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Hypothesis

Integrating Data-Based Strategies and Advanced Technologies with Efficient Air Pollution Management in Smart Cities

Seunghwan Myeong [1,*,†] and Khurram Shahzad [2,†]

1 Department of Public Administration, Inha University, Incheon 22212, Korea
2 Department of Industrial Security & Governance, Inha University, Incheon 22212, Korea; ks1649057@gmail.com
* Correspondence: shmyeong@inha.ac.kr
† These authors contributed equally to this work.

Abstract: The COVID-19 pandemic has demonstrated that creative leadership based on data and citizen volunteers is more significant than vaccines themselves, so this study focuses on the collaboration of sophisticated technologies and human potential to monitor air pollution. Air pollution contributes to critical environmental problems in various towns and cities. With the emergence of the smart city concept, appropriate methods to curb exposure to pollutants must be part of an appropriate urban development policy. This study presents a technologically driven air quality solution for smart cities that advertises energy-efficient and cleaner sequestration in these areas. It attempts to explore how to incorporate data-driven approaches and citizen participation into effective public sector pollution management in smart cities as a major component of the smart city definition. The smart city idea was developed as cities became more widespread through communication devices. This study addresses the technical criteria for implementing a framework that public administration can use to prepare for renovation of public buildings, minimizing energy use and costs and linking smart police stations to monitor air pollution as a part of an integrated city. Such a digital transition in resource management will increase public governance energy performance and provide a higher standard for operations and a healthier environment. The study results indicate that complex processes lead to efficient and sustainable smart cities. This research discovered an interpretive pattern in how public agencies, private enterprises, and community members think and what they do in these regional contexts. It concludes that economic and social benefits could be realized by exploiting data-driven smart city development for its social and spatial complexities.

Keywords: smart cities; artificial intelligence; Internet of Things; air pollution

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1. Introduction

In the twenty-first century, rapid urbanization in a few major cities seems to be increasing, because in 1950, only 30% of the world's population lived in cities; by 2014, that figure had risen to 54%, and by 2050, it is projected to cross 66% [1]. Aside from the number of people, the average size of cities has grown [2]. This pattern of population growth is also raising new challenges as governments try to counter its negative consequences: traffic congestion, waste disposal, access to resources, and more crime. Many technical companies have adopted the smart city trend since 2005 as a potential solution to such issues. An abrupt rise in population trends towards urbanization has been observed recently [3]. The populations in cities are overgrowing and are expected to increase in the future [4]. Socioeconomics in urban areas has increased complexity when it comes to sustainability [5]. The increased urban population faces significant challenges as governments try to cope with health care [6], pollution [7], waste management, and lack of infrastructure [8]. Developing countries face similar challenges where urbanization is as high as 50% [9].

Smart cities utilize information and communication technologies (ICT) to enhance residents' quality of life, economic development, transportation, transport infrastructure, climate, and interactions with the government. Because of the importance of smart cities to various stakeholders and the advantages and drawbacks associated with their implementation, the concept of smart cities has piqued the interest of researchers in a variety of fields, including informatics. Smart cities also address crucial issues of today's urban living, from transportation [10], energy use [11], and the environment to local government and citizen inclusion [12]. The concept of smart cities has revolutionized the modern world by providing a possible solution to air-pollution-related problems by providing a unique blend of technology [13], data [14], and the Internet Things [15]. However, the evolution of urbanized societies has paved the way for the extensive emergence of databases [16] and ICT. Such technologies cover data management [17], computer-based processing [18], effective correlation of people and their environmental issues [19], and leadership skills [10]. A combination of this urbanization and ICT has led to the concept of smart cities [19]. This socio-technological concept is gaining more importance in future cities as they strive to increase development [20]. Smart cities have equipped themselves with modern technologies to encourage efficient performance in urban design [21]. Data-based digitalization has embarked on revolutionary changes in smart cities [8], and such advances have created high growth in data generation [7]. Cities all over the world are attempting to turn into smart cities. Recent cases and studies show that urban Big Data from stakeholders and physical artifacts in cities are critical factors in this transition.

Air pollution cannot be ignored by overpopulated cities in developing countries like Pakistan, where air quality worsens day by day [22]. A considerable rise has occurred in the types and number of sources that emit air pollutants in the region [23]. Intense industrial activity, large populations, and an unprecedented rise in motor vehicle usage pose severe environmental impacts in the region [11]. Air pollution is a significant threat to environment departments, which have not been updated for many years in South Asia, especially in Pakistan [7]. Considerable evidence is available that poor air quality is playing havoc with people's health in this region [24]. The purpose of this study is to find a permanent solution to air pollution in Pakistan. Exploratory research has been carried out to try to find a result so that a data-based smart city can track and control air pollution. This study deals with global challenges and considers data-based pollution control management in a hypothetical smart city. The community framework and alternatives that promote competence in governmental organizations in this Big Data age have been illustrated. They characterize how a development plan can be used in an intelligent smart city design. Our findings and conclusions for data-based control of air pollution are rationalized for emerging economies, creativity, core skills, and social system validity.

