Using Titanium dioxide in coating outdoor advertising surfaces and graffiti ads in reducing atmospheric pollution in Egypt

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Abstract

Developing paint products that help save the environment and address climate change started several years ago, but people who are exposed to toxic air pollutants at sufficient concentrations whether indoor or outdoor, for long periods of time, their chances of getting cancer have increased also they might experience other serious health effects, such as reproductive system problems, birth defects, and aggravated asthma.

There are many types of coatings that purify the atmosphere, whether indoor or outdoor. These coatings can be used in advertising industry, especially external advertising and graphic ads. This technology has not been used in Egypt yet though its optimal use will provide fresh air and better life, reduce allergic chest diseases, and help purify the air for being able to breathe cleaner air.

This paper aims at clarifying the impact of air purification by heterogeneous photo catalysis (ultrafine titanium dioxide or Nanocrystalline titanium dioxide (TiO2) particles with diameters less than 100 nm) that can be coated on advertising outdoor materials and painted on street walls in Egyptian industrial cities. Coating outdoor advertisements with TiO_2 is an advanced surface coating technology designed to self-clean the surface, remove air and water contaminates, suppression of microbial growth, degrading hazardous organic pollutants into harmless substance.

This paper also seeks to contribute in reducing air pollution rates by using advertising as an intermediary to realize the fastest results in the shortest time. Producing safe and healthy living environment is what this paper hopes to achieve in Egypt in a short period of time by help applying these coatings to industrial cities. The effect of using titanium dioxide nanoparticles, identification of its applications, usage on advertising materials and its impact on environment were studied.

Some examples have been discussed and illustrated about using titanium dioxide in advertising and street paintings in air purification beside the statistical method used in analyzing the questionnaire presented to individuals. This paper follows the descriptive approach in collecting theoretical information related to Titanium dioxide and its role in converting outdoor advertisements to giant air purifying advertising systems, followed by presenting some international advertising models that used purifying titanium dioxide in ad painting.

Keywords:

Sustainable advertising, Titanium dioxide, self-cleaning, photocatalytic coating, nanotechnology air purification.

المستخلص:

بدأ تطوير منتجات الطلاء التي تساعد في الحفاظ على البيئة ومعالجة تغير المناخ منذ عدة سنوات ، ولكن الأشخاص الذين يتعرضون لملوثات الهواء السامة بتركيزات كافية داخل المباني وخارجها ، لفترات طويلة ، قد يزيدون من فرص الإصابة بالسرطان أو التعرض لآثار صحية خطيرة أخرى ، مثل مشاكل الإنجاب والعيوب الخلقية والربو المتفاقم.

هناك أنواع عديدة من الطلاءات التي تنقي الجو سواء داخليا أو خارجيا. يمكن استخدام هذه الطلاءات في صناعة الإعلان ، وخاصة الإعلانات الخارجية والإعلانات الجرافيكية المرسومة فى الشوارع وعلى الحوائط. وهي أيضًا تقنية غير مستخدمة في مصر ، وسيوفر استخدامها الأمثل هواءً نقيًا وحياة أفضل، كما سيقلل من أمراض الصدر والحساسية ، ويساعد على تنقية الهواء واستنشاق هواء أنظف.

تهدف هذه الورقة البحثية إلى توضيح تأثير تنقية الهواء عن طريق التحفيز الضوئي غير المتجانس (جزيئات ثاني أكسيد التيتانيوم متناهية الصغر (TiO_2) بأقطار أقل من ١٠٠ نانومتر) المطلية على الإعلانات الخارجية وعلى جدران الشوارع في المدن الصناعية المصرية. إن طلاء الإعلانات الخارجية باستخدام TiO_2 عبارة عن تقنية متقدمة لطلاء السطح مصممة للتنظيف الذاتي للسطح ، وإزالة ملوثات الهواء والماء ، وقمع نمو الميكروبات ، وتحويل الملوثات العضوية الخطرة إلى مادة غير ضارة.

تسعى هذه الورقة أيضًا إلى المساهمة في تقليل معدلات تلوث الهواء باستخدام الإعلانات كوسيط لتحقيق أسرع النتائج في أقصر وقت. إن إنتاج بيئة معيشية آمنة وصحية هو ما تأمل هذه الورقة في تحقيقه في مصر في فترة زمنية قصيرة من خلال المساعدة في تطبيق هذه الطلاءات على المدن الصناعية. تمت دراسة تأثير استخدام جزيئات ثاني أكسيد التيتانيوم النانوية وتحديد تطبيقاتها واستخدامها في المواد الإعلانية وتأثيرها على البيئة.

وقد تمت مناقشة وتوضيح بعض الأمثلة حول استخدام ثاني أكسيد التيتانيوم في الإعلانات ولوحات الشوارع الجرافيك والمرسومة في تنقية الهواء بجانب الطريقة الإحصائية المستخدمة في تحليل الاستبيان المقدم للأفراد. تتبع هذه الورقة المنهج الوصفي في جمع المعلومات النظرية المتعلقة بثاني أكسيد التيتانيوم ودوره في تحويل الإعلانات الخارجية إلى أنظمة إعلانية عملاقة لتنقية الهواء ، ثم عرض بعض النماذج الإعلانية العالمية التي استخدمت تنقية ثاني أكسيد التيتانيوم في الرسم الإعلاني

الكلمات المفتاحية:

الإعلان المستدام ، ثاني أكسيد التيتانيوم ، التنظيف الذاتي ، طلاء التحفيز الضوئي ،نانوتكنولوجى تنقية الهواء.

1. Introduction:

Air pollution is one of the biggest challenges facing the world today, especially in urban areas with very serious public health impacts. The people of low- and middle-income countries are most affected by air pollution. WHO estimates that more than 90% of the 7 million annual deaths in these countries occur from exposure to fine particles in polluted air. (1)

Air pollution is a critical risk factor for non-communicable diseases, causing more than a quarter of adult deaths: 45% of COPD, 30% of lung cancer, 28% of heart disease, and 25% of stroke. Air pollution also causes 52% of deaths from communicable diseases such as acute lower respiratory infections. (2)

Therefore, we must pay attention to the air purification and pollution control. The field of advertising can benefit from the paints that work to purify the air from pollutants and paint outdoor advertising, facades of buildings and factories in industrial cities, in order to breathe

clean air and have a clean environment. Studying the effect of coating outdoor advertising materials (such as banners, billboards, bus shelters, ambient advertising and mobile billboards) with titanium dioxide to reduce air pollution, especially in Egyptian industrial cities is an important issue.

