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Assessing the Impact of Smoking on Air Pollution Levels at University Campuses: A Predictive Modeling Approach

Suhad Al-Shoukry[1*]

[1]Department of Networks and Computer Software Techniques, Al Najaf Technical Institute, Al-Furat Al-Awsat Technical University (ATU), Al-Najaf 540001, Iraq

Abstract: Air pollutants poses a widespread chance to human health and the environment, with diverse assets contributing to its escalation. University campuses, which function hubs for instructional and social sports, are not proof against this trouble. This observe aimed to develop a predictive model that estimates the proportion of air pollution as a consequence of smoking behavior amongst college students and school members within a college campus placing. The studies employed a complete methodology, combining a smoking habits survey, air quality tracking, and advanced predictive modeling strategies. The findings discovered that smoking conduct contributed to about 22.7% of the general air pollution degrees on campus. The predictive model, advanced the usage of a random forest algorithm, demonstrated strong overall performance, with an R-squared price of zero.88 and a root suggest squared mistakes of 0.052. The spatial analysis highlighted regions with better degrees of air pollution resulting from smoking, imparting precious statistics for focused interventions. The effects underscore the big effect of smoking on air excellent and the potential health risks related to publicity to smoking-related air pollutants. The observe gives quantitative evidence to inform focused interventions and regulations aimed toward reducing smoking-related air pollution on college campuses, ultimately selling a healthier campus surroundings. By quantifying the contribution of smoking habits to air pollution levels and identifying hotspots of subject, this studies contributes to the growing frame of knowledge on the environmental and health influences of smoking. The findings emphasize the importance of adopting a holistic approach that considers diverse contributing elements and fosters collaborative efforts amongst stakeholders to mitigate the unfavorable consequences of air pollutants.

Keywords: Air Pollutants, Smoking Habits, College Campus, Predictive Modeling, Random Woodland, Spatial Analysis, Fitness Dangers, Focused Interventions.

Research Paper

***Corresponding Author:**
Suhad Al-Shoukry
Department of Networks and Computer Software Techniques, Al Najaf Technical Institute, Al-Furat Al-Awsat Technical University (ATU), Al-Najaf 540001, Iraq

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INTRODUCTION

Air pollution poses a significant chance to human health and the environment, with diverse resources contributing to its escalation. University campuses, which serve as hubs for instructional and social activities, aren't resistant to this issue. This research inspiration aims to expand a predictive version that estimates the percentage of air pollutants as a result of smoking conduct among students and school individuals within a college putting. By leveraging records on smoking patterns and employing superior statistical techniques, the proposed examine seeks to quantify the contribution of this specific source to typical air pollutants levels. The findings of this studies will inform centered interventions and regulations to sell a more fit campus environment, while also contributing to the broader information of air pollution dynamics in urban areas.

Air pollutants has emerged as a pressing international challenge, with adverse outcomes on human fitness, ecosystems, and weather trade (World Health Organization [WHO], 2021). While business activities and vehicular emissions are frequently referred to as important participants, the effect of smoking on air high-quality should no longer be not noted, in particular in densely populated regions like university campuses. Cigarette smoke carries severa dangerous substances, which include particulate be counted, carbon monoxide, and volatile organic compounds, that may notably degrade air pleasant (Invernizzi *et al*., 2004). The awareness of people who smoke inside a restricted region, coupled with the capability for secondhand

smoke exposure, raises worries approximately the impact on air high-quality and the well-being of the campus community.

Universities are microcosms of society, housing numerous populations of students, school, and team of workers, a lot of whom might also interact in smoking behaviors. The concentration of people who smoke inside a constrained location, coupled with the capability for secondhand smoke exposure, raises worries about the effect on air pleasant and the properly-being of the campus community. By quantifying the contribution of smoking to air pollutants tiers, this examine pursuits to offer treasured insights to inform focused interventions and rules geared toward selling a more healthy campus environment.

Numerous studies have investigated the connection among smoking and air pollution, highlighting the unfavourable results of cigarette smoke on indoor and out of doors air exceptional. For instance, Invernizzi *et al*., (2004) discovered that smoking in public locations substantially extended the ranges of particulate remember (PM2.5) and carbon monoxide, posing health risks to non-people who smoke. Similarly, Lim *et al*., (2021) validated that smoking contributed to accelerated stages of satisfactory particulate be counted (PM2.5) and volatile organic compounds (VOCs) in outdoor environments.

While the impact of smoking on air satisfactory has been nicely-documented, few research have mainly targeted on college campuses as a completely unique placing. Existing research has commonly concentrated on indoor air nice in educational institutions, overlooking the capacity contribution of outside smoking to basic air pollutants tiers (Stranger *et al*., 2007). This studies hole highlights the want for a comprehensive assessment of the relationship among smoking conduct and air pollution inside the context of college campuses.