In addition, the world concept is nothing less than a universal reality. It signifies that catastrophic circumstances in any portion of the planet can affect the whole planet. Air pollution is now a serious concern, and small-town development for managing air pollution should be urgently focused on. Nevertheless, in this respect, Third World countries such as Pakistan remain behind. Citizens are not aware of this, and government officials are not highly involved. Smart city systems will progressively be used to detect public safety issues like riots, natural disasters, gas leaks, and COVID hotspots, allowing municipal authorities to intervene before these occurrences become dangerous to residents. This necessitates an infrastructure that allows cities to immediately understand their own needs. Smart cities can assist municipalities in better understanding what is happening in real time across the city's territory and assets. The SARS-CoV-2 pandemic has undoubtedly put a strain on the finances of many cities, which means that we, as sellers of technology and solutions, must adapt by being more innovative with the business models we present, enabling new tactics. Therefore, this study focuses on the effects of artificial intelligence, technology, and air pollution management through data-based management coupled with creative leadership and citizen participation ideas.

2. Literature Review

Urban areas are witnessing an increase in air pollution levels, making adequate air quality forecasting a critical challenge when it comes to population health. Even though many prediction systems have been researched and modeled, many of them disregard the various effects of air pollution on each person. In recent years, there has been a change in the growth pattern of smart cities, with smart cities seeking to embrace sustainable practices through ICT and other smart solutions. As a result, we present a novel background prediction model that combines an effective air quality prediction algorithm (using a long short-term memory deep neural network) with information about nearby sources of pollution [25]. Air pollution is a fundamental environmental issue in various towns and cities. With the emergence of the smart city concept, appropriate solutions to control people's exposure to pollutants must be part of an appropriate urban development policy. Eco-efficiency models have greatly influenced smart city development after several super-efficiency models were used to calculate the eco-efficiency of different prefecture-level Chinese cities (Figure 1).

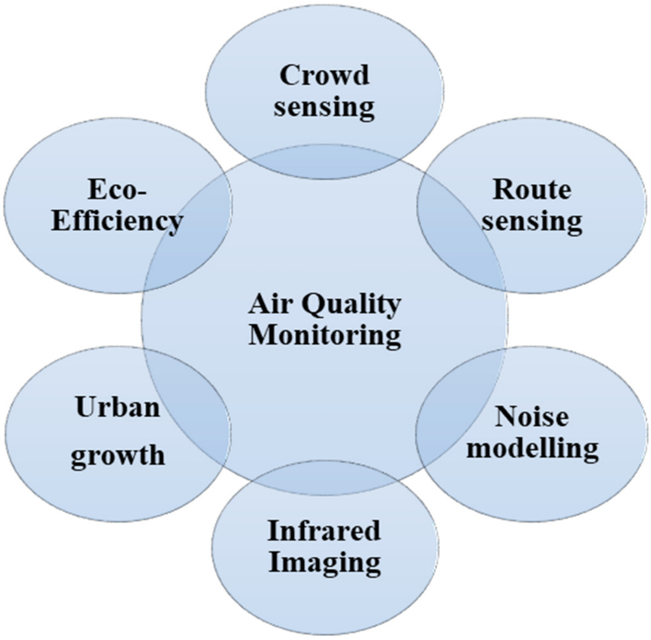

Figure 1. Possible data-based strategies to control air pollution in a smart city.

The idea of air-quality-aware toll structures has been attempted in order to charge drivers based on the route they take through air-quality-affected areas. As a result, transport costs are related to the current level of pollution to reduce an already precarious situation, making it more expensive to do environmental damage than when air pollution is less severe [26].

Climate change, population growth, and resource squandering currently pose problems of such severity that they necessitate a shift in trends in order to alleviate their impact. It is essential to educate the public about the reality and benefits of emerging technology for efficient urban growth. As a result, we wonder if a typical medium-sized city will become a smart city. Our study examines various smart city models adopted to assess this possibility in Spain (e.g., Madrid, Barcelona, Valencia, Malaga, and Santander), comparing them with the specific case of one city that is not yet a smart city (Granada) in order to address which strategic technological measures to introduce in various topical areas of action: infrastructure, sustainability, and molecular biology [27].

