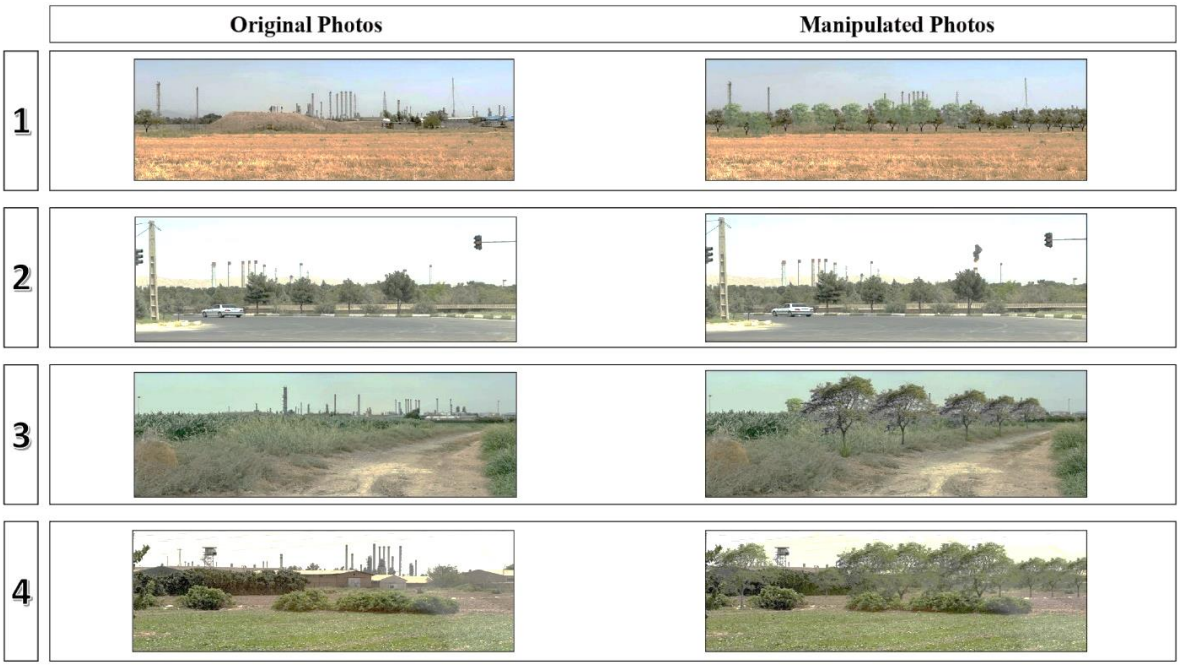

Figure 3. Photographs captured at selected points.

Finally, the survey included a demographic and social section to collect important information about the respondents. This section included information about age, gender, place of residence, level of education, and income.

3. Results

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This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Social- Demographic Findings

The participatory process involved a total of 220 participants. 80 percent of responses were collected via online survey, and the rest via interview. Also, one response was eliminated due to incorrect information. Females account for 52.27% of all respondents, while males make up 45.45% (Table 2). The 25-34 age group is the most represented (31.36%), followed by the 16-24 and 35-44 age groups. The data also shows a decrease in participation among respondents aged 45 and older.

Table 2. Informant characteristics.

Age group	Female	Male	N/A	Total
N/A	8.18%	9.09%	1.36%	18.64%
16–24 years	14.55%	7.73%	0.45%	22.73%
25–34 years	16.82%	14.55%	0.00%	31.36%
35–44 years	7.27%	10.00%	0.00%	17.27%
45–54 years	2.73%	1.82%	0.45%	5.00%
More than 55 years	2.73%	2.27%	0.00%	5.00%
Total	52.27%	45.45%	2.27%	100.00%

Perceived Stress Scale

Table 3 shows the Perceived Stress Scale distribution of respondents. The perceived stress scale evaluates the self-reported amount of stress in the participants by assessing thoughts and feelings in the previous month.

Table 3. Perceived Stress Scale distribution of respondents.