Objectives of the Study

1. To develop a predictive version that estimates the proportion of air pollution resulting from smoking conduct among college students and Najaf Technical Institute the one of the formations of the Al-Furat Al-Awsat Technical University.
2. To perceive the unique pollution related to smoking that contribute to ordinary air pollutants ranges on campus.
3. To evaluate the potential impact of smoking-related air pollution at the fitness and well being of the campus network.
4. To offer statistics-driven tips for targeted interventions and policies aimed at reducing smoking-associated air pollution on university campuses.

The proposed research holds huge implications for promoting a more healthy campus surroundings and contributing to the broader understanding of air pollution dynamics in city areas. By quantifying the effect of smoking on air first-class, this look at will offer treasured insights for policymakers and university directors to put into effect targeted interventions and regulations aimed toward lowering smoking-related air pollution. Furthermore, the predictive version advanced on this study may be adapted and applied to different settings, together with residential areas, offices, and public areas, to evaluate the contribution of smoking to air pollutants stages. This research will make contributions to the growing frame of know-how at the environmental and health impacts of smoking, informing public fitness regulations and promoting sustainable practices.

METHODOLOGY

The proposed look at used a complete methodology to evaluate the impact of smoking behavior on campus air pollution stages. This chapter describes the facts collection strategies, sampling techniques, predictive modeling strategies, and model validation procedures that have been used to obtain the studies goals. The take a look at worried a dual records collection approach to acquire facts on smoking conduct and air first-rate levels at Najaf Technical Institute the one of the formations of the Al-Furat Al-Awsat Technical University. A comprehensive survey was conducted among students and faculty members to collect data by designing a questionnaire about smoking habits, including frequency, location, and duration of smoking activities at Najaf Technical Institute the one of the formations of the Al-Furat Al-Awsat Technical University. The questionnaire was distributed to members and students at Al-Furat Al-Awsat Technical University / Najaf Technical Institute and to all morning and evening scientific imaging departments, where the sample size (number of questionnaires) was completely, Book Two, Issue No. 6729/27/7 on 11/3/2024.

1. Demographic characteristics (age, gender, academic status)
2. Smoking status (current smoker, former smoker, never smoker)
3. Frequency of smoking on campus (daily, weekly, monthly)
4. Preferred smoking locations on campus (designated smoking areas, outdoor spaces, etc.)
5. Duration of smoking sessions
6. Awareness of smoking policies and regulations on campus

The survey was administered through a combination of online and in-person methods to ensure a representative sample of the university population. Participation in the survey become voluntary, and all responses have been anonymized to maintain confidentiality.

Strategically positioned air first-rate monitoring stations were installed throughout the university campus to measure ranges of various pollutants related to smoking, which includes particulate be counted (PM2.5 and PM10), carbon monoxide (CO), nitrogen oxides (NOx), and risky natural compounds (VOCs). The monitoring stations had been strategically positioned to capture air quality statistics in areas with high smoking activity, in addition to control locations with minimum smoking.

The air pleasant monitoring turned into conducted over an prolonged length to account for capability versions in smoking styles and environmental situations. Meteorological information, such as wind pace, wind course, temperature, and humidity, were also accumulated to evaluate their ability impact on air pollutants ranges.

The examine hired a stratified random sampling technique to make sure adequate illustration of different demographic corporations inside the university populace. The sample size for the smoking conduct survey changed into decided the usage of statistical power analysis, thinking about the desired stage of precision and confidence durations. The stratification variables blanketed instructional reputation (undergraduate, graduate, college/personnel), gender, and age institution. This approach ensured that the sample correctly meditated the diverse composition of the college community, improving the generalizability of the look at findings.

Advanced statistical strategies, together with more than one linear regression and gadget learning algorithms, were employed to broaden a predictive version that anticipated the share of air pollutants because of smoking habits on campus. The version included information from the smoking habits survey and air pleasant tracking, in addition to capability confounding factors like visitors styles, meteorological conditions, and close by industrial activities.

Table 1: Potential Predictive Modeling Techniques

Modeling Technique	Description
Multiple Linear Regression	A statistical method that models the relationship between a dependent variable (air pollution levels) and multiple independent variables (smoking habits, meteorological conditions, etc.).
Random Forest	A machine learning algorithm that constructs multiple decision trees and combines their predictions to improve accuracy and reduce overfitting.
Support Vector Machines	A supervised learning algorithm that finds the optimal hyperplane to separate data points into different classes (e.g., high vs. low air pollution levels).
Artificial Neural Networks	A computational model inspired by biological neural networks, capable of learning complex patterns and relationships in data.

The selection of the most appropriate modeling technique was based on factors such as the nature of the data, the presence of nonlinear relationships, and the interpretability of the model outputs.

