Tsinghua University Certificate Program on "Innovation & Entrepreneurship"

Project Title:
Building a smart environment to curb
and
mitigate the effect of air pollution

By Group 45

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Outlines

Background
- Introduction
- Sources of air pollution
- Impact on Ecosystem
- Ways of abatement

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- Air pollution
- Big data, IoT, Smart Environment

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Case Study
- Introduction to the problem
- Africa's most polluted city
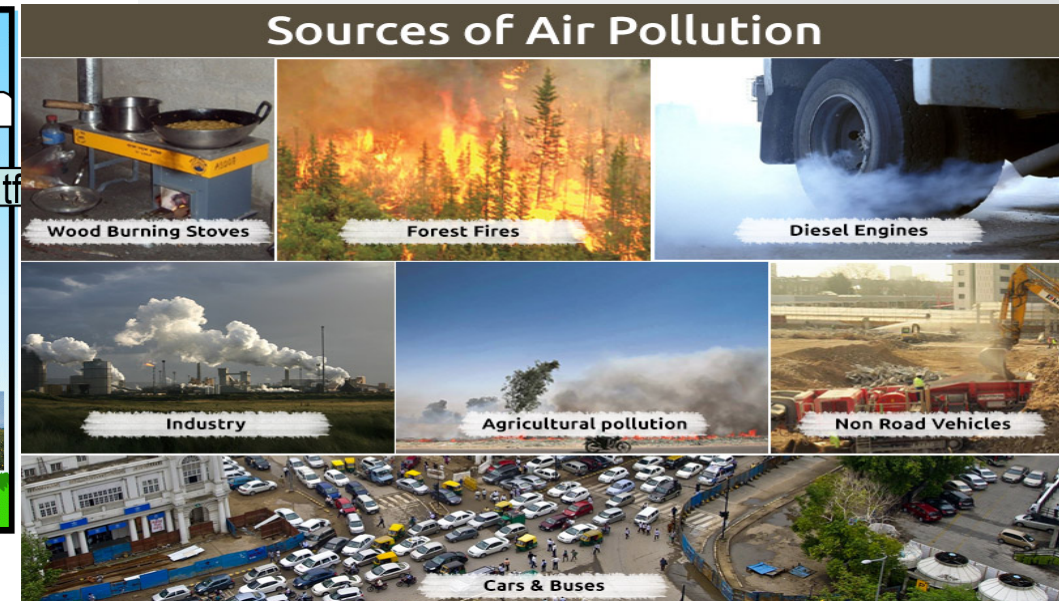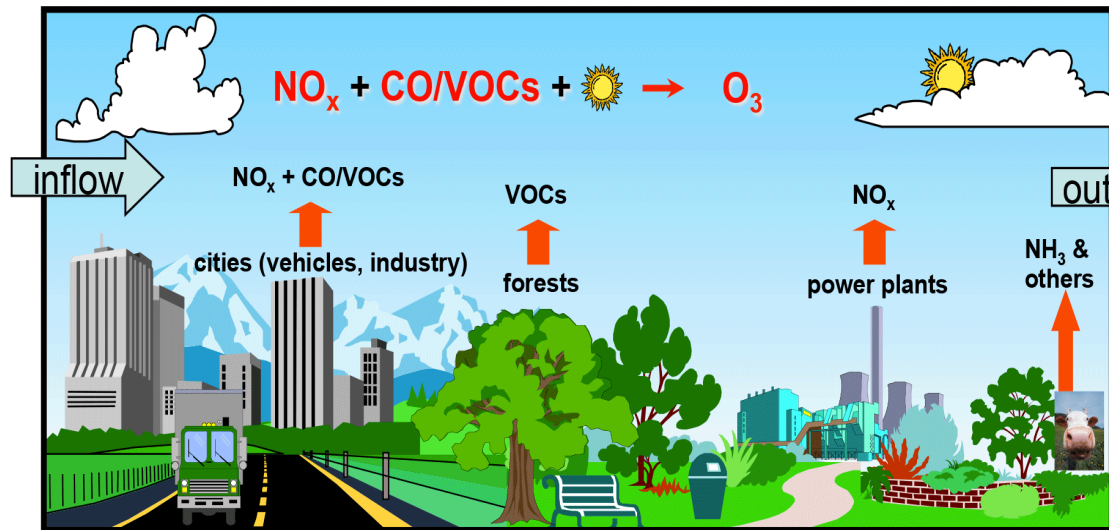- Challenges
- Technical solutions