A few exploratory research types have reported on the determinants of smart cities and their goals through an empirical hierarchical structure analysis. Such studies have indicated that contact networks, public proceedings, and direct participation are essential for a review of each sub-factor [28].

Cities increasingly rely on specialized technology to solve societal, ecological, and morphological problems. The evolving idea of smart cities strongly supports this possibility by encouraging integrated sensors and Big Data via the Internet of Things (IoT). This stream of data opens up new possibilities in urban planning and management and new economic opportunities. Although Big Data processing through artificial intelligence (AI) can contribute greatly to the urban landscape, sustainability and quality of living must not be ignored in favor of technological ones. AI's urban potential and proposals of a new paradigm for connecting AI technology and cities have been examined while maintaining the convergence of key dimensions such as culture, metabolism, and governance, all of which are critical in the effective integration of smart cities [29].

Living in the data age and in the current period of urban digital technology has resulted in a vast number of datasets and data flows related to urban communities. Capturing and analyzing data from different tools is critical in smart cities. Real-time air pollution data are extremely important in regulating air pollution for sustainability and shielding humans from air pollution. However, the overall building expenditures and construction costs in air pollution stations are prohibitively expensive. Such findings are intended to examine whether and how we might cost-effectively quantify air pollution without the use of costly pollution monitors and facilities. A predictor for particulates forecasting to achieve this goal was designed. The proposed model is made up of several components that combine various heterogeneous sources of urban data gathering, and they evaluate particulate matter using a transfer learning perspective in which neural networks and regression are used as the core of the simulation [30].

Several analyses of personal specifications for crowd sensing configurations and specifications for a continuous speed air-monitoring functionality have been determined, along with their positive correlations [31]. The dynamic and graphical scope of development in the Spanish smart city has been taken into account in initiatives for mobility and environmental issues, which are at the heart of the development of a smart city [32]. Noise modeling is also a meaningful way to imagine and control noise emissions.

One of the main questions driving the discussion on the future of cities and urban areas concerns energy sustainability. Simultaneously, AI and cognitive computing have appeared as motivators in developing and maximizing the supply and use of smart services in the urban landscape. Research has provided insights into pilot systems, and experiments demonstrate how AI can provide vital assistance in achieving energy efficiency in smart cities. The findings also contributed to discussing energy efficiency in the urban space by applying results based on a smart cities study. The existing analysis is mainly constrained by data granularity (low frequency) and the evaluation of only about six types of appliances [33].

One of the most serious risks to industrialized societies is air pollution. Pollution is a significant cause of death among children under age 5, according to the World Health Organization (WHO). Smart cities are being called upon to play a pivotal role in reducing emissions by gathering various parameters in real time. For the cities in the Region of Murcia included in the analysis, the results showed an adjustment for the proposed O_3 prediction models of 90% and a root mean square error of less than $11/m^3$ [34].

The outcomes of such research models have shown that it is more reliable to model local noise propagation, and they have improved interpolation accuracy [35]. Since air pollution is a significant environmental threat, it has many adverse consequences on humans, which need to be monitored. Information on air quality contaminants, such as methane, smoke, and other pollutants, is collected by public transport sensors, and information has been analyzed as buses and cars return to their source destinations after going through stationary nodes across the area [15].

Additionally, several outlines of the implied phase's approach (a specific variety of fuel, or liquid biofuels) have been used by utilizing borderline infrared imaging to allow efficient implementation of low-emission areas in potential smart buildings [34]. Smart city development patterns are heavily dependent on local background influences. In particular, economic growth and urban architectural factors are likely to impact a city's digital direction, the spatial position that affects the smart city plan, and the population size correlated with congestion issues, which can be significant components in deciding a smart city's path of deployment [36].

Furthermore, the integration of AI within organizations, as well as the ethical considerations about technology, is critical to the fulfillment of smart city structures. Technological advancement has always been difficult for organizations with few resources. This study proposes that AI become both an outcome and a tool for achieving SBMs in organizations. A corporation must establish a proper framework and a formal strategy to accommodate new technologies in order to better integrate them (AI via KMS) [37].

The real issue in terms of AI involves problems that are peculiarly human. Much of our work is highly routinized, and many of our daily actions and decisions are based on relatively straightforward patterns of stimulus and response. The big questions involve the extent to which those behaviors that are not straightforward can be automated. In fact, although machines are able to beat human players in many board games, and there is now the prospect of machines beating the very machines that were originally designed to play against humans, the real power of AI may well come from collaboration between man and machine working together, rather than ever more powerful machines working by themselves [38].

