



TERM PAPER

ON

**ENGINEERING STRATEGIES FOR HANDLING COVID-19 FOR
ENVIRONMENTAL HEALTH AND ECONOMIC SUSTAINABILITY**

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ABSTRACT

This report gives information about the current pandemic outbreak and its evolutionary background. It highlights its stand in Nigeria and the impacts it has on the Nigerian economy and the nation as a whole. The rising statistics show that the pandemic is likely to grow exponentially with a high increase in mortality rate and poverty if the situation isn't addressed properly. Engineering strategies for handling the pandemic for favourable environmental health as well as economic sustainability are herein discussed. The study carried out shows that if these engineering strategies are implemented, the rate of the COVID-19 effect will be subdued to maintain favourable environmental health and foster economic growth

Keywords:

COVID-19, Economic Sustainability, Engineering strategies, WHO, Nigeria.

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LIST OF ABBREVIATIONS

COVID-19	Corona Virus Disease ,2019
WHO	World Health Organization
AIS	Advanced info service
UNICEF	United Nations Children’s Fund
SARS	Severe Acute Respiratory Syndrome

1 CHAPTER ONE

INTRODUCTION

Did you know that throughout *history*, nothing has killed more human beings than infectious disease COVID-19? The coronavirus disease 19 (COVID-19) is a highly transmittable caused by pathogens crossing from animals to humans. This pathogenic viral infection causes severe acute respiratory syndrome, which emerged in Wuhan, China and spread around the world.

When a virus like the novel coronavirus infects a host, that host becomes a cellular factory to manufacture more viruses. The symptoms created by an infectious pathogen – such as sneezing, coughing or bleeding – put it in a position to spread to the next host, and the next, a contagiousness captured in the replication number, Coronavirus disease spreads primarily through contact with an infected person when they cough or sneeze. It also spreads when a person touches a surface or object that has the virus on it, then touches their eyes, nose, or mouth. As at April 4th, 2020 no specific medicine to cure coronavirus disease (covid-19) has been developed. [1]

There are several preventive measures that cannot be overemphasized, they include: washing your hands regularly for 20 seconds with soap and water or alcohol-based hand rub, covering your nose and mouth with a disposable tissue or flexed elbow when you cough or sneeze, avoid close contact (1 meter or 3 feet) with people who are unwell, stay home and self-isolate from others in the household if you feel unwell, don't touch your eyes, nose, or mouth if your hands are not clean. Because human beings move around interacting with other human beings as they do so in every manner from a handshake to sexual intercourse, they move the microbes with them. The statistics of this disease worldwide as at April 2020 is as follows: Active cases: 1,733,792. Recovered cases: 392,781. Death cases: 106,469. [2]

Indeed, the COVID-19 has taken a huge toll on the health of the people and the global economy. Clearly, the disease has compromised the health and wellbeing of the global population, reversing efforts at attaining especially the sustainable development goal that seeks to ensure good healthy population by cutting down mortality, raising life expectancy and economic growth. The world economy is gloomy, as lock downs

continue to plunge economies into recession, heightening fears of rising poverty, especially in fragile developing economies of sub-Saharan Africa. Lockdowns measures being introduced by governments, as part efforts to break the transmission of the disease in populations, have slowed economic activities, affecting government revenue and expenditures, especially financing of interventions to uplift the well-being of vulnerable and the poor in society, especially in developing countries. If the COVID-19 situation persists longer than anticipated, the economy could suffer from significant decline in government revenue and expenditure, resulting in potential job losses. This could in turn will erode economic gains achieved in recent years and significantly slow down economic sustainability development. [3]

Coronavirus and other emerging viruses have caught the world's attention over the last decade, there are various strategies that can be put in place to sustain the environmental health as well as attaining economic sustainability during this pandemic. One of these strategies is the use of leg-controlled paddles instead of hands because, hands are already being used while washing. This mechanical system is intended to prevent infections and decrease water consumption as well as, save the cost of power and components.