2. Statement of the Problem:

The present study mainly tried to answer the subsequent questions:

Q1: How can coating outdoor advertising materials and street art with titanium dioxide reduce pollution, especially in industrial cities in Egypt?

Q2: How effective titanium dioxide coatings are on street paintings and graffiti ads in beautifying the civilized environment and industrial cities besides air purification?

3. Objectives:

This study aims to:

1. Highlight the important role of titanium dioxide coatings in industrial cities.
2. Raise awareness about other ways to try and do our part for the environment by using creative purifying paints and coatings in advertising techniques to purify air.
3. Integrate aesthetical and functional aspects of advertising using titanium coated substance (TiO_2) in reducing pollution.
4. Learn the way to require advantage of outdoor advertising materials like banners, billboards, bus shelters, ambient advertising and mobile billboards) in air purification, by applying these coatings to all kinds of outdoor advertisements.
5. Provide solutions for treating high levels of air pollution in cultural capitals, crowded places and industrial zones using outdoor advertising.

4. Importance:

This study pays attention to the various and artistic usages of advertisements, specializing in integrating aesthetical and functional aspects of advertising to come up with a high degree of environmental sustainability .These creative outdoor coatings were employed in advertising techniques successively as they have dynamic, physical and kinetic dimensions capable of capturing the eye and also allow air purification to induce lots of chest diseases. The optimal use of giant billboards and creative street graffiti art in other useful works must be displayed besides its important role in advertising, lighting, guidance and environmental beautification.

5. Hypothesis:

Two potential underlying hypothesis are going to be discussed:

H1: Employing titanium dioxide coatings on outdoor advertising materials and street art to determine the concept of air purification.

H2: Using and renewing old ads in old streets, crowded places, bus shelters and ambient ads by TiO_2 coatings, to feature advertising value and satisfy governmental expectations towards pollution problem.

6. Theoretical Framework:

6.1. Air pollution problem:

Air pollution may be a steadily increasing problem in densely populated areas and towns with the foremost significant pollution caused by fine particulate matter, volatile organic compounds (VOCs), and nitrous oxides. When nitrous oxides are presented concurrently with volatile organic compounds (VOCs), they result in ozone formation and amplify the impact of the fine articulate matter. It's important to limit traffic emissions to the maximum amount possible primarily by limiting the traffic and thus the emissions. (3)

Sustainable advertising, deals with the preservation of the environment. The foremost current trends that each country seeks to implement in their organizations, is due to the large population congestion and increase the percentage of pollution resulting from the exhausts of cars, buses, and other consumption factors. Advertising must play a vital role in preserving the environment from pollution, alongside the role of advertising in improving the aesthetic role, which always seeks to declare the reality and maintain visual identity.

The most important human activities that cause air pollution, are emissions from burning fossil fuels in transportation, industry, agriculture and coal-fired power plants, in addition to waste incineration, deforestation and construction activities. Dust storms and monsoon winds contribute in increasing pollutant particles in the atmosphere. (4)

6.2. Egyptian environmental performance index rank:

The 201۸ Environmental Performance Index (EPI) ranked Egypt as 66 out of 180 countries surveyed. EPI is exclusive in its approach because it incorporates many high-priority environmental issues, including resource consumption, depletion of environmental assets, pollution, and species loss among other important topics.


Environmental Performance Index

	CURRENT RANK	CURRENT SCORE	BASELINE RANK	BASELINE SCORE
Environmental Performance Index	66	61.21	70	56.71

Figure 1: Photo taken from the Environmental Performance Index website

The EPI typically ranks countries on performance indicators tracked across policy categories that include both environmental public health (protection of human health) and ecosystem vitality (protection of ecosystems). EPI scored Egypt with 61.21 out of 100 countries (0 = worst, 100 = best).

Within these two policy objectives, the EPI scores national performance in nine issue areas comprised of about 19 indicators.