Score	PSS-1	PSS-4	Score	PSS-2	PSS-3
Never (0)	16.82%	20.45%	Never (4)	14.09%	10.00%
Almost Never (1)	20.00%	20.91%	Almost Never (3)	31.36%	43.18%
Sometimes (2)	8.64%	10.00%	Sometimes (2)	6.36%	4.09%
Fairly Often (3)	50.91%	44.55%	Fairly Often (1)	45.00%	34.55%
Very Often (4)	3.64%	4.09%	Very Often (0)	3.18%	8.18%
Total	100%	100%	Total	100%	100%

After calculating the total scores, in order to make them more readable, 4 categories were created: 0–4 equivalences to low, 4–8 equivalences to medium, 8–12 equivalences to high, and 12–16 equivalences to very high. For example, if a participant answers question 1 (PSS-1) to select almost never (1 score), question 2 (PSS-2) to select very often (0 score), question 3 (PSS-3) to select sometimes (2 score), and question 4 (PSS-4) to select very often (4 score), the total score is:

$$(Score\ of\ PSS\text{-}1) + (Score\ of\ PSS\text{-}2) + (Score\ of\ PSS\text{-}3) + Score\ of\ PSS\text{-}4) =$$
$$1+0+2+4= 7$$

Figure 4 shows the distribution among participants. It shows that the Medium category, which corresponds to 4-8 scores, has the highest percentage (65%), followed by High (24%), Low (7%), and Very High (4%).

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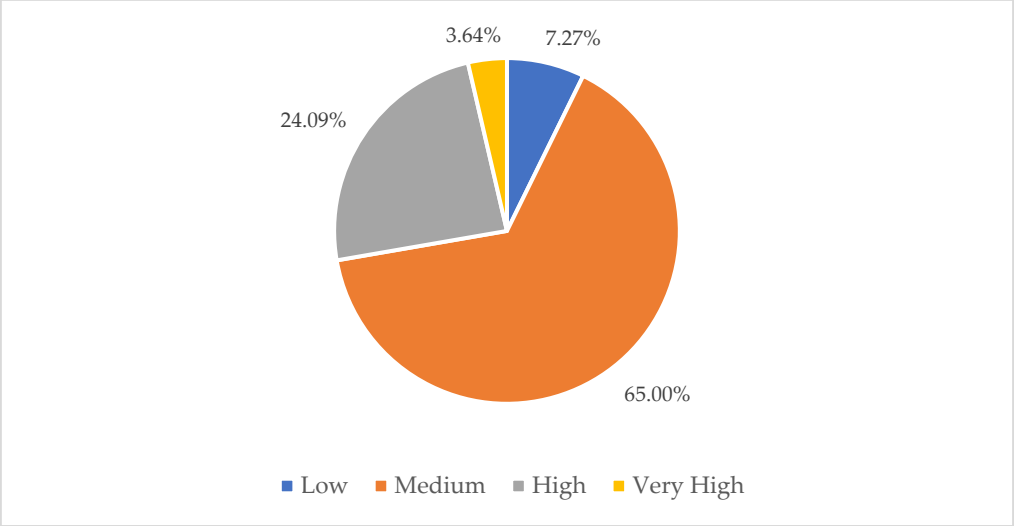

Figure 4. distribution of level of perceived stress.

Landscape Values Perception Findings

Original Photographs versus Manipulated Photographs

According to table 4, people's preferences to manipulated photographs tended to slightly modify the original attribution given to the Photographs. For photographs 1 and 4, the manipulated version translated in lower negative opinions than in the original photographs, whereas in photograph 3, people expressed much more positive opinions, and in photograph 2, negative opinions were actually prevalent.

Table 4. Summary of people's perception and emotions towards the landscape. **Green color transparency reflects positive opinions, with dark green having significantly more positive opinions in manipulated photographs than original photographs and displaying a range of positive opinions from very low (light green color) to very high (dark green color). Finally, the gray color indicates that the manipulated photos have more negative opinions than the original photographs.*

Photographs/Adjectives		Anxious/Serene	Restless/Tranquil	Tense/Calm
Photograph 1	Original	Anxious (50.45%)	Restless (35.35%)	Tense (52.73%)
	Manipulated	Anxious (39.09%)	Tranquil (37.73%)	Tense (43.18%)
Photograph 2	Original	Anxious (48.40%)	Restless (45%)	Tense (48.64%)
	Manipulated	Anxious (49.55%)	Restless (49.55%)	Tense (50%)
Photograph 3	Original	Anxious (53.18%)	Restless (31.82%)	Tense (51.82%)
	Manipulated	Serene (45.45%)	Tranquil (56.36%)	Calm (34.55%)
Photograph 4	Original	Anxious (46.82%)	Restless (40.91%)	Tense (45.91%)
	Manipulated	Anxious (35%)	Tranquil (44.55%)	Tense (38.64%)

Relationship Between Stress Level and Landscape Values Perception

Multinomial logistic regression was used to determine the relationship between stress level and value perception. According to Table 5, the following metrics together indicate that our model fits the data reasonably well. The significant chi-square test indicates that the model fits better than a null model, and the pseudo-R-squared value represents a significant portion of the variance explained. The AIC and BIC values serve as benchmarks for comparing this model to others with varying parameters or structures.