3. Research Model and Hypotheses

3.1. Research Model

Cities face significant challenges as a result of global urbanization patterns and concerns over sustainability. According to previous research, these smart cities have struggled to integrate sustainable development goals into their innovative plans [35]. Current research involves a thorough review of current air quality benchmarks, which recommends implementing a given approach in an ideal smart city (Figure 2). The proposed model would assess air pollution in a defined metropolitan region, identify closed areas of elevated air emissions, and trade information about low air pollution areas.

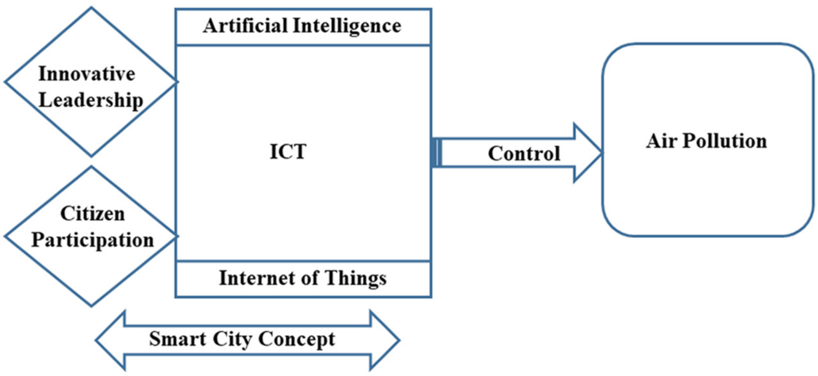

Figure 2. A proposed research model of the present study.

3.2. Hypotheses

Pollution monitoring has the potential to affect individuals and their health. Although the traditional approaches to predicting air pollution have limits, artificial intelligence creates new possibilities. There are, however, several artificial-intelligence-based methods, and determining the right one for the problem at hand can be difficult. This study presents basic computational intelligence-based models for forecasting air quality concentrations in potential smart cities. The following hypotheses (H1 to H4) are proposed to predict approaches to air quality management for public health purposes.

Hypothesis 1 (H1). *Artificial intelligence positively affects management of air pollution.*

The high complexity of smart city technologies includes specialists, market internationalization, globalization strategies, and professional information. However the information within organizations is handled, the latest innovative knowledge management frameworks and transparent approaches are called for, particularly for new revolutionary technology in the IoT to promote information flow. This research introduces a data-based surveillance program that incorporates IoT and environmental surveillance strategies to capture long-term environmental parameters and learn the levels of pollution in a smart city [37]. Hence, we devised the following hypothesis to address the above issue.

Hypothesis 2 (H2). *The Internet of Things has a positive influence on management of air pollution.*

Sustainable enterprises are becoming a significant sub-discipline of the research into entrepreneurship by increasing the call for greener and more sustainable enterprises. Porter and Linde proposed that green legislation and sustainability are cost-effective and have hindered sustainable change. Customarily, environmental regulatory costs have concentrated on static cost impacts, disregarding any lowering of efficiency benefits from innovation [38]. Nicolas et al. believed that prices underestimate product alternatives and overlook the business's actual productivity, which is usually overestimated [12]. As a result, the smart city has received significant interest as an initiative to enhance urban growth. The overt and indirect impacts of smart-design enablers of economic efficiency have not been adequately computed. Findings from the study by Porter and Linde or Nicolas et al. showed that two aspects, including the process variables of a smart city and the expansion of data-based monitoring, should be regulated at the same time if e-government managers want to pursue better pollution control approaches for smart cities. The possible link that needs to be correlated is the significant relationship between the effects of data-based smart cities and controlling air pollution.

Hypothesis 3 (H3). *Innovative leadership has a positive relationship with the management of air pollution.*

The influence of pollution on quality of life, personal well-being, and human efficiency needs to be addressed, mainly when keeping more innovative buildings. Tesanovic and Vadgama believed that monitoring these environmental factors promotes appropriate strategies to reduce the harmful effects of sub-optimal pollution on the respiratory system [30]. Therefore, keeping in view these factors, this research also asks if there is a positive/negative relationship between environmental factors and an environmental monitoring system.

Sustainability needs to be rethought in order to debate urban planning for the city and to create sustainable environments. Some aspects of the development of urban lifestyles in city designs have previously never been considered significant. Over the years, citizen action initiatives for environmental awareness and understanding have been introduced, but most such works are fundamental, i.e., task development, preparation, and analysis are conducted by trained researchers, and people serve as participants. Our goal is to show how citizen data can be used as a tool to improve public awareness of air pollution by involving communities and local participants. Neirotti believed that today, citizens are very concerned with the quality of life in their cities, particularly concerning pollution. Air pollution is of great significance in planning our activities and taking precautionary measures to maintain quality of life [31]. Additionally, the measurement of interaction with air pollution in a smart city can be considered a positive way to make the world safer and healthier. Public engagement is an essential means to achieving sustainable development goals, but it is still in its infancy in some developing countries. Is public engagement beneficial to reducing air pollution and promoting sustainable development? We suggest H4 to answer this query.