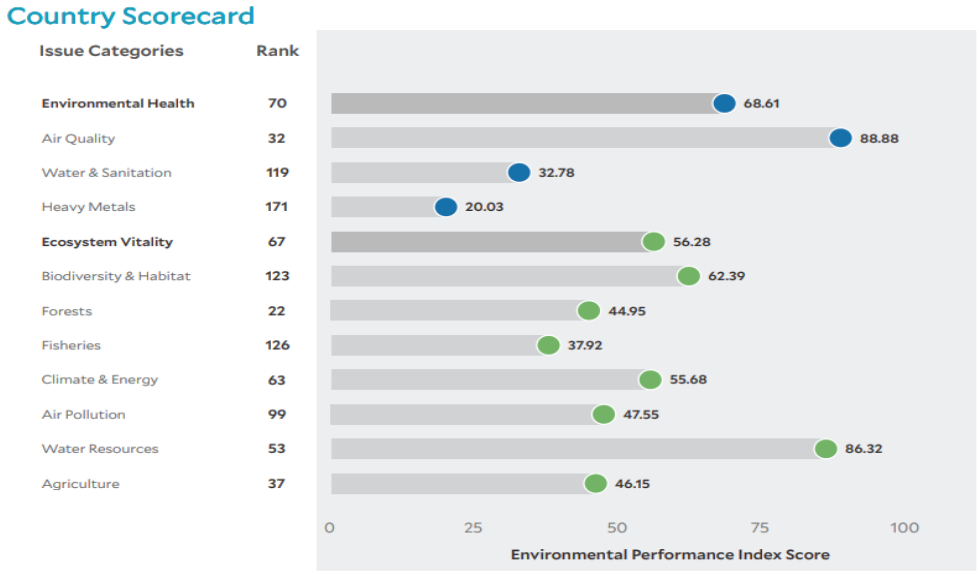


Figure 2: Photo taken from the Environmental Performance Index website

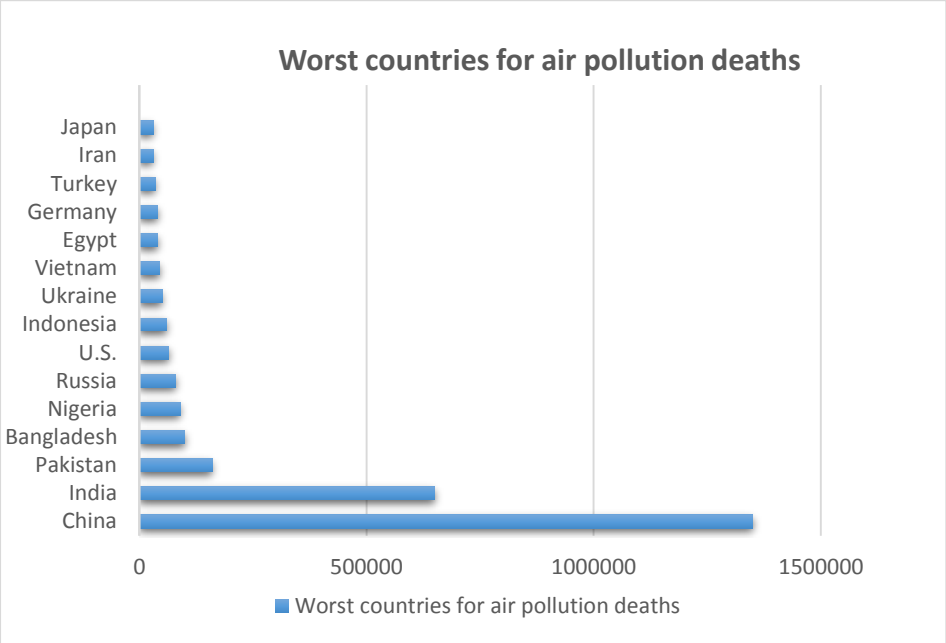
Environment health, being the primary policy objective, is given (68.61%) weightage and it comprises 3 categories, air quality with (88.88%,) water and sanitation with (32.78%), and heavy metals given (20.03%) weightage within the score; whereas ecosystem vitality, being the second policy objective, is again given (56.28%) and it comprises 7 categories, biodiversity & habitat (62.39%) forests (44.95%), fisheries (37.92%), climate & energy (55.68%), air pollution (47.55%), water resources (86.32%), and agriculture (46.15%). [5]

6.3. Egyptian governmental strategy in reducing air pollution

The open burning of waste may be a large source of toxic pollution that ends up in scattering particulates like, monoxide, black carbon, dioxins, furans, and mercury. Air pollution in Egypt is caused by fuel, wood and biomass burning, crop residuals burning in agriculture fields on a large scale, use of adulterated fuel, emission from vehicles and traffic congestion.

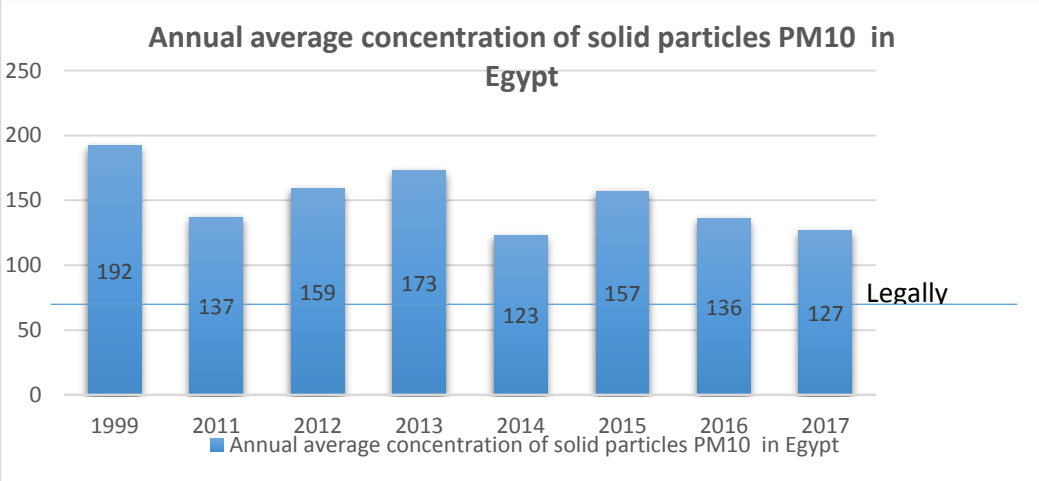
A government report issued by the Ministry of Environment revealed that the percentage of air pollution in Egypt exceeded the allowed limit within the law and exceeded 81%, explaining that pollution increased during 2017 from 2014.

The recent report, under the title "Sustainable Development Strategy Egypt Vision 2030, Improving Air Quality", confirmed that Egypt's population, especially within the big cities, continues to be exposed to high levels of PM10 - PM2.5 particulate pollution. There has been a marked improvement from 1999 as a results of some efforts, especially in the most polluted areas of the republic. [6]



Graph 1: Annual death from outdoor air pollution (16 Sep. 2015)

The graph of the air quality index of the report below, for the years 1999 to 2017, shows that the concentration of solid particles in 2014 was 123 micrograms per cubic meter, while in 2017 increased to 127 micrograms. In 2017, the air pollution rate decreased by about 19 percent, compared to the pollution rate during 2015. Pointing to the ministry efforts to scale back concentrations, which currently reached 19% of 2015, and target a 50% reduction by 2030. (7)



Graph 2: Annual average concentration of solid particles PM10 in Egypt (8)

As part of the Egyptian strategy, the government is functioning on reducing the cars exhaust through replacing old cars with electric ones. New buses are expected to be released soon with several modifications to regulate pollution. This paper also seeks to contribute in reducing air pollution rates by using advertising as an intermediary to realize the fastest results in the shortest time. (9)

In 2017, the world organization Environment Program stated during a report that 40,000 people in numerous parts of Egypt all died from pollution. The report pointed to the absence of trees within Egypt capital which is resulting in the rise of pollution.