Table 5. Model Fit Measures and Overall Model Test Results.

Model Fit Measures

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				Overall Model Test		
Deviance	AIC	BIC	R^2_{McF}	χ^2	df	p
229	523	1022	0.442	182	144	0.019

Table 6 presents the results of a series of linear regressions examining the differences in the perceived stress levels under different conditions of emotional perception for certain photographs. The photographs are categorized based on the emotional states they evoke: Anxious/Serene, Restless/Tranquil, and Tense/Calm. Comparisons are made across different stress levels (High, Medium, and Very High) relative to a Low stress baseline. The key metrics presented for each condition are the estimate, lower and upper bounds of the 95% confidence interval, standard error (SE), Z-score, and p-value. Each emotional state category has "Neutral" as reference level, which means that comparisons are made against this neutral baseline. For example, when studying how serene, anxious, tranquil, restless, tense, or calm perceptions affect stress, these effects are compared to how "Neutral" perceptions influence stress.

Similarly, "Low" stress is the reference category. This means that changes in stress due to emotional perceptions are compared to a low stress baseline. Each stress level (Medium, High, and Very High) is evaluated based on how much more or less stress is perceived compared to the Low stress level.

According to Table 6, in the High-Low stress level in Photograph 2 (Anxious/Serene), "Anxious-Neutral" shows a significant negative effect (-5.4329, p = 0.026). In addition, in Photograph 1 (Restless/Tranquil), "Very Tranquil-Neutral" has a very high estimate (22.6392) with a very significant p-value (< 0.001). Also, in Photograph 2 (Tense/Calm): "very calm-neutral" has a very high estimate (-31.1297) with a very significant p-value (<0.001).

In Medium-Low stress level, in Photograph 1 (anxious/serene), “Very serene-neutral” has a high estimate (117.9843) with a very significant p-value (<0.001). Also, for Photograph 2 (anxious/serene), there are some positive and negative estimates with a high significant p-value ("Anxious-Neutral," "Serene-neutral", “Very Serene-Neutral". Also, for Photograph 4 (Anxious/Serene), “Very Anxious-Neutral” has a negative estimate of -8.7050 with a significant p-value of 0.027. In a Restless/tranquil emotional state, in Photograph 1 in "Very Tranquil-Neutral", there is a positive estimate (222.2857). Also, in Photograph 4 in "Very Tranquil-Neutral", it has a negative estimate (-7.9392).

Also, in a tense or calm emotional state, there are two significant negative estimates, followed by “calm-neutral” in Photograph 2 and “very tense-neutral” in Photograph 3.

In the very high-low stress level, in the anxious/serene emotional state, in Photograph 1, there is a highly significant negative estimate of “very serene-neutral.”. Also in Photograph 2, there are two negative estimates with a very high significant p-value, followed by "Serene-Neutral" and “Very-Serene-Neutral." In a Restless/Tranquil emotional state, there is a negative estimate (-0.0321) with a very high significant p-value in Photograph 2 (Very Tranquil-Neutral") and a positive estimate (8.2108) in Photograph 1 ("Very Tranquil-Neutral").

Table 6. Impact of Emotional Perceptions on Stress Levels: A Linear Regression Analysis.

			95% Confidence Interval				
Level of stress	**Predictor**	**Estimate**	**Lower**	**Upper**	**SE**	**Z**	**p**
High - Low	Intercept	4.6995	-2.3343	11.7332	3.58873	1.3095	0.190
	Photograph 1-(Anxious/Serene) :						
	Anxious – Neutral	2.1149	-1.1772	5.4069	1.67964	1.2591	0.208