Hypothesis 4 (H4). *Citizen participation positively influences the management of air pollution.*

4. Research Design

4.1. Research Method

This study employed a positivistic philosophical view. A quantitative methodology was adopted to conduct a survey. The study aimed to provide an empirically proven model for implementing smart city projects in urban areas because, all across history, technology has been an inextricable part of the evolution of cities. In recent years, there has been a change in smart cities' growth patterns, with smart cities seeking to embrace sustainable practices through the use of ICT and other smart solutions [35]. The predictors in the study are artificial intelligence, the Internet of Things, innovative leadership, and citizen participation, whereas the criterion is air pollution. All the variables were measured quantitatively. According to previous research, smart cities have struggled to integrate sustainable development goals into their smart plans, focusing more on achieving competence rather than sustainability objectives and goals [35]. The present study was intended to track the environmental effects of a smart city and to track data-based management of pollution and the role of leadership in Pakistani cities. Punitive optional elements have also been attempted by ICT and the IoT (Figure 3).

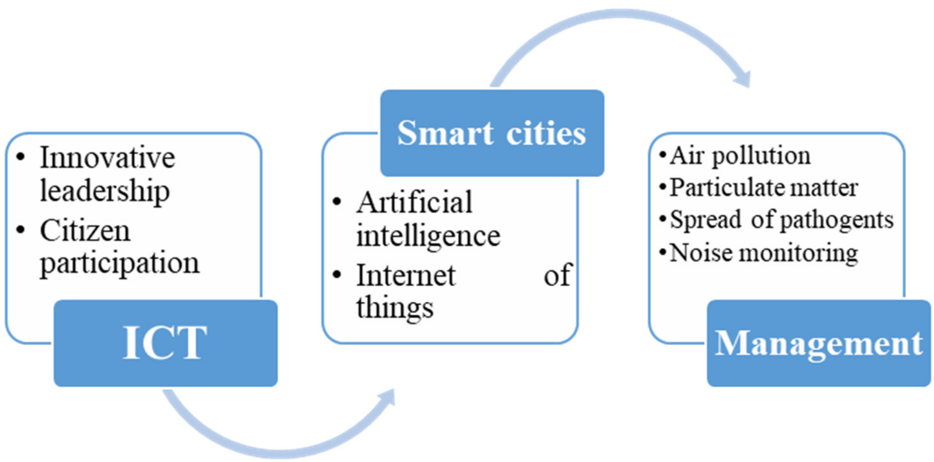

Figure 3. Data-based pollution monitoring in smart cities.

A survey was used to obtain the data because surveys are based on realistic situations that support ease in economic and technical implementation of results. The project group developed a questionnaire/discussion with a more significant stakeholder: policy leaders. Evaluation was performed to demonstrate how well the smart city can be established using the current plan, how the installation of detectors is essential for building a smart city, and how we must use data from new sensors to execute advanced data analytics in city designs.

4.2. Instrumentation and Data Collection

To establish associations between various urban indicators, questionnaires using a five-point Likert scale were developed to measure the variables in the study (Appendix A). The questionnaires were validated using the opinion of five experts. After refinements based on expert opinion, the questionnaire was sent to 51 urban, educated citizens of Pakistan. The reliability of artificial intelligence (0.841), the Internet of Things (0.892), innovative leadership (0.826), citizen participation (0.856), and air pollution (0.781) was estimated. The final questionnaires were used to obtain data from 152 policymakers through Google Forms because the Covid-19 pandemic reduced access to data through face-to-face interviews.

Full details on public office holders were collected. There were 152 persons, with a significant range of factors suggesting their physical, regulatory, and pollution strategic planning attributes. The initial prediction models were focused on pollution optimization techniques, and data were created for this analysis. An intelligent energy management idea was proposed, which makes more rigorous use of IoT platforms, data preprocessing, and data science designed to assist in a decision-making method for electricity efficiency and restoration initiatives. All data preprocessing tasks were followed by a clustering process. Missing values for each input attribute were replaced by using the mean sum of a variable's cost-effective advertising.