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Conclusion

Air Pollution

Air pollution occurs when toxic substances are released into the atmosphere in the form of gases, finely particulates matters, liquid aerosols at a capacity above the natural environment to dissolve them, and thereby causing unbalance and issues.

- **Natural sources**
- **Anthropogenic (Man-made sources)**

$$NO_x + CO/VOCs + \text{☀} \rightarrow O_3$$

inflow

NO$_x$ + CO/VOCs

cities (vehicles, industry)

VOCs

forests

NO$_x$

power plants

NH$_3$ & others

outf

Sources of Air Pollution

Wood Burning Stoves

Forest Fires

Diesel Engines

Industry

Agricultural pollution

Non Road Vehicles

Cars & Buses

Impact on Ecosystem

- Air temperature over land increases

- 2. Flooding the coastal cities

- 3. Desertification of fertile areas

- 4. Air temperature over Ocean increases

- 5. Arctic sea ice decreases

- 6. Glaciers are melting

- 7. Sea levels are rising

- 8. Humidity increases

- 9. Ocean heat increases

- 10. Sea surface temperature increases

- 11. Snow decreases

- 12. Earth lower atmosphere temperature increases

- 13. Extreme events

EFFECTS OF AIR POLLUTION

- Damage to ecosystems

Spruce forest.

Decline of forests due to air pollution.

Ways of abatement & Pollutant Types

- **Control Before Combustion**
- **Control During Combustion**
- **Control After Combustion e.g. Selective Catalytic Reduction of NO_x, Selective non catalytic Reduction, CO_2 Reduction etc.**

- **Particulates**
- **Ozone**
- **Nitrogen and Sulfur Oxides**
- **Carbon Monoxide**
- **Heavy Metals e.g. Mercury etc.**