In UK, with all but essential workers barred from travelling to work and most public spaces closed in an effort to curb the spread of the novel coronavirus, the emergence and effects of this virus show just how fragile our way of life is, it is this moment we can take a decisive turn on the road to a resilient, zero-carbon future. With most industries closed down, dependence on fossil fuel reduces and also aviation operation. A new turn is the zero-carbon future, in which communities and the economy are resilient to the impact of climate change, this reduces emission ensuring clean air, providing good jobs and also safeguarding economic growth for sustainable development[4]

Another strategy is the use of Robots. Robots helping populations affected by the pandemic worldwide. Countries throughout the world are deploying robots to help amidst the growing crisis. In Bangkok, Chulalongkorn University has teamed up with Advanced Info Service (AIS) to develop robots that utilize 5G technology to monitor coronavirus patients while keeping doctors in the loop from afar. As Business Insider

points out, the city of Wuhan, where the outbreak started, is using robots to spray disinfectant throughout urban spaces. Other use cases include robots for delivering packages to sick people, robots that take people's temperatures and hand out sanitizing gel, robots that spread awareness on COVID-19, robot assistant doctors, and even robot chefs that prepare food while minimizing human contact. [5]

The reactions to the COVID-19 pandemic are essentially the structural amplification behind other social and ecological crises: prioritizing one form of interest over another. This dynamic has significantly contributed to shaping global responses to COVID-19. So how will our economic future grow as responses to the virus evolve? There are four possible scenarios from an economic perspective: A decline into barbarism, a vigorous state capitalism, a revolutionary state socialism and a transformation into a broad, mutually integrated society. Examples of all such possibilities, if not similarly ideal, are entirely possible. It is much easier to address both COVID-19 and climate change if you reduce non-essential economic activities. If the production rate is reduced, power consumption from natural energy based sources is reduced, and the release greenhouse gas is contained. COVID-19's epidemiology is developing quickly. Yet it's equally clear, the central logic; People come in contact and infections spread. It occurs in homes and at work, and on journeys people make. Reducing contact is likely to reduce transmission from person to person and generally lead to fewer cases. [6]

2 CHAPTER TWO

LITERATURE REVIEW

2.1 COVID-19 in Nigeria

For many, 2020 started like every other year an expectation for a fresh start. Nobody anticipated that the year would reveal one of the most infectious diseases ever to hit us - COVID-19. As the death toll and number of infections mounted globally, the world began to panic. Borders shut, schools and offices closed, temperature checks and the use of hand sanitizers became a routine in public places and in homes. The rapidly changing COVID-19 scenario seems to have stopped the entire nation for a moment. Things have changed incredibly rapidly. There is knowledge about the virus everywhere you look, and how to defend yourself against it. Coping with the coronavirus in a country of about 200 million people with a healthcare system that is overstretched and lacks the important resources - from staff to equipment – poses a particular challenge. And healthcare workers are at the front line of response, in Nigeria, as elsewhere. [7]

The major fear of this disease in Nigeria is not because of the disease itself, but because of Nigeria's large population, high levels of poverty, and most importantly, the shortage of healthcare workers, health infrastructure and facilities. The possibility of the number of cases getting into the thousands and reaching the situation that countries in Europe and North America are dealing with right now, we may not be able to handle such numbers here in Nigeria, due to our weak infrastructure. Presently, there are more than 230 cases of COVID-19 in Nigeria, but there are fears that the number could be much higher, as relatively few tests have still been conducted. Nigeria hopes to beat COVID-19 and reduce casualties by using lockdowns, encouraging social distancing and encouraging good personal hygiene.

“People need to see this as the actual pandemic that it is and take all the outlined precautions. A lot of people are still moving around and visiting neighbours' and friends like it's a public holiday. If we can all adhere strictly to the rules of this lockdown, then we have a fighting chance to beat this virus.”[7]

UNICEF is supporting the Nigerian Government's response to the outbreak, by encouraging preventive actions in communities with risk communications, providing

hygiene and medical kits to schools and health clinics and the general public, and monitoring the impact of the outbreak to support continuity of care, education and social services. Also providing awareness campaigns by health educators in all local governments. This is a collective effort that calls on everyone to play their part – whether it's individuals shopping for an elderly neighbour, companies enabling employees to work from home, businesses switching manufacturing capacity to producing hand sanitiser, or governments putting aside party differences to agree on massive assistance measures that will help combat the effects of this world-wide pandemic.