The UN report explained that Cairo is comparable to Iran's capital Tehran and also the US city of Los Angeles in their air pollution ratios. Things in Cairo differs slightly because the topography allows for an efficient decrease in pollution compared to the opposite two cities. As a result, the Egyptian state has resorted to developing many solutions to combat air pollution. (10)

6.4. Titanium dioxide (TiO_2) for air purification in urban and metropolitan areas:

Referring to these statistics and diagrams, researchers recognize the air purification potential of TiO2 for urban and metropolitan areas that suffer high air pollution concentrations (Benedix 2000; Poon 2007; Hassan et al. 2011). (11)

When exposed to ultra-violet light, titanium dioxide (TiO2) acts as a catalyst converting harmful compounds like nitrogen monoxide and nitrogen dioxide into nitrates. These nitrates settle on the surface and are washed away by rainfall. The gas which may cause ozone formation, acid rain and also the formation of the particulate matter is captured from the air.

Photocatalytic materials like titanium dioxide can even capture harmful organic compounds from the air. "Various research projects have demonstrated the photocatalytic effect within the laboratory (e.g., Beeldens, 2006 (12), Mueller, N., and B. Nowack, 2008 (13), Zhao, J., and X. Yang, 2003 (14)) . In these tests, the conversion of nitrogen dioxide as a result of a single contact between the air and the photocatalytic material was determined and reductions of between 30 and 95% were measured. (15)

Therefore, in the ads shown below, the possibility of coating this type of ads (Ambient and bus shelters ads) with titanium dioxide to try to reduce air pollution, and these are some of the models that this nanotechnology can be applied to.

Figure 3: An image showing some advertising models that can be used in the titanium dioxide coating technique to convert them into more useful advertisements.

6.5. Uses of Titanium Dioxide:

Titanium dioxide has many usages in a lot of fields that may be listed below as follows:

6.5.1. TiO_2 in protecting the environment (16)

When using titanium dioxide in advertising outdoor paintings, some issues may be taken into consideration by observing some previous studies which will be summarized into the following:

1- TiO_2 converts hazardous organic contaminants into CO_2 and H_2O.

2- Breaks down airborne pollutants, odor, VOCs (Volatile Organic Compounds).

3- Suppresses the microbial growth.
4- Decomposes organic compounds on a molecular level.
5- Turns the surface to be hydrophilic, allowing water to clean away contaminants.

6.5.2. TiO_2 in air purifying paints:

Some characteristics were showed when TiO2 was coated on a surface and were listed below as follows:

1. Self-Cleaning: The organic interface between the surface and adsorbed species is diminished. The adsorbed species can then be more easily washed away by rinsing or rain.
2. Depollution: Pollutants, like oxides of nitrogen and sulfur present in vehicle exhaust and VOCs, are altered once they contact the surface to form less harmful molecules.
3. De-odorizing: Toxic and unsightly odors will be neutralized. (17)
4. Eliminates bacteria: prevents rotting and molding in space, it eliminates bacteria developed every year because of moisture. (18)
5. Long lasting: The moisture-proof paint does not fade, mold and crack easily, and lasts longer. It acts as a great protector for walls, the paint does not contain any harmful chemical to cause any kind of allergy.
6. Suitable indoor and outdoor: air-purifying paints eliminates 100% formaldehyde and VOCs present within the air to enhance the indoor air quality Suitable for residential, commercial, healthcare, hospitality and education facility, the water-proof paint eliminates moisture, rotting and molding in the room and kills harmful bacteria that grow during the rainy season. (19)

Figure ٤: An image showing some advertising models that can be used in the titanium dioxide coating technique to convert them into more useful advertisements.

6.5. Applications of TiO_2 in outdoor advertising and graffiti street art:

Evaluation of advertisements treated with titanium dioxide provided promising results as recent researches shows that a skinny surface coating is in a position to get rid of a big portion of NOx, SOx, and VOC pollutants from the atmosphere when placed as close as possible to the source of pollution. It absolutely was reported that every unit area of titanium dioxide coating, when subjected to sunlight, can remove nitrogen oxides and VOCs from about 200m3 and 60m3 of air per day, respectively (Berdahl and Akbari 2008).(20)

Figure ٥: Boysen and its creative agency, TBWA/SMP effectively turn walls into trees by using KNOxOUT to paint one-square-meter artworks along Manila's busiest and most treeless highways (21)

6.6. Examples of using TiO_2 coatings in transforming walls into giant air purifiers:

Revolutionary paint offers solution to pollution. Advertising agencies must be creative and explores solutions to today's environmental challenges, taking an upbeat look at ecological, scientific, technological design projects around the world. (22)

Advertisements must be environmentally friendly and don't produce any waste that harms public health or the environment because it should have a functional aspect at an identical time, following are some examples and models that used coatings to purify air from dust, contaminants and various exhausts.

All of the following models are already presented in some European countries. They are various drawings painted with titanium dioxide coating material rather than being creative advertisements, so these examples are considered art works instead of being ads.

Therefore, this research aspires to integrate nanotechnology and advertising by coating various advertising models, whether they are outdoor advertisements or graffiti drawings on walls, with this paint to purify the air and take advantage of the many advertisements in all parts of Egypt and transform them to be effective.

6.6.1. Cleaning artwork at an elementary school in Miami, Florida:

Figure ٦: An air-cleaning artwork at a school in Miami, Florida that was installed in 2017. Photo Credit: Pacific Paint (Boysen) Philippines (23)

A local paint manufacturer and distributor has developed a sort of paint that may eliminate harmful air pollutants like nitrogen oxide, and other volatile organic compounds. Mainly generated by vehicle emissions, NOx could be a common air pollutant known to possess serious

consequences for health and therefore the environment, including causing air pollution, acid rain and smog. (23)

6.6.2. The Manuel Gea Gonzales Hospital in Mexico City:

Figure ٧: The Manuel Gea Gonzales Hospital in Mexico City installed a hive-like facade painted with KNOxOUT to purify the air that enters the building. | Photo Credit: Pacific Paint (Boysen) Philippines. (24)

The paint is activated using light energy, enabling the active ingredient to convert NOx into nitric acid, which is rapidly neutralized by alkaline calcium carbonate particles to produce harmless quantities of calcium nitrate, water and negligible amounts of carbonic acid gas. KNOxOUT could remove up to 160 grams of NOx annually, equivalent to the air cleaning impact of a mature tree.