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Serene – Neutral	1.1958	-2.7228	5.1143	1.99931	0.5981	0.550
	Very Serene – Neutral	-14.2037	NaN	NaN	NaN	NaN	NaN
	Very anxious – Neutral	20.1354	-64.4262	104.6971	43.14450	0.4667	0.641
	Photograph 2-(Anxious/Serene) :						
	Anxious – Neutral	-5.4329	-10.2025	-0.6633	2.43353	-2.2325	0.026
	Serene – Neutral	-9.2535	NaN	NaN	NaN	NaN	NaN
	Very Serene – Neutral	-12.8545	NaN	NaN	NaN	NaN	NaN
	Very anxious – Neutral	-3.1994	-10.8985	4.4997	3.92820	-0.8145	0.415
	Photograph 3-(Anxious/Serene) :						
	Anxious – Neutral	4.7599	-1.1784	10.6982	3.02981	1.5710	0.116
	Serene – Neutral	-1.6589	-6.9051	3.5873	2.67667	-0.6198	0.535
	Very Serene – Neutral	1.3853	-4.6191	7.3898	3.06355	0.4522	0.651
	Very anxious – Neutral	17.4496	-51.6138	86.5130	35.23706	0.4952	0.620
	Photograph 4-(Anxious/Serene) :						
	Anxious – Neutral	-1.1640	-5.7256	3.3976	2.32740	-0.5001	0.617
	Serene – Neutral	-1.4336	-5.2306	2.3634	1.93727	-0.7400	0.459
	Very Serene – Neutral	7.5441	-1.6046	16.6927	4.66778	1.6162	0.106
	Very anxious – Neutral	-7.3304	-15.1242	0.4633	3.97649	-1.8434	0.065
	Photograph 1-(Restless/Tranquil):						
	Restless – Neutral	-1.3410	-5.1444	2.4624	1.94055	-0.6910	0.490

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Tranquil – Neutral	-0.0192	-3.1819	3.1435	1.61366	-0.0119	0.990
	Very Tranquil – Neutral	22.6392	21.7142	23.5642	0.47196	47.9685	< .001
	Very restless – Neutral	14.9166	-144.8612	174.6945	81.52081	0.1830	0.855
	Photograph 2-(Restless/Tranquil):						
	Restless – Neutral	4.1601	-0.2208	8.5410	2.23518	1.8612	0.063
	Tranquil – Neutral	-0.2035	-4.6895	4.2826	2.28885	-0.0889	0.929
	Very Tranquil – Neutral	9.3087	-154.5762	173.1935	83.61627	0.1113	0.911
	Very restless – Neutral	1.2321	-5.8739	8.3381	3.62559	0.3398	0.734
	Photograph 3-(Restless/Tranquil):						
	Restless – Neutral	19.2499	-63.6016	102.1015	42.27198	0.4554	0.649
	Tranquil – Neutral	1.6671	-2.9020	6.2362	2.33122	0.7151	0.475
	Very Tranquil – Neutral	-0.9003	-5.7378	3.9372	2.46815	-0.3648	0.715
	Very restless – Neutral	-4.2033	-39.3953	30.9888	17.95547	-0.2341	0.815
	Photograph 4-(Restless/Tranquil):						
	Restless – Neutral	0.8658	-4.1287	5.8604	2.54828	0.3398	0.734
	Tranquil – Neutral	0.4577	-2.5142	3.4295	1.51628	0.3018	0.763
	Very Tranquil – Neutral	-6.8524	-14.2658	0.5610	3.78241	-1.8116	0.070
	Very restless – Neutral	18.1303	-103.2041	139.4647	61.90645	0.2929	0.770
	Photograph 1-(Tense/Calm):						
	Calm – Neutral	-2.0745	-6.5029	2.3539	2.25942	-0.9182	0.359