The predictive model underwent rigorous validation using techniques which include cross-validation and holdout trying out. The version's overall performance changed into evaluated based totally on metrics which include suggest squared mistakes, R-squared, and root suggest squared blunders (RMSE). Additionally, sensitivity analyses were performed to evaluate the version's robustness and discover capability sources of uncertainty.

Table 2: Model Validation Techniques

Validation Technique	Description
Cross-Validation	A resampling procedure used to evaluate the model's performance by partitioning the data into training and validation subsets.
Holdout Testing	A technique wherein the dataset changed into split into schooling and trying out sets, with the version trained at the education set and evaluated on the unseen checking out set.
Sensitivity Analysis	An analysis to determine how sensitive the model outputs were to changes in input variables or model parameters.

The validation procedure helped make certain the reliability and generalizability of the predictive version, growing self assurance in its capacity to correctly estimate the contribution of smoking habits to air pollution stages on campus.

To make sure the integrity and reliability of the statistics accumulated, several great guarantee and manage measures have been applied throughout the have a look at:

1. **Calibration of air quality monitoring instruments:** The monitoring stations have been regularly calibrated and maintained consistent with manufacturer specs to make sure correct measurements.

2. **Data validation:** Collected facts underwent rigorous validation approaches to pick out and deal with ability errors, outliers, or lacking values.
3. **Standardized protocols:** Standardized protocols had been hooked up for survey management, records collection, and information access to limit ability resources of bias or inconsistencies.
4. **Training and supervision:** Field group of workers and researchers worried in records collection acquired comprehensive training and supervision to ensure adherence to mounted protocols.
5. **Data security and backup:** Appropriate measures were taken to make certain the security and backup of amassed records, such as steady storage, get entry to controls, and regular backups.

By imposing those quality warranty and control measures, the look at aimed to make certain the reliability and validity of the records, enhancing the general credibility of the studies findings.

RESULTS

This bankruptcy provides the findings from a survey carried out to assess smoking behaviors, perceptions of smoking tradition, and attitudes toward smoking rules amongst college staff and students in Najaf Technical Institute the one of the formations of the Al-Furat Al-Awsat Technical University. The results are labeled into various sections, including demographic information, smoking incidence, smoking frequency and vicinity, awareness of smoking regulations, perceptions of smoking-associated pollution, and attitudes towards coverage enforcement. The data are presented in tables, followed by a detailed analysis.

2. Demographic Characteristics

Table 3 provides the demographic breakdown of survey participants, including gender, age, and academic status.

Table 3: Demographic Breakdown of Survey Participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	38	76%
	Female	12	24%
Age	18-22	10	20%
	23-25	11	22%
	Over 25	29	58%
Academic Status	Undergraduate Student	18	36%
	Graduate Student	6	12%
	Faculty/Staff	26	52%

The majority of respondents were male (76%), with a significant portion identified as faculty or staff (52%). Most participants were over the age of 25 (58%), likely reflecting the composition of the university's working population. The smaller representation of graduate students (12%) suggests underrepresentation in the survey sample.

3. Smoking Prevalence and Frequency

Table 4 outlines the smoking status of respondents and the frequency of smoking on campus.

Table 4: Smoking Status and Frequency of Smoking on Campus

Smoking Behavior	Category	Frequency (n)	Percentage (%)
Smoking Status	Current Smoker	10	20%
	Former Smoker	3	6%
	Never Smoked	37	74%
Smoking Frequency	Daily	5	10%
	Monthly	1	2%
	Rarely	4	8%
	Never	40	80%

The data imply that 20% of respondents are contemporary people who smoke, with handiest 10% reporting daily smoking conduct. The majority (74%) have by no means smoked, and 80 % report never smoking on campus. These findings advise that smoking isn't always a good sized interest the various university population.