Big data, Internet of Things (IOT), Smart Environment

source : www.datasciencecentral.com

Source: www.StrategyofThings.io
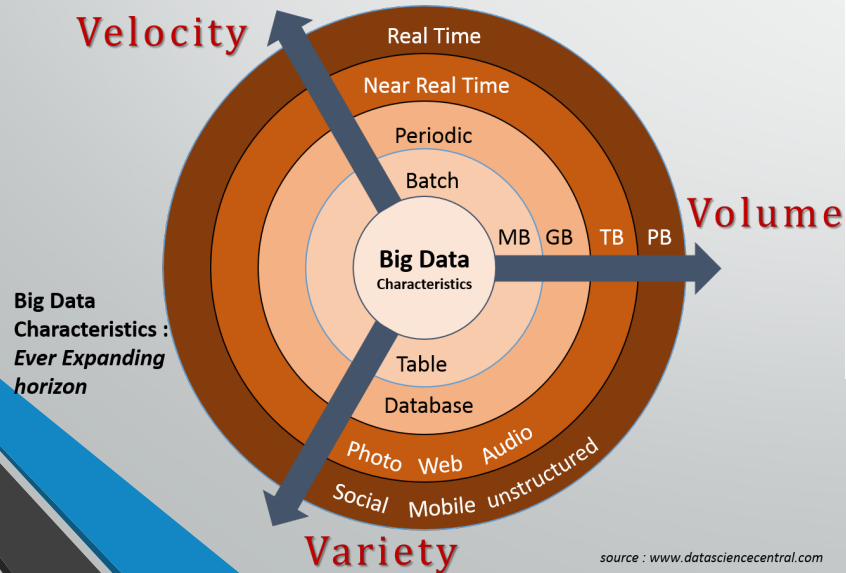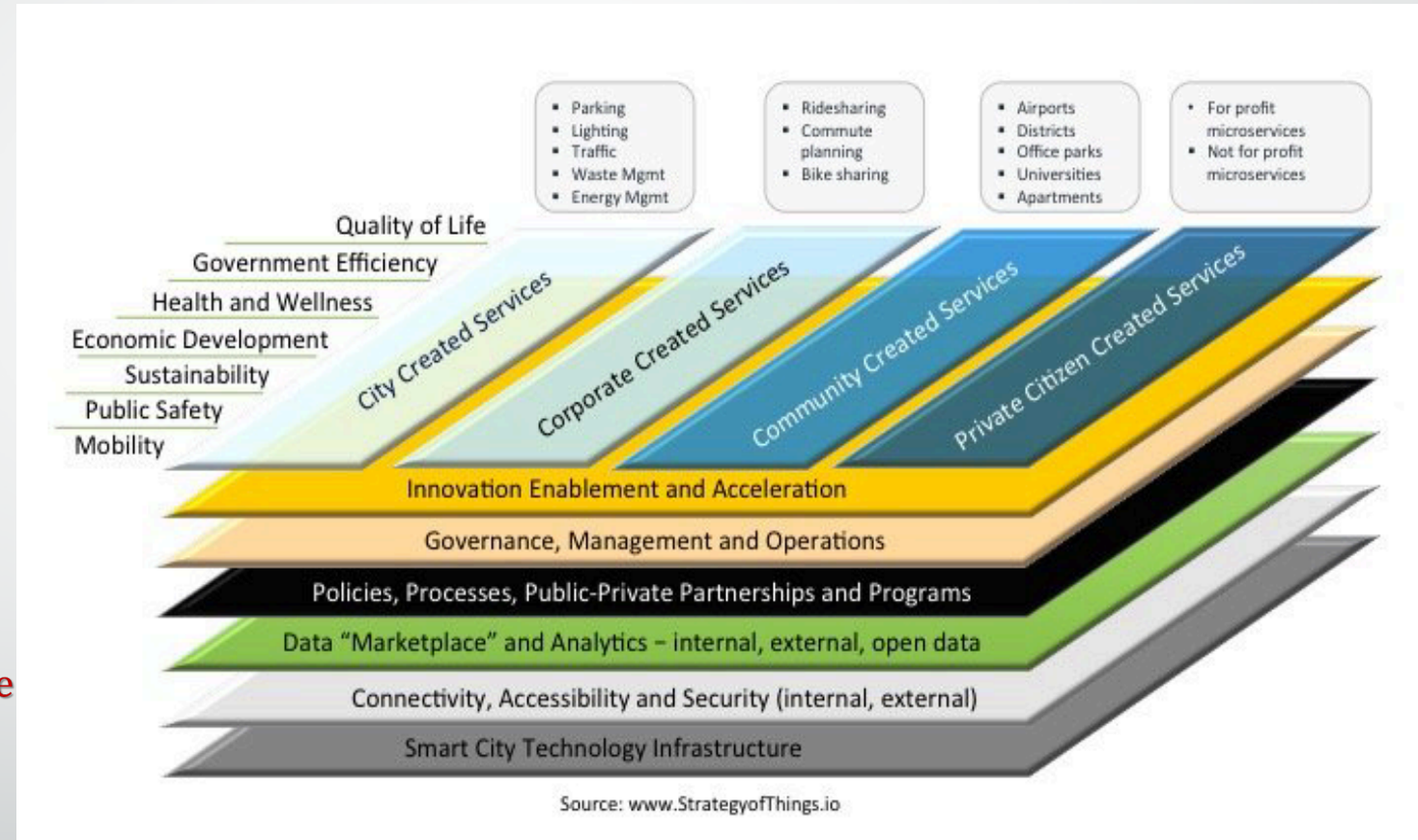
Africa's Most Polluted City (Case Study)

- Kano State is Nigeria's second largest manufacturing center and Northern Nigeria's biggest with textiles, tanning, clothing, cosmetics, plastics, enamel and becoming the commercial center of northern Nigeria.