A recent test was conducted at King's College London has confirmed results of the Manila trial. In urban areas where tree planting isn't viable because of an absence of space. Project EDSA, an initiative that involved painting lung-shaped trees and other artworks along the country's busiest thoroughfare. (24)

6.6.3. Paint Edsa Green' project:

Figure ٨: Paint Edsa Green' project starts, May 09, 2011 (25)

Meanwhile, graphic designers are set to color art pieces at the interchange pillars of Edsa-Ortigas, as "Edsa may be a very hard place to figure it's not a gallery. People throw garbage, then there's heavy traffic. So, they needed people to grasp what's called 'architectonic space.' A public space isn't just a wall," (25)

Graphic designer and advertising companies should play a very important role in the way to activate the role of advertising in beautifying and cleaning the environment, creating the proper atmosphere and repairing the damage caused by other technologies.

6.6.4. Metro Manila:

Figure ٩: Guadalupe MRT Station [26]

Metro Manila is considered as the 4th most polluted city within the entire world. Other than carbon monoxide, Oxides of Nitrogen or Nox, is one in every of the pollutants within the air that individuals breathe. Trial data indicates that NOx levels within the vicinity of the Guadalupe MRT Station are from time to time over 200 micrograms per cubic meter — a figure that's quite 5 times that of the Globe Health Organization (WHO) recommendation of 40 micrograms per cubic meter.

The Guadalupe MRT station as well as the embankment wall opposite the station along EDSA of over 6,200 sq. meters of area was painted with 740 liters Boysen KNOxOUT. Results of the trial indicate that World's largest air cleaning Boysen KNOxOUT lowered air pollution [26]

Whether these paints are painted only with none design. If these paints and coatings are employed in advertising design, either graphic design or within the design of the 3d street arts and drawings, it'll lean a special character and depth of advertising and design with changing the final taste to the best.

6.6.5. Pasay Tramo artwork:

Figure ١٠: Pasay Tramo Artwork by Erika Tan [27]

Located along Pasay Tramo, this artwork designed by Erika Tan was based on the 2009 Ateneo de Manila University study on Pollution Levels in Metro Manila cities from 2006 to 2009 and therefore the International Energy Agency's 2004 study on carbon dioxide emissions from fuel combustion 1971 to 2002. As a part of the smog-busting series of massive air-cleaning public art under BOYSEN KNOxOUT Project: EDSA. [27]

6.6.6. Cubao Artwork on Manila's busiest and most polluted highway:

Figure ١١: Cubao Artwork by Tapio Snellman [28]

With very limited space to plant trees on Manila's busiest and most polluted highway, the rehabilitation endeavor called BOYSEN KNOxOUT Project: EDSA creatively shows how both art affects and science effects town dwellers at the same time. The project has eight massive displays of art measuring 1,000 square meter each using KNOxOUT, a scientifically-proven air cleaning paint that has the maximum amount smog eating prowess jointly mature tree. Now, town is experiencing a development that no one would ever thought possible, that started with some brush strokes. Change is within the air and every one can be a part of it. [28]

6.6.7. Air Cleaning Artwork: Rockwell Wall between Buendia and Estrella, EDSA:

Figure ١٢: Air Cleaning Artwork: Rockwell Wall between Buendia and Estrella, EDSA by TBWA, June 7, 2013. [29]

Located between Buendia and Estrella, this Rockwell EDSA wall called “Lungs” showcases trees shaped like internal respiratory organ. The design supported the concept that each painted tree literally cleans the air, allowing breathing to be easy. These trees are going to be the fifth installment of an ambitious urban overhaul that aims to bring air pollution levels down within the metro using air purifiers within the style of 8 massive artworks under BOYSEN KNOxOUT Project: EDSA. [29]

6.6.8. Konings tunnel in Netherlands:

Figure ١٣: The Hague performs an innovative environmental experiment in the Konings tunnel, May 22, 2013. (30)

De-polluting the Konings tunnel. In an exceedingly landmark European trial, The Hague in Netherlands has used KNOxOUT air-cleaning in a tunnel which when proved successful could become a benchmark for air quality improvement in tunnels worldwide. (30)

6.6.9. A main highway, with air-purifying paint in Metro Manila:

Figure ١٤: Filipino artists paint a mural on a wall in EDSA, a main highway, with air-purifying paint in Metro Manila February 1, 2012. REUTERS/Erik De Castro. (31)

As countless vehicles stream past a day, belching exhaust that helps to form a noxious, unhealthy smog. Boysen contains modified titanium dioxides, which are designed to interrupt down toxic fumes into harmless substances. (31)

7. Research methodology:

Like all the models that were previously shown, advertisements and technical graffiti art works can be employed in streets in the same way to help purify the air from pollutants and car exhaust, to exploit advertising works of all kinds and adapt them more in the field of environment and health service.

It is also possible to develop in the use of these coatings and advertisements, not only by painting drawings on the walls and on public streets and graffiti art, as it can be used by painting licensed advertisements in markets and public places, whether outdoor billboards or licensed advertisements on buildings or bus stops, or ads placed on means of transportation.

This paper follows the descriptive approach in collecting theoretical information related to Titanium dioxide and its role in converting outdoor advertisements to giant air purifying advertising systems, followed by presenting some international advertising models that used purifying titanium dioxide in ad painting.