2.2 Effects of COVID-19 in Nigeria

1. Declining consumption:

- Partial (or full) restrictions on movement, thus causing consumers to spend primarily on essential goods and services.
- Low expectations of future income, particularly by workers in the gig economy that are engaged on a short-term/contract basis, as well as the working poor in the informal economy.
- The erosion of wealth and expected wealth as a result of the decline in assets such as stock and home equity. The federal government has imposed a lockdown in Lagos and Ogun states as well as Abuja (which have the highest number of coronavirus cases combined). Subnational governments have quickly followed suit by imposing lockdowns in their states. Nigeria has a burgeoning gig economy as well as a large informal sector, which contributes 65 percent of its economic output. Movement restrictions have not only reduced the consumption of nonessential commodities in general, but have affected the income-generating capacity of these groups, thus reducing their consumption expenditure.

2. Declining investments:

- Investments by firms will be impeded largely due to the uncertainties that come with the pandemic-limited knowledge about the duration of the outbreak, the effectiveness of policy measures, and the reaction of economic agents to these measures—as well as negative investor sentiments, which are causing turbulence in capital markets around the world. Indeed, the crisis has led to a massive decline in stock prices, as the Nigerian Stock Exchange records its worst performance since the 2008 financial crisis, which has eroded the wealth of investors. Taking into consideration the uncertainty that is associated with the pandemic and the negative profit outlook on possible investment projects, firms are likely to hold off on long-term investment decisions.[8]

3. Declining net exports:
 - The restrictions on movement of people and border closures foreshadow a decline in exports. Already, countries around the world have closed their borders to nonessential traffic, and global supply chains for exports have been disrupted. Although the exports of countries that devalue their currency due to the fall in the price of commodities (like Nigeria), will become more affordable, the limited markets for nonessential goods and services nullifies the envisaged positive effect on net exports.
4. Increasing rate of poverty:
 - This disease which causes direct damage to the livestock sector, leading to shortage of food and food price hikes in affected areas.
5. Increase in rate of unemployment:
 - With most companies shutting down due to this pandemic, in order to restore the company afterwards, laying off staff will be implemented leading to high rise in unemployment.

With these being mentioned, there are various positive ways in which this virus has affected Nigeria:

6. Increase in government expenditure:
 - With oil being Nigeria's major source of foreign exchange, amid the steep decline in oil prices, the official exchange rate has been adjusted from 306 to 360 naira. The exchange rate under the investors and exporters (I&E) window has also been adjusted from 360 to 380 naira in order to unify the exchange rates across the I&E window, Bureau de Change, and retail and wholesale windows. Furthermore, the government has introduced import duty waivers for pharmaceutical companies and increased efforts toward ensuring that they receive forex.
7. Improvement in the health care sector:
 - The COVID-19 pandemic is a wake-up call to policymakers as the unusual and unprecedented nature of the crisis has made it impossible for citizens to rely on foreign health care services, and more difficult to solicit for international support, given the competing demand for medical supplies and equipment. A more integrated response spanning several sectors—including the health, finance, and trade sectors—is required to address structural issues that make the country less resilient to shocks and limit its range of policy responses. In the long term, tougher decisions need to be made, including but not limited to diversifying the country's revenue base away from oil exports and improving investments in the health care sector in ensuring that the economy is able to recover quickly from difficult conditions in the future.[8]

2.3 Effects of COVID-19 on environmental health and economic sustainability

The COVID-19 has also taken on a tremendous toll on people's wellbeing and the global economy. Obviously, the epidemic has undermined the global population's health and well-being, undermining attempts to achieve target of sustainable development, which strives to maintain a healthier world by reducing mortality, rising life expectancy and economic growth. The world economy is dim, as lock-downs continue to plunge economies into recession, exacerbating fears of growing poverty, especially in sub-Saharan Africa's fragile developing economies. Lockdown measures introduced by governments as part of efforts to break the transmission of the disease among populations have slowed economic activity, impacting government revenue and spending. In particular, funding of programs to improve the well-being of the vulnerable and the poor in society, especially in developing countries. If the COVID-19 situation continues longer than anticipated, the economy may experience a substantial decline in government revenue and spending, leading to possible job losses. This, in effect, could erode the economic gains made in recent years and considerably slow down the progress of economic sustainability. With most industries closed down, dependence on fossil fuel reduces and also aviation operation. A new turn is the zero-carbon future, in which communities and the economy are resilient to the impact of climate change, this reduces emission ensuring clean air, providing good jobs and also safeguarding economic growth for sustainable development.