- The state is the largest most populous country in Nigeria as of 2006 census with an estimate of 11 million people. With this large population, the people of Kano depend on traditional cooking fire woods and other emitting toxic gas equipment.

- A report by IQ Airvisual, a Swiss-based international organization, ranked Kano as the most polluted city in Africa, with air pollution levels reaching 54.4 percent

Challenges

- **According to Health Effects Institute (HEI) and the Institute for Health Metrics and Evaluation (IHME) all from USA indicted that more than 100,000 deaths in Nigeria were caused by air pollution as of 2016.**

- **Africa suffers from a significant lack of data on the monitoring of the open air quality, making it difficult to control.**

- **WHO 2016 Global Particulate Matter (PM) measurements have been recorded for only 8 out of 47 African countries. Drawn from sources of real-time governmental air quality monitoring and selected privately run IQAir AirVisual nodes, the 2018 World Air Quality Report offers an overview of cities' average PM2.5 per year.**

- **Air Pollution deaths cost global economy US $225 Billion.**

Smart Environment

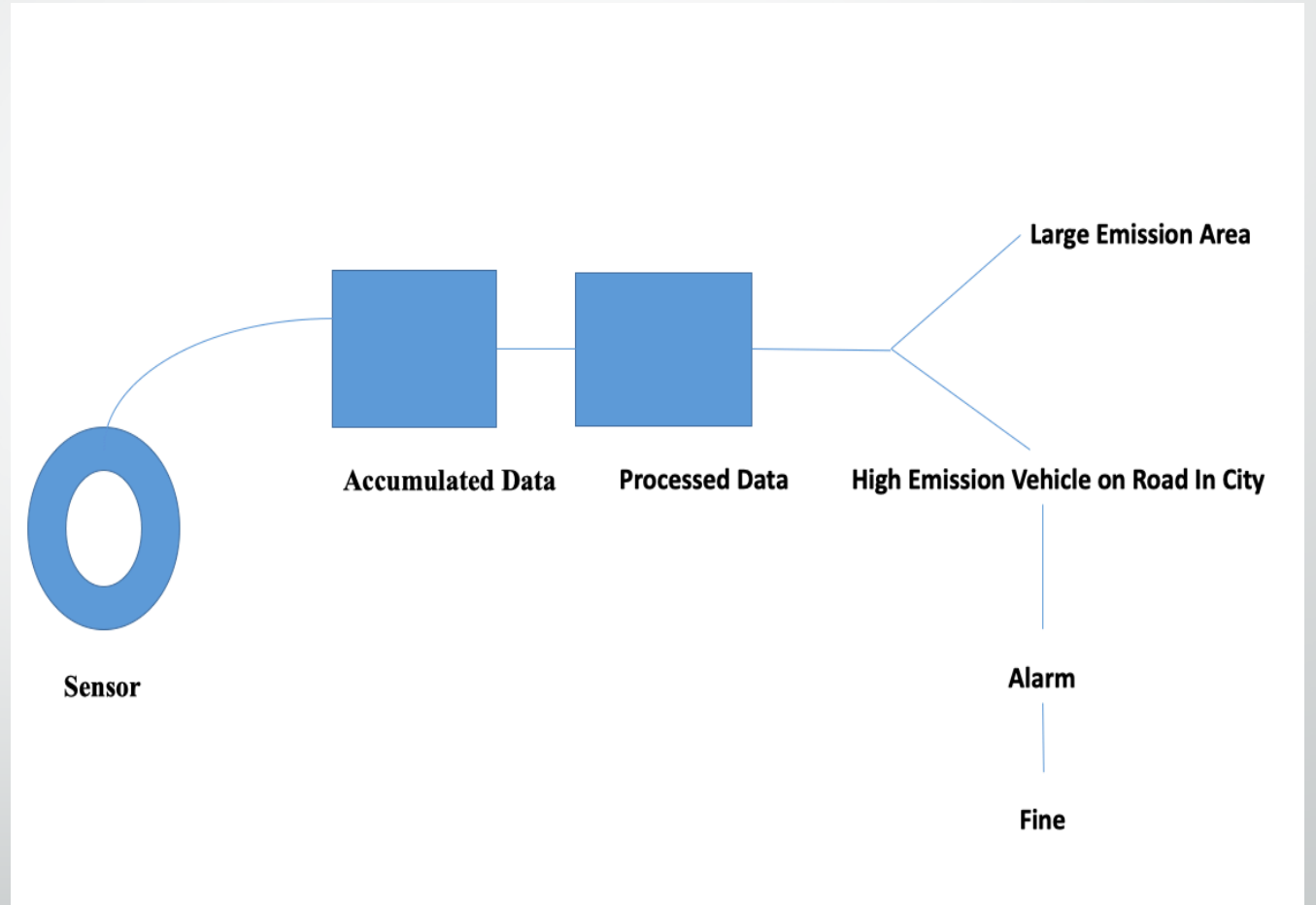

- Smart Environment System is currently developing mainly on observation or monitoring of the condition in water environment. Numerous researches bring up the topic of this water observation due to the various of substances that the water contains to be observed.

Big Data Characteristics : *Ever Expanding horizon*

source : www.datasciencecentral.com