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Tense – Neutral	-3.7870	-8.0405	0.4665	2.17020	-1.7450	0.081
	Very calm – Neutral	-2.4014	-8.3044	3.5017	3.01182	-0.7973	0.425
	Very tense – Neutral	-20.8973	-103.2092	61.4145	41.99662	-0.4976	0.619
	Photograph 2-(Tense/Calm):						
	Calm – Neutral	-5.5131	-11.9175	0.8912	3.26759	-1.6872	0.092
	Tense – Neutral	-1.2143	-7.0962	4.6677	3.00107	-0.4046	0.686
	Very calm – Neutral	-31.1297	-31.1297	-31.1297	3.23e-8	-9.63e−8	< .001
	Very tense – Neutral	-3.2254	-10.7030	4.2523	3.81521	-0.8454	0.398
	Photograph 3-(Tense/Calm):						
	Calm – Neutral	2.8066	-0.9492	6.5625	1.91628	1.4646	0.143
	Tense – Neutral	-0.7021	-5.7671	4.3629	2.58423	-0.2717	0.786
	Very calm – Neutral	-1.3507	-5.5685	2.8671	2.15198	-0.6276	0.530
	Very tense – Neutral	-8.4144	-17.9133	1.0844	4.84643	-1.7362	0.083
	Photograph 4-(Tense/Calm):						
	Calm – Neutral	-0.4287	-4.4682	3.6108	2.06102	-0.2080	0.835
	Tense – Neutral	6.0316	-0.2591	12.3223	3.20960	1.8792	0.060
	Very calm – Neutral	3.2780	-2.2398	8.7959	2.81528	1.1644	0.244
	Very tense – Neutral	21.5797	-44.7373	87.8967	33.83583	0.6378	0.524
Medium - Low	Intercept	5.2528	-1.6813	12.1870	3.53791	1.4847	0.138
	Photograph 1-(Anxious/Serene) :						
	Anxious – Neutral	1.8543	-1.3422	5.0507	1.63086	1.1370	0.256

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Serene – Neutral	1.4828	-2.2499	5.2155	1.90446	0.7786	0.436
	Very Serene – Neutral	17.9843	17.9840	17.9846	1.46e-4	122913.8936	< .001
	Very anxious – Neutral	19.0630	-65.4704	103.5965	43.13012	0.4420	0.658
	Photograph 2-(Anxious/Serene) :						
	Anxious – Neutral	-4.8493	-9.5388	-0.1597	2.39267	-2.0267	0.043
	Serene – Neutral	16.2681	16.2661	16.2702	0.00105	15466.8847	< .001
	Very Serene – Neutral	-30.4460	-30.4460	-30.4460	1.12e-5	-2.71e−6	< .001
	Very anxious – Neutral	-2.5419	-10.1186	5.0348	3.86572	-0.6576	0.511
	Photograph 3-(Anxious/Serene) :						
	Anxious – Neutral	4.6028	-1.2304	10.4359	2.97617	1.5465	0.122
	Serene – Neutral	-1.1342	-6.2639	3.9956	2.61725	-0.4333	0.665
	Very Serene – Neutral	2.9104	-2.8587	8.6795	2.94347	0.9888	0.323
	Very anxious – Neutral	19.3867	-49.6427	88.4161	35.21974	0.5505	0.582
	Photograph 4-(Anxious/Serene) :						
	Anxious – Neutral	-0.8112	-5.2726	3.6502	2.27625	-0.3564	0.722
	Serene – Neutral	-0.9796	-4.5997	2.6405	1.84703	-0.5304	0.596
	Very Serene – Neutral	5.4433	-3.5797	14.4663	4.60367	1.1824	0.237
	Very anxious – Neutral	-8.7050	-16.4425	-0.9675	3.94777	-2.2050	0.027
	Photograph 1-(Restless/Tranquil):						
	Restless – Neutral	-0.9996	-4.6794	2.6803	1.87753	-0.5324	0.594

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Tranquil – Neutral	0.6944	-2.3422	3.7310	1.54932	0.4482	0.654
	Very Tranquil – Neutral	22.2857	21.3607	23.2107	0.47196	47.2191	< .001
	Very restless – Neutral	14.1970	-145.5799	173.9739	81.52033	0.1742	0.862
	Photograph 2-(Restless/Tranquil):						
	Restless – Neutral	4.1021	-0.1943	8.3984	2.19206	1.8713	0.061
	Tranquil – Neutral	0.6743	-3.6219	4.9706	2.19199	0.3076	0.758
	Very Tranquil – Neutral	7.8182	-156.1162	171.7526	83.64155	0.0935	0.926
	Very restless – Neutral	2.2883	-4.6603	9.2369	3.54527	0.6455	0.519
	Photograph 3-(Restless/Tranquil):						
	Restless – Neutral	19.7659	-63.0708	102.6026	42.26439	0.4677	0.640
	Tranquil – Neutral	1.4255	-3.0346	5.8856	2.27562	0.6264	0.531
	Very Tranquil – Neutral	-1.0140	-5.6939	3.6660	2.38779	-0.4246	0.671
	Very restless – Neutral	-4.4225	-39.5804	30.7354	17.93805	-0.2465	0.805
	Photograph 4-(Restless/Tranquil):						
	Restless – Neutral	0.7631	-4.1926	5.7187	2.52844	0.3018	0.763
	Tranquil – Neutral	0.3786	-2.4111	3.1684	1.42336	0.2660	0.790
	Very Tranquil – Neutral	-7.9392	-15.3128	-0.5656	3.76212	-2.1103	0.035
	Very restless – Neutral	17.6491	-103.6811	138.9792	61.90429	0.2851	0.776
	Photograph 1-(Tense/Calm):						
	Calm – Neutral	-1.4782	-5.8054	2.8490	2.20780	-0.6696	0.503