3 CHAPTER THREE

METHODOLOGY

3.1 Engineering Strategies for handling COVID-19

The Engineering strategies carried out in handling COVID 19 plays a major role in improving environmental health and economic sustainability. These strategies include:

1. Building of health centers:

Engineers engage in building hundreds of temporary hospitals across the nation to cope with the thousands of new coronaviruses (COVID-19). Cases are being diagnosed daily, after the United States endured its deadliest with 575 fatalities. Isolation center's having over 1,000-bed hospital are built in the space of a week worldwide. Meanwhile, engineers are still searching for hotels, dormitories, convention centers and large open space to build as many as 700 temporary hospitals worldwide. With that been said, all over the globe officials have been forced to canvass for extra spaces to ease the strain on existing hospital systems to manage resources for sustainability. Therefore, instead of building a large room for just one infected person, demarcations are being made, or the spaces are divided into little cubicle to contain as many individuals.

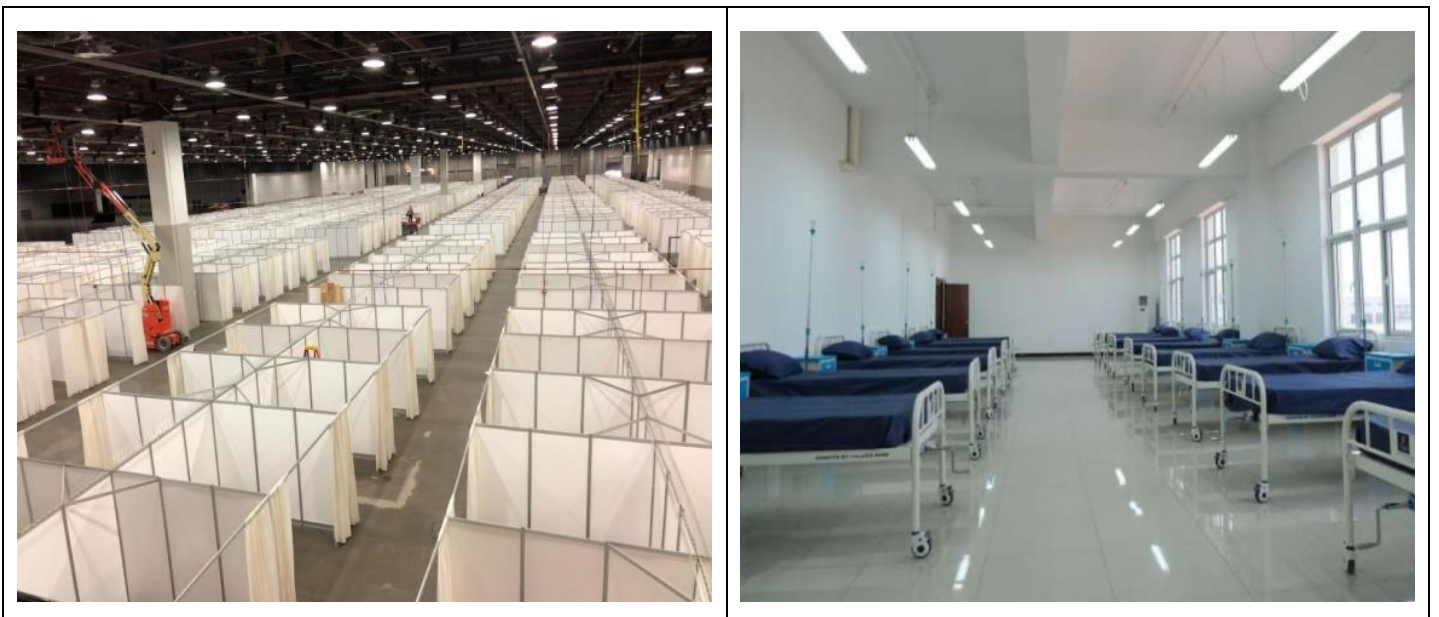


Figure 3-1: isolation centers

2. The use of zero-carbon power and transport systems

COVID-19 has changed our lives in ways that we never imagined. In just a few short months, the impact of this devastating virus has shut schools, offices, stores and factories. Airlines are grounded. Borders are closed. Many of us are quarantined at home. It is this moment we can take a decisive turn on the road to a resilient zero-carbon future. A zero-carbon future in which communities and the economy are resilient