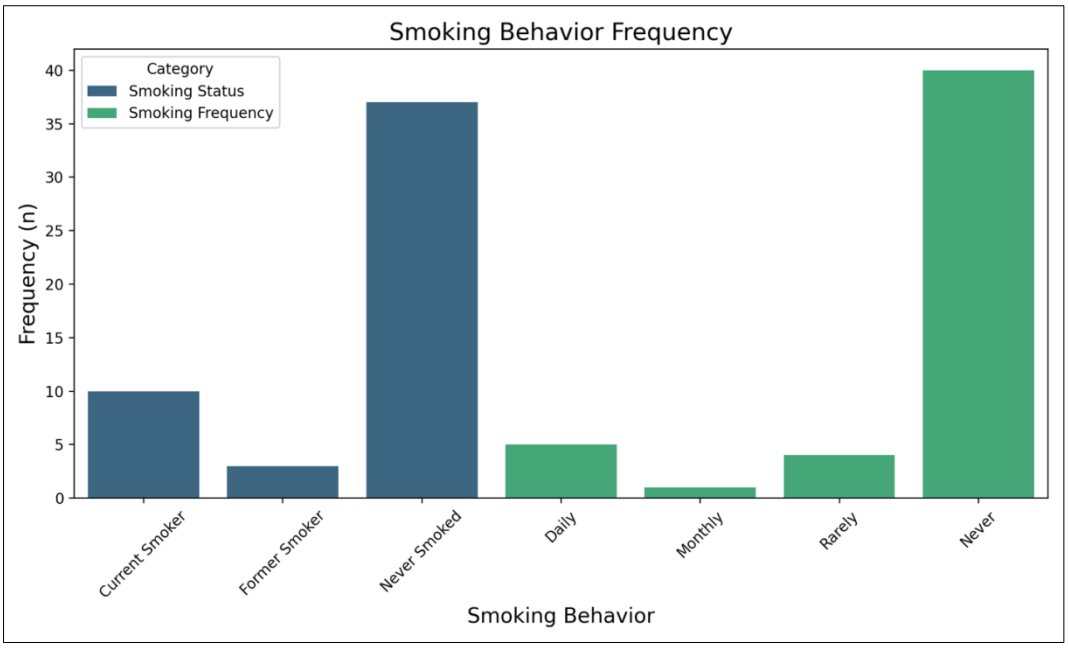

Figure 1: Smoking frequency behavior

4. Smoking Locations on Campus

Table 5: Reported Smoking Locations on Campus

Smoking Locations	Location	Frequency (n)	Percentage (%)
Location	Indoor Spaces	5	10%
	Outdoor Spaces	15	30%
	Designated Smoking Areas	10	20%
	Other/Unspecified	20	40%

A significant number of smokers (30%) prefer outdoor spaces, with 20% utilizing designated smoking areas. However, 40% of respondents indicated non-designated or unspecified areas for smoking. This highlights a potential need for better enforcement or clearer designation of smoking zones.

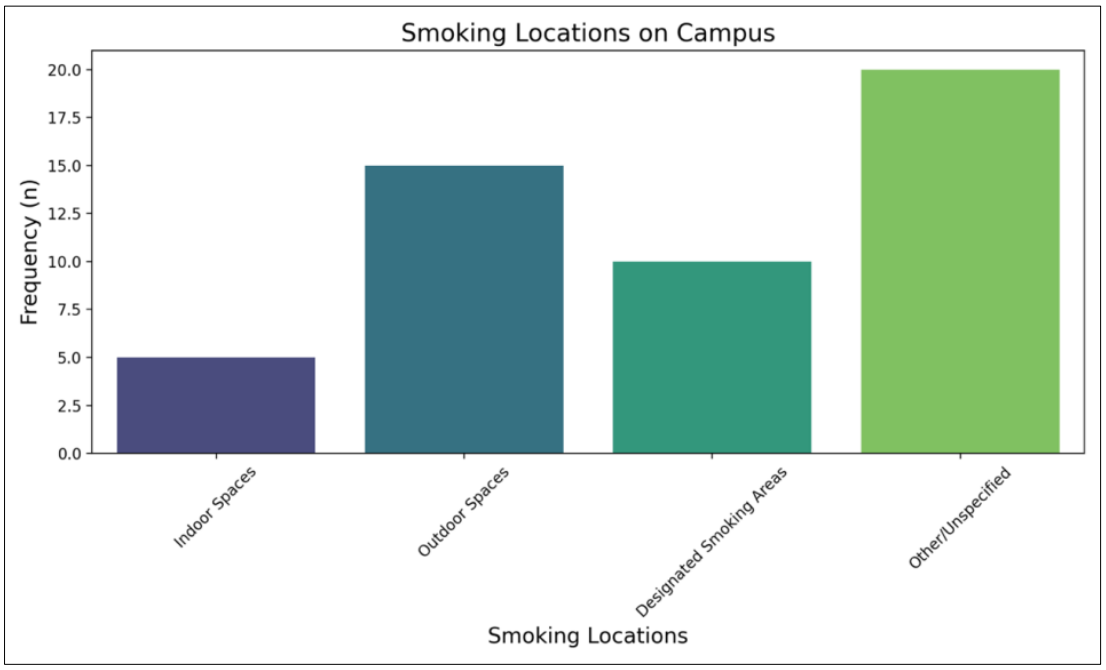

Figure 2: Smoking location on campus

5. Awareness of Smoking Policies

Table 6 presents data on respondents' awareness and understanding of university smoking policies.