Real estate owners and civil authorities consider placing signs or painting on property without permission as a distortion or outlawing and necessitates fines to be paid sometimes, so the direction of the state itself must be to change through advertising, taking into account the laws and regulations governing outdoor street advertisements, which only requires painting external advertisements. These coatings are authorized by advertising companies and the state in order to maximize the benefit from advertising. In agreement with the companies and the government, the paid outdoor advertisements can also be coated with titanium dioxide.

This research also includes the analytical part and a questionnaire for a proposal to solve the problem of air pollution within the crowded places in Cairo submitted to 150 recipient included specialists and non-specialists (ordinary recipients), where the paper is distributed via written questionnaire and Internet via social media.

7.1. Introduction about the problem:

Cairo is considered to be the most congested city in Egypt. Qalyubia, Giza and Cairo provinces together represent what is known as Greater Cairo. The main streets and squares of the city of Cairo are experiencing high traffic densities, leading to an increase in air pollution from car exhausts, traffic jams and overcrowding, for example:

- **The Cornice:** The Cornice is one of the busiest places in Cairo, especially as it is close to the downtown area where traffic is increasing.
- **Shubra Street:** One of the most famous streets in the Egyptian capital and currently the most crowded with citizens, shops and establishments, the population density is estimated at 70 thousand people per square kilometer, which made the Egyptians call it «People's Street of China».
- **Faisal Street:** Faisal Street in Giza is one of the most crowded streets in Egypt, with many modern shops, restaurants, companies and factories as well as government facilities.
- **Attaba:** Attaba Square is a point of origin for Cairo.
- **Ramses Square:** One of Cairo's busiest squares, as well as one of the least sensitive to the acumen of planning, the central train station to all areas of the republic. Ramses square had previously the statue of Ramses II and his famous fountain, but it was transferred in 2006.

Figure ١٥: Crowded places in Egypt that shows high rates of air pollution

Figure ١٦: advertising examples in Egyptian streets that can be coated by titanium dioxide to reduce air pollution among cars and streets

7.2. Recruitment of the participants and sample size:

The selected sample was (١٥0 recipients) who live and work in Cairo, and were subjected to crowded places, high densities of air pollution due to traffic jams and crowded places. The questionnaire was distributed to them in order to identify their opinions regarding this problem, also the usages and advantages of using titanium dioxide in advertising paintings along crowded places to reduce pollution and purify air.

20 questionnaires were excluded for their incomplete answers and 130 samples were left valid for analysis as shown in the following table:

Table 1. Sample percentage for the case study.

	Distributed questionnaires	Returned questionnaires	Excluded questionnaires	Analysis questionnaires
No.	150	150	20	130
Per.	100%	100%	13%	87%

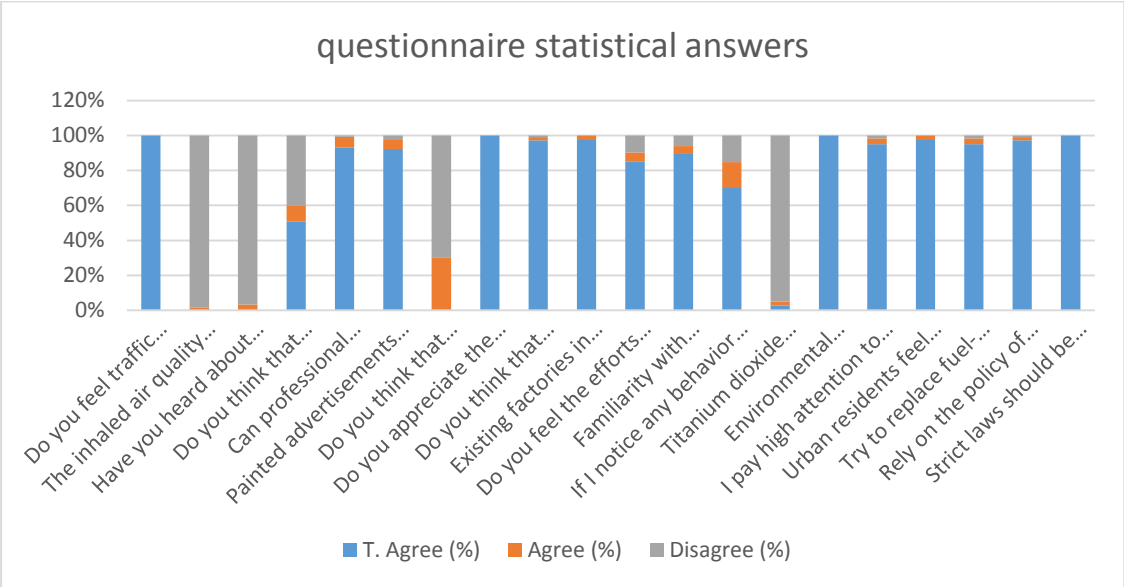
The questionnaire form was designed to measure the response of the consumer towards the problem of air pollution in crowded places in Egypt with sample questions, besides the beliefs of using advertising in air purification system. The results related to the questionnaire statistical analysis was as follows:

Table 2. Results of questionnaire related to statistical analysis for the case study

	Elements of designing questionnaire	**T. Agree (%)**	**Agree (%)**	**Disagree (%)**
1	Do you feel traffic congestion and overcrowding in Cairo public squares?	100%	0%	0%
2	Is the inhaled air quality good for the Egyptian citizen?	0%	1.7%	98.3%

3	Have you heard about titanium dioxide coating in air purification?	0%	3.3%	96.7%
4	Do you think that outdoor advertising can help in solving air pollution problem?	50.8%	9.2%	40%
5	Can professional advertising coatings beautify streets and crowded squares?	93%	6.2%	0.8%
6	Are painted advertisements on walls like and facades interesting 3D art on floors to watch?	92.3%	5.1%	2.6%
7	Do you think that advertising can help in purifying the atmosphere?	0%	30%	70%
8	Do you appreciate the role of the government, organizations and agencies in the last few years working to purify the air from pollutants and exhausts?	100%	0%	0%
9	Do you think that transportation causes significant pollution in the air?	97.2%	1.8%	1%
10	Are existing factories in industrial cities are harmful to the environment and involved in air pollution?	97.5%	2.5%	0%
11	Do you feel the efforts of the Ministry of Environment to cope with air pollution that as also extended to recycling projects of rice straw, whose burning causes air pollution?	85%	5.2%	9.8%
12	Does familiarity with environmental issues such as global warming and pollution in all its forms help to raise environmental awareness?	90%	3.9%	6.1%
13	If I notice any behavior that is harmful to the environment, do I have to inform the competent authorities?	70%	14.8%	15.2%
14	Is Titanium dioxide coated outdoor advertising ineffective?	2.8%	2.2%	95%
15	Is environmental education as important as any other curriculum?	100%	0%	0%
٦1	Do I pay high attention to environmental issues being raised through various media?	95.1%	3.2%	1.7%
17	Do urban residents feel the most polluted air because of the abundance of cars, machinery and factories that emit carbon monoxide?	97.5%	2.5%	0%