to the impacts of climate change. One where investments contribute to reducing emissions, ensuring clean air and providing good jobs as well as safeguarding economic growth, this long-term stimulus investment should be used to build a better future. We have the solutions to build zero-carbon power and transport systems. We know how to put people to work building energy efficient, low-carbon buildings and infrastructure. Nature-based solutions are available now to rapidly reduce and sequester emissions. Many of the technologies needed to create zero-carbon industrial sectors already exist.[9]

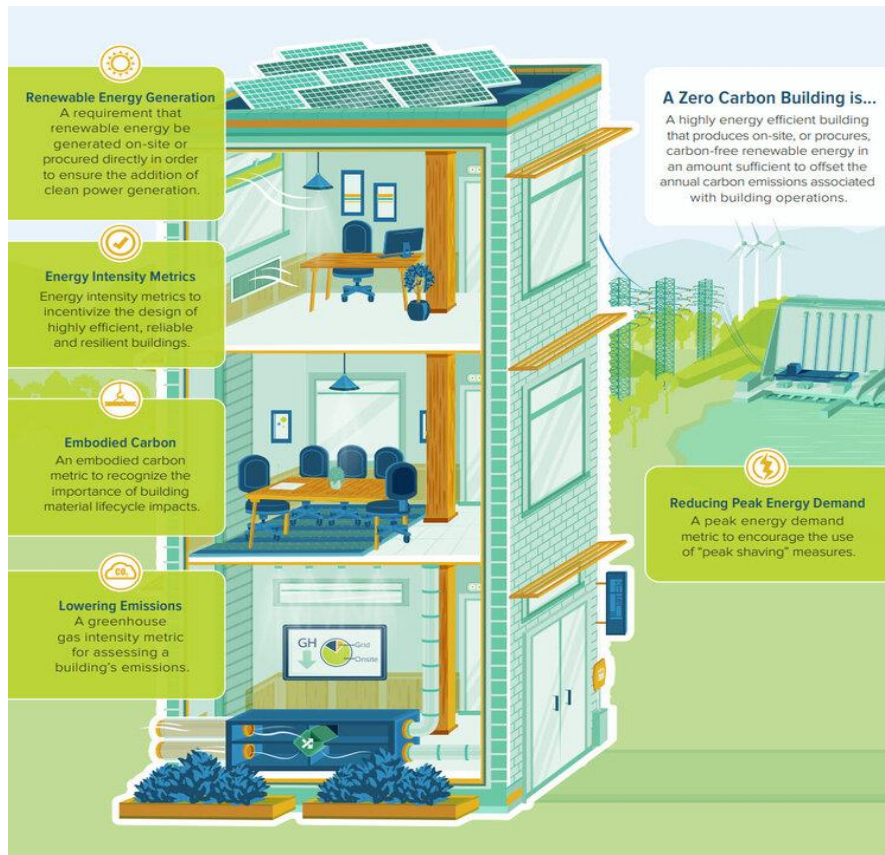


Figure 3-2: zero carbon steps

3. Design of equipments needed to decrease rate of fatality in COVID-19:

The major equipment needed for covid-19 is ventilator, as hospital administrators and public health officials scramble to meet a shortage of ventilators for patients, team of doctors and engineers are filling some gaps by modifying breathing machines that are plentiful, such as those used to treat sleep apnea. This technological fix is happening at the same time as a bubbling medical debate among physicians over whether too many coronavirus patients are being placed on traditional ventilators that some argue that it may do more harm than good. Another team of engineering students designed and built a conversion kit to retrofit several sleep apnea machines that have been donated to a volunteer group in the bay and are called ventilator sos. This modified devices are helpful for patients who are improving or have milder symptoms, saving the ventilators for severely ill patients who are battling advanced respiratory failure.