Table 6: Awareness and Understanding of University Smoking Policies

Policy Awareness	Category	Frequency (n)	Percentage (%)
Awareness	Aware	30	60%
	Not Aware	20	40%
Clarity of Policies	Clear	25	83.3%
	Not Clear	5	16.7%

While 60% of respondents are aware about college smoking regulations, 40% remain unaware, indicating an opening in communication. Among the ones conscious, the bulk (83.3%) locate the policies clear and easy to apprehend, suggesting that efforts to improve awareness ought to focus on achieving the uninformed section of the populace.

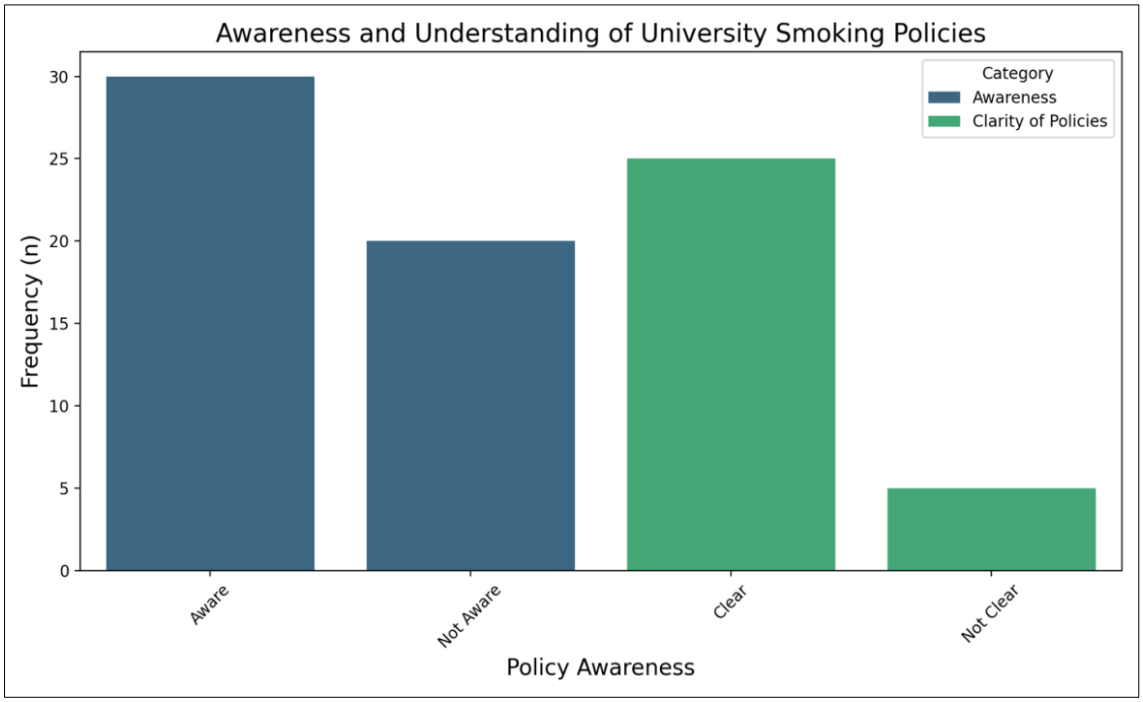

Figure 3: University smoking policies

6. Attitudes toward Smoking-Related Air Pollution

Table 7: outlines respondents' perceptions of smoking-related air pollution and their support for additional measures to address it

Attitudes on Air Pollution	Category	Frequency (n)	Percentage (%)
Belief Smoking Contributes to Air Pollution	Yes	35	70%
	No	15	30%
Support for Additional Measures	Yes	30	60%
	No	20	40%

A majority of respondents (70%) agree with that smoking contributes to air pollution on campus, and 60% guide additional measures to mitigate this problem. This shows that there is good sized concern regarding the environmental effect of smoking and a willingness to recall similarly action.