5. Results and Discussion

Correlation analysis is a powerful tool used to assess the association strength between two quantitative variables. A higher, linear relationship between two or more variables indicates a positive dependency between them. At the same time, a low correlation tends to mean that the variables are not very closely related (Table 1). This study employed Pearson regression analysis.

Table 1. Correlation of different variables for a data-based monitoring system in a smart city.

Factors	Internet of Things	Innovative Leadership	Citizen Participation	Air Pollution
Artificial intelligence	0.446 **	0.407 **	0.427 **	0.602 **
Internet of Things		0.446 **	0.422 **	0.296 **
Innovative leadership			0.303 **	0.261 **
Citizen participation				0.436 **

$n = 152$, $p < 0.01$, ** $p < 0.001$.

A management network for growing smarter ecosystems (smart cities) has several co-protocol gateways that enable it to handle and centralize all details, irrespective of the fundamental interlinking infrastructure [39]. The correlation among five variables related to the purpose of the study finds the effect of data-based smart cities focusing on the issues of controlling air pollution [40]. Furthermore, it showed a significant positive relationship between every other variable. The relationship of artificial intelligence to the Internet of Things (r = 0.446, sig. = 0.000), innovative leadership (r = 0.407, sig. = 0.000), citizen participation (r = 0.427, sig. = 0.000), and air pollution (r = 0.602, sig. = 0.000) is significantly positive. Results imply that IoT technology, together with AI, can potentially form the basis for enhanced and completely new goods and services in a smart city to control pollution through data-driven signals [41]. AI also simplifies navigation of inspection devices (sensors) and the detection of defects in the data gathered by them. After simple bivariate correlation, regression analysis was performed on predictor factors since that is a reasonable way of determining whether one variable will anticipate another.

Along with the results of regression analysis, multicollinearity was estimated. Multicollinearity exists when two or more predictors in the model are correlated and provide overlapping response information [42]. Multicollinearity was evaluated by variance inflation (VIF) and tolerance considerations. If the VIF value reaches 4.0, or if the tolerance is less than 0.2, there will be multicollinearity (Table 2).

Table 2. Multiple regression data on dependent predictors in this research model.

IV	DV	Beta (β)	T	F	R^2	Sig.	Multicollinearity	
							Tolerance	VIF
AI	AP	0.649	9.245	85.468	0.363	0.000	1.000	1.000
IOT	AP	0.319	3.800	14.437	0.088	0.000	1.000	1.000
IL	AP	0.380	3.315	10.987	0.068	0.001	1.000	1.000
CP	AP	0.618	5.935	35.226	0.190	0.000	1.000	1.000

$n = 152$, $p < 0.01$.

5.1. The Role of Artificial Intelligence

The results indicate that artificial intelligence significantly (β = 0.649, sig. = 0.000) explains the control of air pollution. Cities are gradually moving to advanced solutions for tackling financial, economic, and environmental-concerns morphology and many other things. The new idea of smart cities actively promotes this possibility by encouraging the convergence of sensors and data analysis through the Internet of Things. The implementation of AI has started to gain popularity in smart cities. Given the importance of this question, the purpose of this paper is to undertake a research study to examine the position of AI among various industries in smart cities. As the earth's climate continues to change, the consequences are becoming worse. There were 772 catastrophic climate occurrences in 2016, three times the number that occurred in 1980 [43]. Therefore, our first hypothesis stems from the fact that AI positively affects air pollution management. The work leads to the idea that successful community planning provides templates that should be used at the point of data analysis to predict and maintain emission reductions in a smart city with acceptable precision. The most reliable model was built in this research. It was achieved by utilizing the strengths of three different models. The findings suggest a smart energy management infrastructure for a smart city, with the creation of forecasting as an integral part of prevention and control of pollution [43]. The previous studies envisioned using machine-learning techniques based on sensing data relating to air pollution prediction in smart cities. Researchers previously utilized advanced and refined techniques, rather than simple machine learning techniques. Climate, spatial features, and time characteristics were considered in previous studies [44].

5.2. IoT Influences in Controlling Pollution

The results indicate that the Internet of Things significantly (β = 0.319, sig. = 0.000) explains air pollution control. Air quality has a leading position in public well-being, which has a stronger effect on life expectancy. As this paper reveals, IoT-based air quality will monitor a network comprising clean air sensors, so this framework relies on IoT and cloud computing innovations to monitor pollution anywhere at any time to find if the Internet of Things has a positive influence on air pollution management [45]. The motivation behind this investigation is to assess the usefulness of the IoT in using human capital to reduce emissions in a smart city.