Also, another engineering technology that should be implemented is the use of an arduino controlled ventilator which is connected to the beds of each patient. This machine will be programmed to detect the heart failure and it will beep if a patient is about to have one, with this there will be easy access to the machine by patients and reduce the risk of doctors and nurses getting infected. Since we are in the 22nd century, the use of robots should be implemented to treat infected patients, whereby this robots will be controlled by experts to provide the needs of each patient.

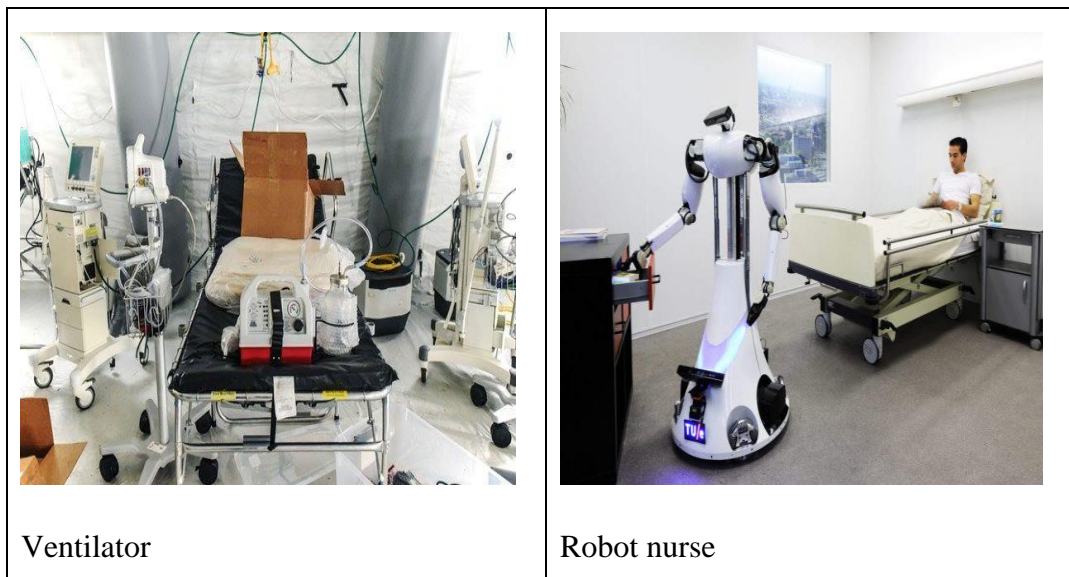


Figure 3-3: (a) Ventilator (b) Robot nurse

4. Water sinks having Leg-controlled pedals:

Due to the lack of water resources and extreme use of portable water, a mechanical system is proposed to prevent infection and decrease water consumption in washing of hands and faces, utensils, ablution and similar operations. This study presents a suitable cost of mechanical way with easy implementation to save water and prevent infection. The proposed methods depend on controlling the water flow valve using leg-controlled pedals instead of hands because, hands are already busy while washing. This mechanical system is intended to save the cost of power, components and for safety thus, electrical or electronic control is not used. The system design is developed in a way that eases its practical application on the already installed water valves without need to replace these valves entirely. The system is characterized by its simplicity, easy installation and maintenance besides its low effective cost. With the use of this water resources are managed for economic sustainability.