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Tense – Neutral	-3.1430	-7.3019	1.0160	2.12195	-1.4812	0.139
	Very calm – Neutral	-4.9258	-10.8244	0.9729	3.00959	-1.6367	0.102
	Very tense – Neutral	-21.6336	-103.9102	60.6430	41.97862	-0.5153	0.606
	Photograph 2-(Tense/Calm):						
	Calm – Neutral	-6.1634	-12.4447	0.1179	3.20481	-1.9232	0.054
	Tense – Neutral	-1.8393	-7.6322	3.9536	2.95560	-0.6223	0.534
	Very calm – Neutral	-5.5442	-13.6020	2.5135	4.11117	-1.3486	0.177
	Very tense – Neutral	-3.5975	-10.9240	3.7290	3.73809	-0.9624	0.336
	Photograph 3-(Tense/Calm):						
	Calm – Neutral	2.3387	-1.3210	5.9984	1.86723	1.2525	0.210
	Tense – Neutral	-1.1078	-6.0398	3.8243	2.51638	-0.4402	0.660
	Very calm – Neutral	-1.4103	-5.4198	2.5992	2.04568	-0.6894	0.491
	Very tense – Neutral	-9.2410	-18.5987	0.1167	4.77443	-1.9355	0.053
	Photograph 4-(Tense/Calm):						
	Calm – Neutral	0.3186	-3.5597	4.1969	1.97874	0.1610	0.872
	Tense – Neutral	5.7890	-0.3843	11.9624	3.14972	1.8380	0.066
	Very calm – Neutral	3.8337	-1.5243	9.1917	2.73372	1.4024	0.161
	Very tense – Neutral	23.1036	-43.2034	89.4106	33.83072	0.6829	0.495
Very High - Low	Intercept	-26.5160	-316.5767	263.5446	147.99285	-0.1792	0.858
	Photograph 1-(Anxious/Serene):						

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Anxious – Neutral	10.7056	-333.2569	354.6681	175.49428	0.0610	0.951
	Serene – Neutral	-3.7956	-289.8616	282.2704	145.95471	-0.0260	0.979
	Very Serene – Neutral	-1.4589	-1.4592	-1.4586	1.47e-4	-9919.0120	< .001
	Very anxious – Neutral	21.7959	-126.4369	170.0287	75.63037	0.2882	0.773
	Photograph 2-(Anxious/Serene) :						
	Anxious – Neutral	-5.9914	-276.2947	264.3119	137.91239	-0.0434	0.965
	Serene – Neutral	-0.8896	-0.8914	-0.8878	9.18e-4	-969.4100	< .001
	Very Serene – Neutral	-6.3288	-7.3901	-5.2675	0.54150	-11.6876	< .001
	Very anxious – Neutral	1.8782	-255.6415	259.3979	131.39000	0.0143	0.989
	Photograph 3-(Anxious/Serene) :						
	Anxious – Neutral	-5.5638	-201.5949	190.4674	100.01772	-0.0556	0.956
	Serene – Neutral	4.9162	-265.2728	275.1053	137.85407	0.0357	0.972
	Very Serene – Neutral	-17.9057	-232.8648	197.0534	109.67504	-0.1633	0.870
	Very anxious – Neutral	24.9166	-125.9910	175.8242	76.99510	0.3236	0.746
	Photograph 4-(Anxious/Serene) :						
	Anxious – Neutral	-18.0372	-323.5809	287.5064	155.89249	-0.1157	0.908