- The environment condition has always been essential for human, many universities and institutions, national or international, have attempted in researching the Smart Environment System. Various methods have been developed in observing water environment, which commonly by utilizing a variety of devices such as ROV (Remotely Operated Underwater Vehicle) or Sensor.
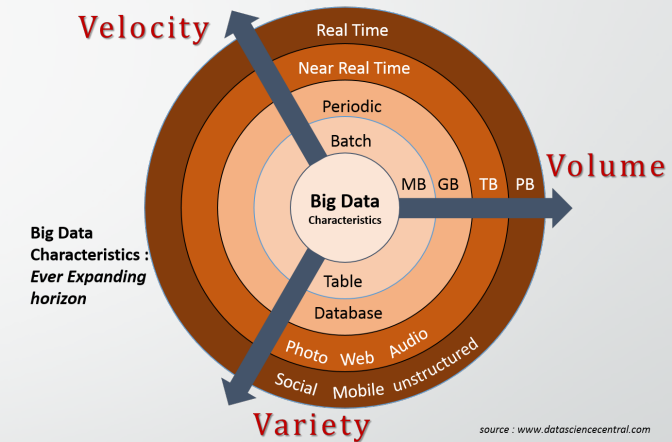
Free Pollution Environment

Technical Solutions

- **Generate Data of Strategic Locations**
- **IoT Devices**
- **Deep learning Algorithms e.g. Artificial neural network (ANN), convolutional neural networks (CNNs**

Sensor

Accumulated Data

Processed Data

Large Emission Area

High Emission Vehicle on Road In City

Alarm

Fine

Conclusions

- A city in northern part of Nigeria was mentioned as the most polluted city in Africa by IQ Airvisual 2019 and possible ways to curtail the problem using the artificial neural network (ANN), convolutional neural networks (CNNs) to harvest and analyze data were studied.

- Sensors with alarming technology can be deployed to detect vehicles, homes, traditional eating spots like Suya spot, markets and well known major areas.

- Laws and regulations can be enacted to set limitation for emissions.

- In case of violations, the violators can be fined.

- With these in place, the rate of mortality, diseases can be minimized and curtail which has a positive effect if actualize widely by the developing nations.

- Other nations like South Africa, Uganda, Ethiopia can use the technology to minimize the air pollution