18	Should we try to replace fuel-based energy sources with clean energy sources such as solar and electric power?	95.1%	3.2%	1.7%
19	Should we rely on the policy of recycling and reuse of non-biodegradable materials, and encourage the use of biodegradable materials such as the use of paper instead of plastic?	97.2%	1.8%	1%
20	Do strict laws should be passed not to cut down trees and pay more attention to growing more trees worldwide?	100%	0%	0%



7.2.1. Questionnaire results estimated from the above table results showed that:

1. People in Cairo and crowded places agreed by 100 % that they feel traffic congestion and overcrowding especially in Cairo public squares, as they also appreciate the role of the government, organizations and agencies working to purify the air from pollutants and exhausts.
2. Environmental education is as important as any other curriculum, and strict laws should be passed not to cut down trees and pay more attention to growing more trees worldwide, that also was shown in the table that 100 % agreed.
3. Sample of the questionnaire disagreed about the good quality of inhaled air but they haven't heard about titanium dioxide coating in air purification.
4. Only 60% of the questionnaire sample think that outdoor advertising can help in solving air pollution problem had a vision and imagination of what can be done in order to improve air quality, but 40% sees that it does not help and they had no vision about that issue.
5. About 70% think that advertising can't help in purifying the atmosphere, but 93% said that professional advertising coatings beautify streets and crowded squares, 92.3% said that painted advertisements on walls like 3D art on floors and facades are interesting to watch.

6. 97.2% believed that transportation causes significant pollution in the air, and 97.5% said that existing factories in industrial cities are harmful to the environment and are involved in air pollution.
7. 85% of the questionnaire sample feel the efforts of the Ministry of Environment to cope with air pollution, 95.1% tries to replace fuel-based energy sources with clean energy sources such as solar and electric powers.
8. 97.5% of urban residents feel the most polluted air because of the abundance of cars, machinery and factories that emit carbon monoxide, and 95% believed that titanium dioxide coated outdoor advertising is effective in air purification.

7.2.2. Conclusion and discussion:

1. It is clear from the preceding table that the questionnaire showed that people felt the problem of air pollution that actually exists. It also showed that the number of sample selected for the questionnaire did not hear about the coating of titanium dioxide and its many uses in air purification, as well as most of them showed question marks about the link of titanium dioxide to outdoor advertising besides the possibility of outdoor advertising in air purification. So I had explained the research first to the questionnaire sample to be able to answer the questions above in order to be successful to achieve its purpose.
2. The questionnaire questions showed the sample's interaction with the environment, its sense of responsibility towards the environment and the problem of air purification from pollutants, and some had different solutions to that problem.
3. The government is already seeking to take some steps to address these issues:

a. The efforts of the Ministry of Environment to cope with air pollution have also extended to recycling projects of rice straw, whose burning causes air pollution. Compaction, collection and recycling during the system period avoided approximately 18,000 tons of pollutants that were estimated to spread in the air in case of burning rice straw.
b. Pollution loads have been reduced, and the number of monitoring stations in the National Ambient Air Quality Monitoring Network has been increased to 96 monitoring stations, achieving the government's 2018/2019 program target, in addition to the increase in the number of industrial facilities associated with the National Emission Monitoring Network to 56 industrial facilities.

4. The field of advertising is a wide field of outdoor and indoor advertising, and the use of titanium dioxide coating is effective in air purification. Therefore, this paper indicates the possibility of combining advertising and titanium dioxide together to benefit from, and maximize the benefits of advertising and solve a concrete problem in many countries with ease, and with less time.

8. General Results:

1- The age of nanotechnology requires the development of advertising methods and techniques to achieve the highest efficiency in air purification and human health preservation.
2- The use of nanotechnology in the treatment of traditional advertising materials not only improves their original characteristics in facing the factors and conditions of damage, it also eliminates air pollution in the vicinity of the displayed advertising, and gives it new features and functions.

3- The use of nanomaterials leads to the longevity of the advertisement, reduction of the maintenance cost, restoration, purification of air from pollutants, dust and exhaust cars in large proportions.
4- Nanotechnologies and nanomaterials are among the most important modern concepts that, when introduced in the field of advertising production, can offer products with new characteristics and advantages that are superior than those produced by conventional methods.
5- The photocatalytic activity of titanium dioxide results in thin coatings of the material, exhibiting self-cleaning and disinfecting properties under exposure to UV radiation.

9. General discussion:

1. Titanium dioxide coatings are a revolutionary technology which take advantage of the nature of TiO_2 nanoparticles and their interaction with UV radiation. The nature of this compound lends itself to sustainability. (32)
2. Furthermore, the WHO confirmed the compound has little to no impact on land or aquatic species, indicating the very low threat posed to public health and the biological environment by TiO2. (33)

10. General Conclusion:

1. Titanium dioxide photo catalysis is a step towards a greener future as Remediating air / water contaminants is to employ photo catalyst that oxidize these toxic compounds.
2. While this paper has scratched the surface on the nature of titanium dioxide and its many unique properties, it is clear that this compound represents a viable remedy to the air pollution crisis.
3. The complex mechanism of the TiO_2 photocatalytic process is extremely efficient in removing harmful pollutants from the surrounding atmosphere, and it can be implemented into films and coatings that provide numerous benefits, as well as the different materials of advertising that are used in wide range across streets, bus shelters, on railways and on crowded places.
4. These coatings possess the power to reduce both outdoor and indoor air pollution while remaining entirely self-sufficient, capable of being applied to any surface by spraying or coating, and even in the manufacturing of any of the advertising materials such as PVCs, advertising paper and acrylic …etc.
5. TiO_2 photocatalytic films also provide various other benefits, from odor elimination to the removal of grime and bacteria, so this paper highly recommends the use of this substance as the WHO organization found that it has no side effect on human beings.