This report used variables such as learning and growth, health and protection, recruitment, employee engagement, and security and privacy to detail the success of the IoT among participants. The previous study on the IoT effects provided an analysis of, and research on, IoT devices in terms of pollution management [39]. The relationship of the IoT is significantly positive to innovative leadership (rho = 0.446, sig. = 0.000), citizen participation (rho = 0.422, sig. = 0.000), and air pollution (rho = 0.261, sig. = 0.000). The findings suggest the IoT might be a platform with a wide range of technical supports, including radio frequency identification technology, virtualization, logistics management, and e-commerce, to control pollution levels in a generalized smart city. The ability to collect data on a remote server and transmit data from any sensing module through an open-source system has been studied widely. The use of Google mapping has helped researchers locate areas with air pollution in developing data-based smart cities [46].

5.3. Role of Innovative Leadership

The results indicate that innovative leadership significantly (β = 0.380, sig. = 0.000) explains air pollution control. Infrastructure-focused smart city development engaged in building cutting-edge cloud infrastructure for crime prevention, traffic relief, environmental protection, and disaster relief has now been shifting to the center on internal process innovation through comprehensive employee education and training about smart city principles, with an emphasis on data-driven policymaking rather than infrastructure-driven decision making [41]. This study aims to include some analytical data on the relationship between environmental leadership and the cost of pollution control across multiple organizations. In recent years, innovative leadership has earned adequate attention from the corporate world, but few researchers have analyzed safety structures and conditional circumstances that connect environmental leadership to strong performance. There has been emphasis on innovative leadership that has a positive relationship with air pollution management [47].

In order to get a deeper understanding of the importance of leadership opinions of pollution in sustainable smart cities, this study looked at the interconnections between leadership opinion, motivation, and political commitment to address the ever-increasing pollution. The findings of the present research showed that the relationship of innovative leadership to citizen participation (rho = 0.303 **, sig. = 0.000) and air pollution management (rho = 0.602 **, sig. = 0.001) is significantly positive [48]. Previous evaluations of collaborative pieces of evidence in the following cases have indicated that decisions to promote government regulations concerning air pollution control require a concise problem, a clearly defined problem-solving strategy, and leadership to support at least some important cooperative groups. The previous cases show a range of collective action patterns, implying that success has many paths [49].

5.4. Role of Citizen Participation

The relationship of citizen participation to air pollution management is significantly positive (β = 0.618, sig. = 0.000). Most importantly, the research shows that creative leadership makes a major contribution to the participation of individuals in processes or media that are motivated to help individuals participate in pollution control strategies.

This study addressed an energy-efficient and easier sequestration technology-led approach for smart cities. It also addressed how data-based solutions and artificial intelligence can be incorporated into effective control of public emissions in intelligent cities as a central field of intelligent environments. The predictive model is made possible by data-gathering networks and regression analysis using variance reduction approaches. Variance analysis of all the hypotheses under study proved them acceptable (Table 3). Hypothesis 1 was accepted as R^2, for artificial intelligence explains 36.3% of the variance in the factor “reduce air pollution” that was significant (F = 85.468, sig. = 0.000) [50].

Table 3. Hypothesis acceptance.

Hypothesis	Factor	*F*-Value	Sig. * Value	Status
H1	Artificial intelligence positively affects management of air pollution	85.468	0.000	Accepted
H2	The Internet of Things has a positive influence on management of air pollution	14.437	0.000	Accepted
H3	Innovative leadership has a positive relationship with the management of air pollution	10.987	0.001	Accepted
H4	Citizen participation positively influences the management of air pollution	35.226	0.000	Accepted

* Average of dependent predictors.

Hypothesis 2 is accepted as R^2 for the Internet of Things, which explains 8.8% of the variance in the “reduce air pollution” factor, which is significant (F = 14.437, sig. = 0.000). Hypothesis 3 was accepted as R^2 for innovative leadership, which explains 6.8% of the variance in the “reduce air pollution” factor, which was significant (F = 10.987, sig. = 0.000). Hypothesis 4 was accepted as R^2 for citizen participation, explaining 19.0% of the variance in the “reduce air pollution” factor, which was also significant (F = 35.226, sig. = 0.000). Beta values show the most robust factor (β = 0.602) to reduce air pollution. Second is citizen participation (β = 0.436), third is the IoT (β = 0.296), and the last is innovative leadership (β = 0.261). All factors had a significance value below 0.05, which shows their unique contribution to reducing air pollution.

In recent studies on the smart city model, there has been a gradual adoption of efficiency improvements. Pollution sensing has permitted expert data collection. The data streams from sensors across wide geographic scales provide an appropriate IT infrastructure to manage the collected measurements properly. We present an improved version of a city landscape to enable any data-based expedient [51].