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Serene – Neutral	-27.5125	-339.6767	284.6517	159.27037	-0.1727	0.863
	Very Serene – Neutral	22.8097	-223.9838	269.6032	125.91736	0.1811	0.856
	Very anxious – Neutral	-23.1986	-244.3849	197.9876	112.85220	-0.2056	0.837
	Photograph 1-(Restless/Tranquil):						
	Restless – Neutral	9.9340	-250.1160	269.9840	132.68102	0.0749	0.940
	Tranquil – Neutral	5.6066	-167.0692	178.2825	88.10154	0.0636	0.949
	Very Tranquil – Neutral	8.2108	8.2106	8.2110	8.99e-5	91318.9991	< .001
	Very restless – Neutral	-6.6587	-326.1989	312.8814	163.03368	-0.0408	0.967
	Photograph 2-(Restless/Tranquil):						
	Restless – Neutral	16.2813	-294.4418	327.0044	158.53511	0.1027	0.918
	Tranquil – Neutral	23.7384	-264.3237	311.8006	146.97317	0.1615	0.872
	Very Tranquil – Neutral	-0.0321	-0.0323	-0.0320	8.55e-5	-375.8820	< .001
	Very restless – Neutral	19.9280	-261.9520	301.8079	143.81895	0.1386	0.890
	Photograph 3-(Restless/Tranquil):						
	Restless – Neutral	30.3006	-368.9689	429.5702	203.71271	0.1487	0.882
	Tranquil – Neutral	1.1550	-223.9985	226.3085	114.87635	0.0101	0.992

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Very Tranquil – Neutral	-14.8075	-183.8176	154.2026	86.23123	-0.1717	0.864
	Very restless – Neutral	-3.4429	-35.0953	28.2096	16.14952	-0.2132	0.831
	Photograph 4-(Restless/Tranquil):						
	Restless – Neutral	-1.7501	-262.6201	259.1198	133.09936	-0.0131	0.990
	Tranquil – Neutral	2.7264	-262.4988	267.9516	135.32146	0.0201	0.984
	Very Tranquil – Neutral	-8.1195	-20.1809	3.9419	6.15387	-1.3194	0.187
	Very restless – Neutral	-4.7047	-247.2398	237.8303	123.74465	-0.0380	0.970
	Photograph 1-(Tense/Calm):						
	Calm – Neutral	4.9525	-303.9748	313.8799	157.61889	0.0314	0.975
	Tense – Neutral	-22.6183	-238.5635	193.3270	110.17817	-0.2053	0.837
	Very calm – Neutral	-3.2255	-172.1436	165.6925	86.18427	-0.0374	0.970
	Very tense – Neutral	-28.5373	-453.9261	396.8516	217.03912	-0.1315	0.895
	Photograph 2-(Tense/Calm):						
	Calm – Neutral	-26.2947	-491.2659	438.6765	237.23456	-0.1108	0.912
	Tense – Neutral	-7.7818	-234.8986	219.3349	115.87803	-0.0672	0.946
	Very calm – Neutral	23.3459	-185.6352	232.3270	106.62496	0.2190	0.827

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Level of stress	Predictor	Estimate	95% Confidence Interval		SE	Z	p
			Lower	Upper			
	Very tense – Neutral	-13.7971	-227.3986	199.8043	108.98232	-0.1266	0.899
	Photograph 3- (Tense/Calm):						
	Calm – Neutral	17.7439	-141.8107	177.2985	81.40692	0.2180	0.827
	Tense – Neutral	4.3553	-215.6174	224.3280	112.23303	0.0388	0.969
	Very calm – Neutral	15.8358	-249.5955	281.2671	135.42661	0.1169	0.907
	Very tense – Neutral	15.7802	-174.8174	206.3777	97.24542	0.1623	0.871
	Photograph 4- (Tense/Calm):						
	Calm – Neutral	-4.8382	-264.2047	254.5283	132.33226	-0.0366	0.971
	Tense – Neutral	-2.0770	-148.2941	144.1401	74.60193	-0.0278	0.978
	Very calm – Neutral	-25.5973	-143.0798	91.8852	59.94116	-0.4270	0.669
	Very tense – Neutral	47.0470	-73.6793	167.7733	61.59619	0.7638	0.445

4. Discussion

General Observations

The investigation of visual perception in industrial areas represents a crucial aspect of urban planning and design, and a significant correlation has been observed between this phenomenon and perceived stress. Gaining insight into how individuals perceive and interpret their environment in these areas enables urban planners and designers to make strategic choices aimed at perceived stress reduction and the enhancement of safety. This process involves careful consideration of various factors, including the visual aesthetics of industrial zones, the clear visibility of potential hazards, and the general visual effect on the local community.

Several studies [16,20–23,25,27,28,35] have consistently demonstrated the positive impact of urban green spaces as landscape values on reducing stress levels and promoting overall well-being and explored the restorative effects of green environments on mental health, emphasizing the significance of landscape characteristics and spatial distribution in influencing stress levels and psychological well-being in urban settings.