11. Recommendations:

This paper recommends the following:
1- The need to increase usage of trends emphasizing nanotechnology and advertising researches, and encourage advertising organizations to use titanium dioxide coatings to purify the air.
2- The need to use modern compounds and technologies in advertising industry to make advertising powerful and more functional.

3- The need to develop the corporation and social responsibilities and duties between governments and advertising organizations.
4- The need to attract the attention of modern methods and technologies using Nano substances in advertising coatings.
5- The need to stay away from boring and traditional methods of advertising and take the advantage of titanium dioxide and its derivatives and intensify their role in an attractive and interesting way by using creative advertising techniques with coated TiO_2.
6- The need to do a lot of research linking nanotechnology and advertising with practical and laboratory experiments.
7- The need to activate the maximum utilization of the use of nanoparticles in the manufacture and recycling of all materials related to outdoor advertising.

12. References

1. https://www.who.int/ar/news-room/detail/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action
2. https://apps.who.int/iris/bitstream/handle/10665/259058/RC_technical_papers_2017_inf_doc_3_20012_ar.pdf?sequence=1&isAllowed=y
3. https://www.engineeringnews.co.za/article/air-purifying-concrete-can-reduce-atmospheric-pollution-2019-01-10/rep_id:4136 (accessed on 10th may 2019)
4. http://www.emro.who.int/ar/media/news/9-out-of-10-people-worldwide-breathe-polluted-air.html
5. https://epi.envirocenter.yale.edu/epi-country-report/EGY
6. https://www.almasryalyoum.com/news/details/1295735
7. https://www.egypttoday.com/Article/1/51519/Prominent-Egyptian-plan-to-reduce-air-pollution-by-50-in
8. https://www.almasryalyoum.com/news/details/1295735
9. https://www.egypttoday.com/Article/1/51519/Prominent-Egyptian-plan-to-reduce-air-pollution-by-50-in
10. https://ww.egyptindependent.com/cairo-is-worlds-second-most-polluted-city-who/
11. Poon, C.S., and Cheung, E. (2007). "NO removal efficiency of photocatalytic paving blocks prepared with recycled materials." Construction and Building Materials, Vol. 21,1746-1753.
12. Beeldens, A. An Environmentally Friendly Solution for Air Purification and Self Cleaning Effect: the Application of TiO2 as Photo catalyst in Concrete. Proceedings of Transport Research Arena Europe – TRA, Göteborg, Sweden, 2006.
13. Mueller, N., and B. Nowack. Exposure Modeling of Engineering Nanoparticles in the Environment. Environmental Science and Technology, 2008, 42: 4447-4453.
14. Zhao, J., and X. Yang. Photocatalytic Oxidation of Indoor Air Purification: A Literature Review. Building and Environment, 38, 2003, 645-654.
15. Press release from Jan de Beer, cell 082 456 3677:
16. http://www.greenmillennium.com (accessed on: 1st June 2019)
17. http://www.cristal.com/products-and-services/ultrafine-and-specialty-tio2/applications/Pages/photocatalysis.aspx

18. https://www.designdiffusion.com/en/2018/11/16/a-roma-murales-mangia-smog-realizzato-con-vernici-airlite/
19. https://www.homecrux.com/9-air-purifying-paints-thatll-freshen-up-your-indoor-environment/84703/
20. Berdahl, P., and H. Akbari. Evaluation of Titanium Dioxide as a Photo catalyst for Removing Air Pollutants. CEC-500-2007-112. PIER Energy-Related Environmental Research Program, California Energy Commission, 2008
21. https://www.myboysen.com/air-cleaning-paint/
22. https://www.thehindu.com/sci-tech/energy-and-environment/revolutionary-paint-offers-solution-to-air-pollution/article26903323.ece
23. https://www.thehindu.com/sci-tech/energy-and-environment/revolutionary-paint-offers-solution-to-air-pollution/article26903323.ece
24. https://www.thehindu.com/sci-tech/energy-and-environment/revolutionary-paint-offers-solution-to-air-pollution/article26903323.ece
25. https://ecodistributioninc.wordpress.com/2013/04/30/enchanted-clean-air-project-paint-edsa-green/
26. http://www.annakatharinamd.com/2009/11/16/boysen-knoxout%E2%80%94a-can-of-paint-as-a-weapon-to-pollution/
27. https://www.facebook.com/notes/the-boysen-knoxout-project-edsa/air-cleaning-artwork-pasay-tramo-artwork-by-erika-tan/471280326279801/
28. https://www.facebook.com/notes/the-boysen-knoxout-project-edsa/air-cleaning-artwork-cubao-artwork-by-tapio-snellman/470829849658182/
29. https://www.facebook.com/notes/the-boysen-knoxout-project-edsa/air-cleaning-artwork-rockwell-wall-between-buendia-and-estrella-edsa-by-tbwa/471695136238320/
30. https://www.reuters.com/article/us-philippines-paint/street-artists-join-the-war-on-manila-smog-idUSTRE81L17020120222
31. https://www.reuters.com/article/us-philippines-paint/street-artists-join-the-war-on-manila-smog-idUSTRE81L17020120222
32. “Aqueous Titanium Dioxide Photo catalysis Features.” Green Millennium. Accessed 2nd June .2019. http://www.greenmillennium.com/features/
33. S. Shah, Z. Shah, M. Hussain, M. Khan. “Hazardous Effects of Titanium Dioxide Nanoparticles on the Ecosystem.” Hindawi. 2017. (accessed on 28th april 2019). https://www.hindawi.com/journals/bca/2017/4101735/