6. Conclusions and Policy Implication

From the analysis, most respondents concluded that data security and validation might be very beneficial for controlling air pollution in a smart city. The goal is to reduce health hazards and increase understanding of the consequences of exposure to air pollution. This study discusses the main issues of an on-the-spot pollution framework, such as sensors, creating technology on the IoT, and collecting and transmitting data across communication networks. Protection is a key priority of the proposed IoT solution. All other elements of the devices are security-related. The IoT protection administrators are expected to enforce such network protection practices when implementing new technology. Hypotheses have been developed using the previous literature as context. The idea discusses IoT safety issues in the channels between IoT gateway systems and the cloud infrastructure as to which data are transferred. The installation of protection complies with current protocols, practice guidelines, and requirements to guarantee a secure and robust solution for environmental issues in smart cities. The solution also allows the data collected to be interpreted and analyzed using data analytics to construct pollution maps.

The empirical findings of the study designate that complex proceedings are leading to successful and sustainable smart cities through coordination of their resources and the activities of individuals and organizations on innovation management and leadership platforms. In the context of the developmental scene and these actors' social and cultural capacities, numerous (yet complementary) relations have to be further harmonized. Urbanization interests are growing by prioritizing more technologically powered manufacturing processes and service distributions so they become intelligent. In comparison, the proliferation of these modern organizations, and how they lead in practice, is well known. This study exposed a discursive trend in the way public bodies, private companies, and community leaders see and do things in the locally based context, and it concludes that economic and social gains can be achieved by leveraging the social and spatial complexities of intelligent growth in smart cities. Regulation of air pollution focuses on eliminating or reducing to acceptable concentrations the airborne, physical, and suspended particulate matter and biological agents in the air, which can adversely affect the health and welfare of human beings, damage animal or plant life, and damage socially valuable materials and/or harm them (e.g., climatic modifications). Careful attention should also be paid to the substantial dangers connected to radioactive contaminants and to special measures for controlling and disposing of them.

In a smart city specifically, the problem of air pollution needs to improve urgently. This study describes the results of smart air pollution technology to measure air quality in intelligent cities. We suggest data-based sensing of pollution. The test evaluated the measuring system and showed an air quality index via the Internet of Things. This study can help people know the current air quality in real time through the IoT as a service.

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Appendix A. Questionnaire (Five-Point Likert Scale)

Demographic section:

1. Are you a citizen of Pakistan?
2. What is your level of education?
3. Are you a government employee?
4. Are you a permanent employee in a government sector?

Air pollution:

1. I believe that most of Pakistan's population is breathing polluted air.
2. I believe that air pollution is a major environmental problem in Pakistan.
3. I believe that air pollution is a major cause behind many lung and heart diseases in Pakistan.
4. I believe that air pollution will be more harmful in the future in Pakistan.
5. I believe that air pollution requires a technological solution in Pakistan.

Smart city:

1. I believe that a smart city can influence air pollution.
2. I believe that the environment can be improved through the smart city concept.
3. I believe that a smart city can monitor air pollution more efficiently.
4. I believe that a smart city concept will be effective at controlling air pollution.
5. I believe it is easier to work on controlling air pollution in a smart city.

Artificial Intelligence:

1. I believe that artificial intelligence can predict air pollution in hours.
2. I believe that air pollution should be controlled through artificial intelligence in urban areas of Pakistan.
3. I believe that artificial intelligence could help polluting factories switch to cleaner units for a good environment.
4. I believe that artificial intelligence can be used to locate the areas where air is polluted.
5. I believe that, through artificial intelligence, polluting factors can be tracked easily.

Internet of Things:

1. I believe that Internet of Things sensors provide updates and predict air pollution in real time.
2. I believe that factors causing air pollution can be changed with the help of the Internet of Things.
3. I believe that artificial intelligence and the Internet of Things is required in Pakistan to overcome environmental problems.
4. I believe that, through the Internet of Things, air pollution would be controlled.
5. I believe that a smart city can collect data faster through the Internet of Things and can monitor air pollution faster.

Innovative Leadership:

1. I believe that leadership in Pakistan must take initiatives to introduce the smart city concept to remove air pollution.
2. I believe that improving the environment is a responsibility of government.
3. I believe that leadership in a smart city can help to reduce air pollution.
4. I believe that smart leadership is required to control air pollution.

Citizen Participation:

1. I believe that citizen participation is mandatory to implement the smart city concept to reduce air pollution.
2. I believe that a smart city will have positive impact on a citizen's life.
3. I believe that citizen participation in a smart city can help to reduce air pollution.
4. I believe that citizen participation is required to reduce air pollution.

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