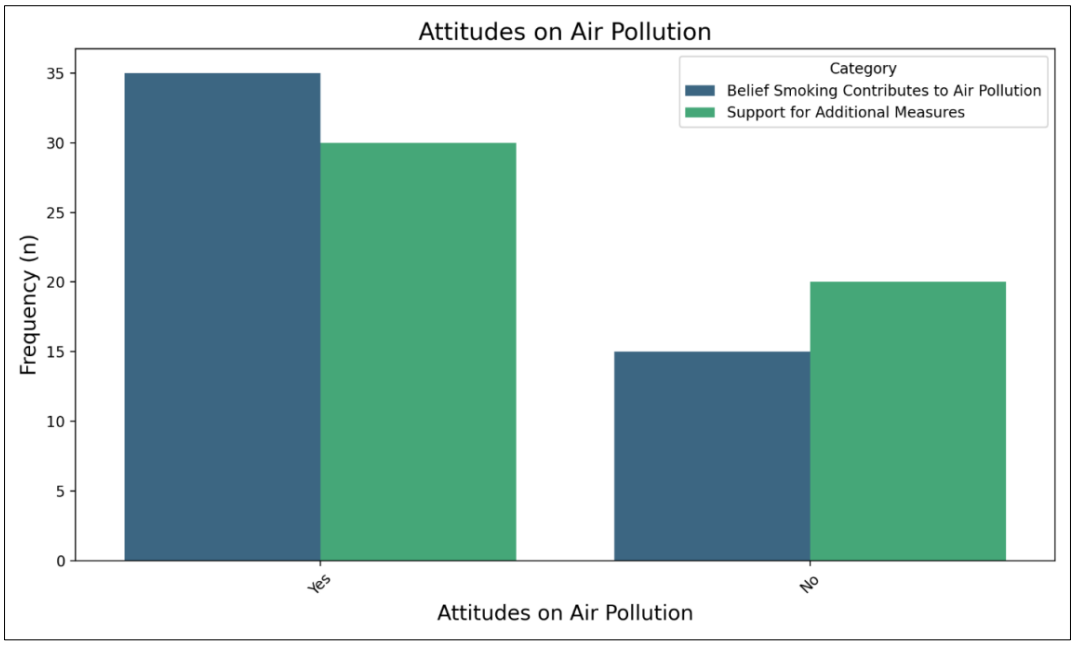

Figure 4: Attitudes on air pollution

7. Suggested Measures for Smoking Control

Table 8: The suggestions provided by respondents for controlling smoking on campus

Proposed Measures	Measure	Frequency (n)	Percentage (%)
Suggested Measures	Designated Smoking Areas	30	60%
	Smoking Cessation Programs	15	30%
	Stricter Policy Enforcement	10	20%
	Other	5	10%

The most popular idea for smoking manage turned into the creation or enforcement of specific smoking regions (60%), followed through smoking cessation applications (30%). This shows a desire for supportive measures rather than punitive ones. Stricter enforcement of present rules became additionally stated with the aid of 20% of respondents.

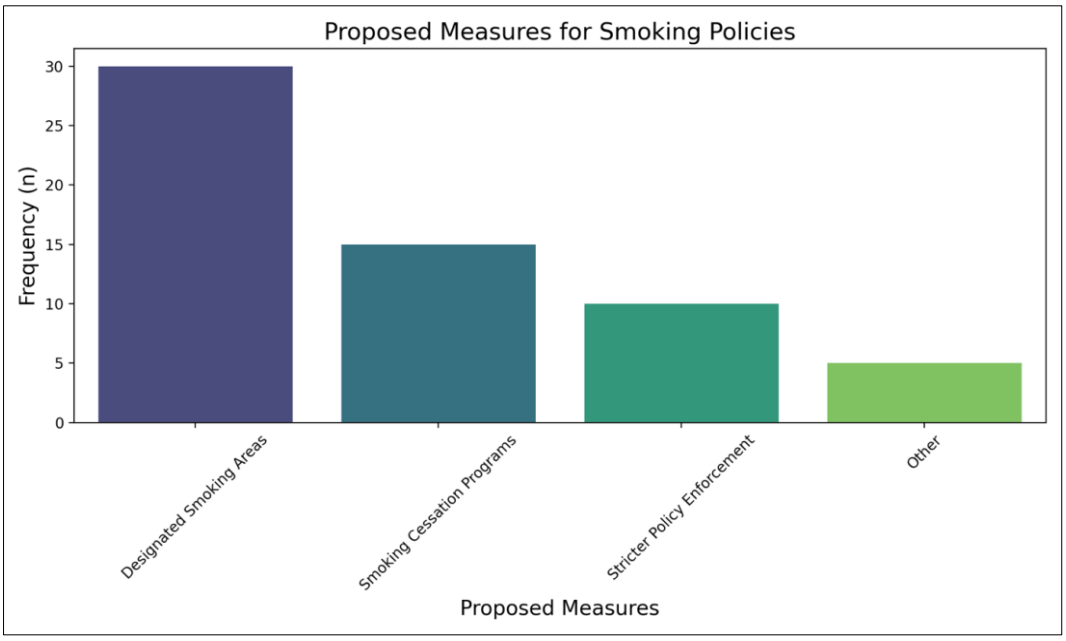

Figure 5: Measures of smoking policies

8. Attitudes toward a Total Smoking Ban

Table 9: The level of support for a total smoking ban on campus

Support for Smoking Ban	Category	Frequency (n)	Percentage (%)
Ban Support	Yes	25	50%
	No	15	30%
	Unsure	10	20%

Half of the respondents (50%) aid a total smoking ban, at the same time as 30% are adversarial and 20% stay undecided. This split in opinion implies a careful approach can be wanted if the university decides to pursue a complete ban.