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Compared to other studies, the present study provided significant insights into a variety of topics, including, perceived stress levels, and the emotional impact of Photograph manipulation, all of which have important implications in urban planning and management.

The analysis of engagement patterns in perceived stress levels indicates that the majority of participants, accounting for 65% of respondents, fall within the medium stress category, which includes scores ranging from 4 to 8. Subsequently, a significant proportion of individuals, specifically 24%, encounter high levels of stress. Conversely, a smaller percentage of 7% undergo low levels of stress, while 4% endure extremely elevated levels of stress. The distribution of stress levels among respondents emphasizes the high occurrence of moderate stress and emphasizes the significance of comprehending how stress is perceived to provide targeted interventions and support.

The study's comparison of emotional perceptions in original and manipulated photographs reveals that visual changes have a significant impact on viewers' emotional perceptions. The effectiveness of these manipulations in altering perceptions of restlessness suggests a complex interaction between visual elements and perceived emotions, emphasizing the importance of visual signals in image processing. For example, photograph number 3 is perceived as an anxious place in the original Photograph but a serene place in the manipulated Photograph. Greenery improves landscape aesthetics and reduces perceived stress levels, making it an important consideration in urban planning and environmental design discussions. Integrating green spaces not only improves the appearance of the surroundings, but it also promotes mental health and ecological balance within communities. Furthermore, this study shows the relationship between perceived stress and landscape values perception. The linear regression analysis of the impact of emotional perceptions on stress levels reveals significant variations across different emotional states and Photographs. While some predictors show statistically significant associations with stress levels, others do not. The emotional perception of manipulated Photographs has an impact on perceived stress levels, particularly serene and tranquil perceptions, which consistently show a decrease in stress. However, the effects vary depending on the individuals' initial stress level. Emotional perceptions have a significant impact on stress levels, with notable variations depending on emotional state and context (Photograph).

The most consistent significant predictors are observed in the very serene and very tranquil states, implying that these states can significantly reduce or increase stress levels, depending on the context (Photograph).

These findings highlight the intricate interplay between stress perception, environmental appraisal, and individual stress levels, providing insight into the complex dynamics that shape people's emotional responses to their surroundings.

Implications For Planning

The study's findings have significant implications for urban planning and design, particularly in terms of managing and reducing perceived stress levels in industrial areas. First, engagement trends indicate the need for more inclusive and adaptable participatory methods that bridge the digital divide and increase community involvement in planning processes. Second, the link between the visual visibility of industrial structures and stress emphasizes the importance of strategic landscape design and visual screening in mental health management practices.

Urban planners and designers are encouraged to incorporate multifunctional, dynamic, and inclusive public spaces that are enhanced with natural elements to improve visual aesthetics and reduce the perceived stress level associated with industrial activities. The efficacy of Photograph manipulation in altering emotional perceptions demonstrates visual media interventions' potential to improve public well-being and shape positive attitudes toward industrial zones.

Consideration of The Applied Methods

The study's methodologies, which included empirical analysis, the semantic differential method, and psychophysiological measurements, provided a solid foundation for understanding both the subjective and objective aspects of visual perception and emotional response. However, the study

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had limitations due to restricted internet access in Iran at certain times. Furthermore, the low participation rate of Bagher-Shahr residents, many of whom were undocumented immigrants with limited literacy skills, hampered comprehensive data collection. These issues highlight the importance of more inclusive and adaptable research methodologies in future studies. Future research should investigate how advances in Photograph editing technology can improve societal well-being through visual media, as well as how to reduce negative emotions caused by the presence of the oil refinery and generate positive emotions, thereby calming and improving the population's mental health.

5. Conclusions

This study focuses on the effectiveness of targeted interventions in perceived stress, and the emotional effects of Photograph manipulation. Furthermore, the study also suggests that Photograph manipulation can improve emotional responses to industrial settings, making it a promising tool for improving public well-being and perception through visual media.

These interventions are integrated by participatory methods, which offers numerous advantages. For example, manipulated photographs can aid in public advocacy efforts by providing visual evidence to support community concerns or goals. By superimposing photographs of potential impacts, community advocates can effectively communicate their message and rally support for their cause. Finally, the findings of this study highlight the intricate relationship between specific emotional perceptions and their impact on stress, emphasizing the significance of context in emotional experiences.

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