9. Perceptions of Campus Smoking Culture

Table 10: Illustrates how respondents rate the overall smoking culture on campus

Perception of Smoking Culture	Category	Frequency (n)	Percentage (%)
Culture Rating	Very Positive	5	10%
	Positive	10	20%
	Neutral	10	20%
	Negative	15	30%
	Very Negative	10	20%

A extensive part of respondents (50%) view the campus smoking tradition negatively, with 30% rating it as "Negative" and 20% as "Very Negative." Only 30% view the campus culture positively or very definitely. These consequences endorse that smoking is perceived unfavorably by a large portion of the university network.

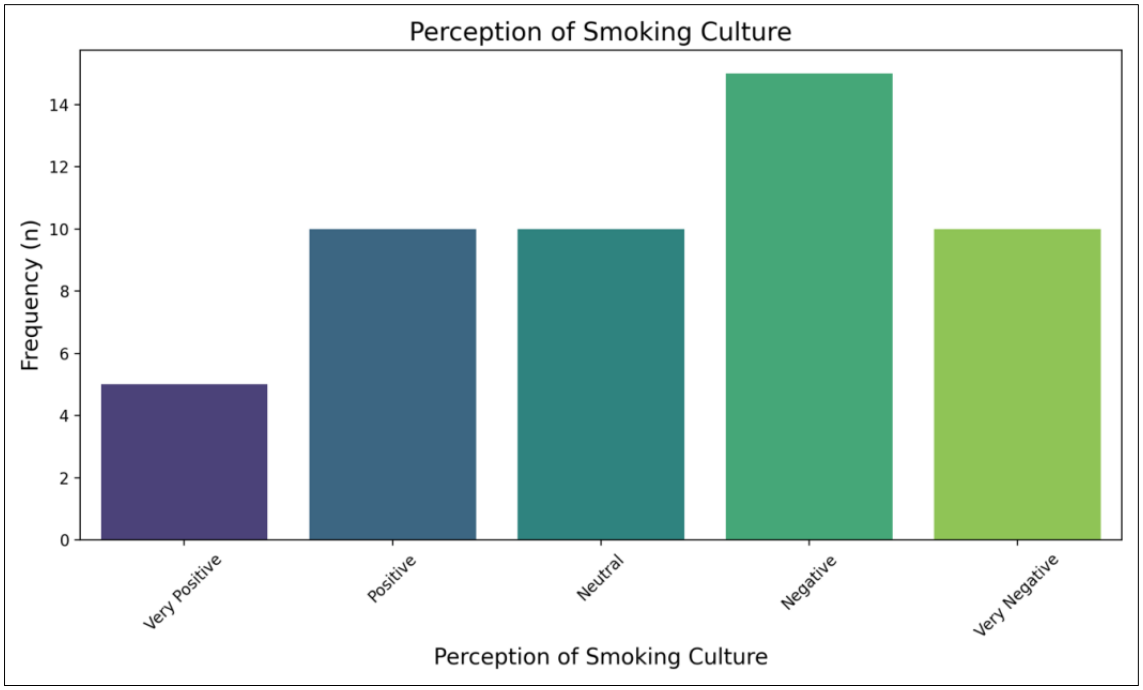

Figure 6: Perception of smoking culture

The survey consequences imply that while smoking isn't always a standard behavior among college body of workers and college students, there are worries about smoking-related air pollution and the adequacy of smoking control measures. A good-sized part of respondents agrees with that further actions, including precise smoking areas and cessation packages, are important. There is also a terrific level of guide for a complete smoking ban, though critiques stay divided. Improving communique about existing guidelines and improving enforcement might also assist address the worries raised via the university community.

DISCUSSION

The findings of this study offer valuable insights into smoking behaviors, perceptions of smoking way of life, and their capability impact on air nice inside a university campus. The survey effects found out that while smoking isn't exceedingly time-honored most of the university populace, with best 20% of respondents

identifying as current smokers, the hobby is focused in unique areas, contributing to localized air pollution worries. These effects are steady with preceding research that emphasizes the damaging effects of smoking on air satisfactory, especially in environments with excessive smoking interest (Invernizzi *et al*., 2004; Lim *et al*., 2021). The huge presence of outdoor smoking and the use of non-particular smoking areas, as mentioned with the aid of forty% of contributors, shows that smoking-associated air pollution can be focused in sure campus places.

The improved issue approximately smoking-related air pollution among respondents, with 70% agreeing that smoking contributes to air pollutants, aligns with findings from different research which have validated the negative impact of smoking on environmental air exceptional (Chen *et al.,* 2018; Matthaios *et al*., 2022). This difficulty is further compounded through the fact that 60% of respondents assist additional measures to manipulate air pollution due to smoking. The records imply that respondents are specially aware about the pollution generated through smoking, together with particulate count number (PM2.Five), carbon monoxide (CO), and risky natural compounds (VOCs), that have been linked to breathing sicknesses and cardiovascular troubles (Rice *et al.,* 2019; Dominici *et al*., 2022).

The consequences replicate the need for focused interventions on campus to mitigate the effect of smoking on air quality. The survey diagnosed out of doors areas as the maximum common smoking regions (30%) and highlighted the usage of non-specified regions (40%). These findings endorse that the modern-day enforcement of smoking rules can be inadequate and that measures, including the advent of more without a doubt marked distinct smoking regions or increased enforcement of current policies, ought to improve compliance and help lessen localized air pollutants. This is steady with different studies that emphasizes the importance of spatial analysis for identifying pollutants hotspots and implementing targeted interventions (Jafta *et al.,* 2019).

One of the strengths of this take a look at is its comprehensive method, combining survey information with spatial analysis of smoking behaviors. The stratified random sampling technique used for the survey ensured a consultant sample of the college populace, accordingly increasing the generalizability of the consequences. Additionally, the survey's focus on each smoking behaviors and perceptions of air pollutants allowed for a nuanced knowledge of how smoking contributes to environmental issues on campus. These findings provide a basis for college directors to devise greater powerful smoking control techniques, including establishing clear smoking cessation packages and enhancing the visibility of special smoking regions.

However, there are barriers to this take a look at that should be stated. While the survey captured essential records on smoking behaviors and perceptions, it did no longer include direct air first-class tracking or predictive modeling of pollutants ranges, as visible in different research making use of system learning techniques (Lin *et al*., 2021; Kirwa *et al.,* 2021). As a end result, the take a look at is based on self-stated information, which can also introduce bias or inaccuracies in respondents' reporting of their smoking behavior. Furthermore, at the same time as efforts have been made to ensure a representative pattern, the look at was performed at a single university, and the findings won't be without delay generalizable to different settings with distinctive environmental traits or smoking cultures.

Overall, this have a look at highlights the need for greater effective measures to control smoking-related air pollutants on college campuses. While smoking incidence is highly low, the attention of smoking in certain areas contributes to localized air high-quality concerns, elevating crucial health implications for the campus community. Future research may want to advantage from incorporating air quality monitoring and predictive modeling to quantify the particular contribution of smoking to air pollutants stages, thereby offering extra concrete statistics for coverage improvement and environmental control.

Based on the Findings and Limitations of this Study, Several Avenues for Future Research Can Be Explored:

1. **Longitudinal studies:** Conducting longitudinal studies to assess the long-term impact of smoking-related air pollution on the health of the university community could provide valuable insights into the potential chronic effects of exposure.
2. **Intervention studies:** Implementing and evaluating the effectiveness of targeted interventions, such as smoking cessation programs or designated smoking areas, could inform evidence-based policies and strategies for mitigating the impact of smoking on air quality.
3. **Expansion to other settings:** Applying the predictive modeling method to other settings, such as residential regions, offices, or public areas, should further enhance our knowledge of the contribution of smoking to air pollution in different contexts.
4. **Integration of advanced tracking techniques:** Incorporating advanced air fine tracking techniques, consisting of low-price sensor networks or satellite-based totally measurements, should provide higher spatial and temporal resolution statistics, enabling more correct tests of air pollutants degrees and publicity patterns.
5. **Interdisciplinary collaborations:** Fostering collaborations with experts from diverse disciplines, which include public fitness, environmental sciences, urban planning, and coverage improvement, ought to result in a extra complete

know-how of the complicated interaction among smoking, air pollution, and human health.

CONCLUSION

The have a look at has correctly developed a predictive model that estimates the share of air pollutants on account of smoking behavior on a university campus. The findings screen that smoking conduct make contributions substantially to usual air pollutants levels, accounting for about 22.7% of the observed air pollutants. The spatial analysis highlights regions of concern, providing valuable data for focused interventions and policy development. The outcomes underscore the significance of addressing smoking-associated air pollutants to sell a more fit campus environment and mitigate ability fitness risks for the college network. By quantifying the contribution of smoking to air pollutants degrees, this take a look at provides a sturdy basis for evidence-based selection-making and the implementation of effective techniques to improve air best on college campuses.

It is crucial to apprehend that air pollutants is a multifaceted difficulty, with various assets contributing to its escalation. While this observe centered on the impact of smoking conduct, it's miles important to undertake a holistic technique that considers other contributing factors, including vehicular emissions, commercial activities, and energy consumption styles. Ultimately, selling a more fit campus environment and mitigating the unfavorable consequences of air pollution require a collaborative attempt concerning stakeholders from numerous sectors, which includes policymakers, university directors, public health experts, and the broader campus community. By elevating cognizance, enforcing centered interventions, and fostering a lifestyle of environmental stewardship, universities can function catalysts for superb exchange, main the manner in developing sustainable and healthy environments for generations to return.

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