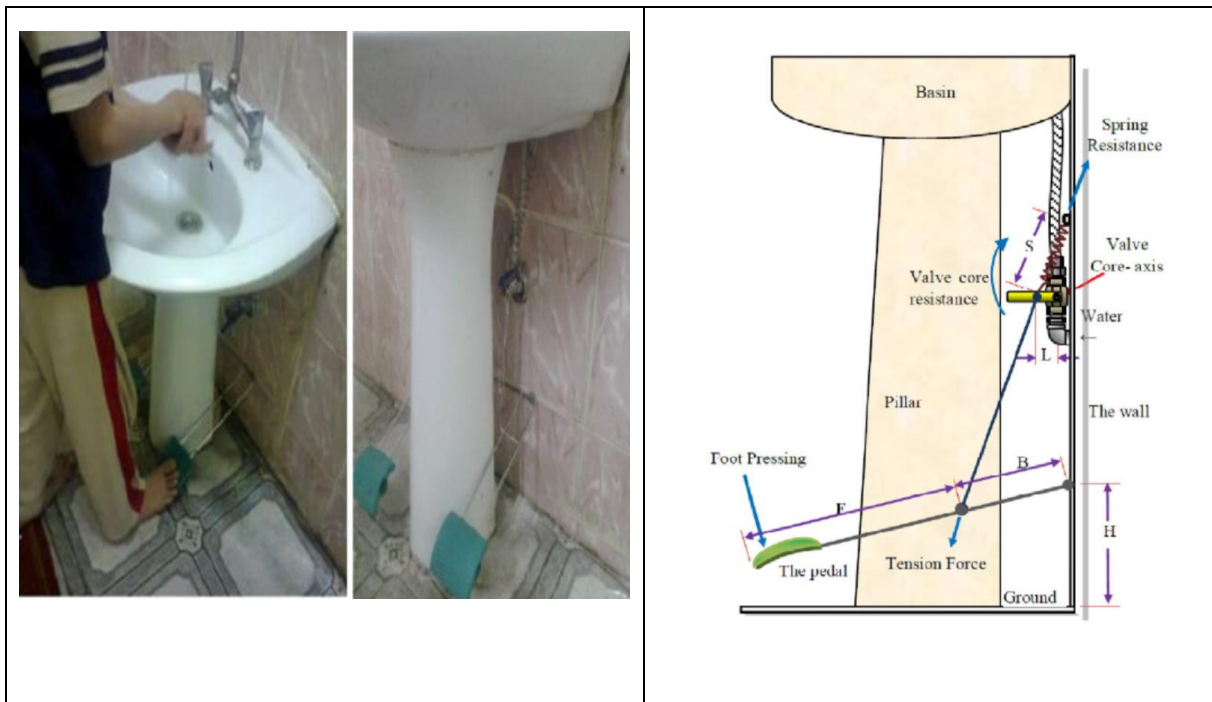


Figure 3-4: leg-controlled water sink

5. Coronavirus isolation pods should be implemented

Special fully-sealed isolation pods were recently created for safely transporting COVID-19 patients. The specially-designed pods are equipped with air pumps that

create a negative pressure within the sealed space. The negative pressure means that, even if the plastic lining of the pod is torn during the transfer of a patient, any fluids will remain inside the isolation pod — an ingenious method for stopping the spread of the infectious disease amongst healthcare workers.



Figure 3-5: isolation pod

6. The snorkeling mask ventilator

Only a few days after helping an Italian hospital by playing their part in fixing the broken supply chain for ventilators, the same group of engineers shared a 3D printed design for an adapter that converts snorkel masks into ventilators. Through the use of the adapter, a converted "Easy breath" snorkel mask becomes a functional C-PAP mask for oxygen therapy — a treatment that is critical for the recovery of people with severe cases of COVID-19.[9]



Figure 3-6: A Snorkeling Mask

7. Develop the use of renewable energy

The renewable energy will reduce global warming, cost of electricity provision, improve the economy, for they will also supply power to other under-developed or developing countries, improve their public health and also provide power that will be able to sustain them for 50 decades to come. Thereby also providing power for the hospitals to function during a pandemic, this will support the nation and also improve sustainable development. For most isolation power, there is need for a constant 24/7 light. This can be done with the use of solar panels, hydropower, backup power saver (inverter) and also renewable power.



Figure 3-7: Renewable energy source

4 CHAPTER FOUR

RESULT AND DISCUSSION

4.1 A case study on the engineering strategies applied to COVID-19

- 1) The result of the coronavirus conducted in various countries and collated by the world health organization, WHO is as follows:

The number of total COVID-19 cases is what we want to know to understand the scale of the COVID-19 outbreak, and respond appropriately, we would want to know how many people are infected by COVID-19, We would want to know the total number of cases. However, the total number of COVID-19 cases was reported to be 1,836,959 worldwide. When media outlets reported the number of recovered cases it was reported to be 421,363, and the total number of deaths was 113,266.

Analysis and solution:

Analysing this result, it is shown that the number of people recovering from this disease is beyond the number of deaths. It was reported that, when doctors made use of the various engineering strategies the recovery case increased by far. A major solution that was implemented was the use of modified sleep apnea for minor covid-19 patients and the use of ventilators for major patients; also they made sure of the demarcated rooms for each individual.

- 2) It was reported by a hospital specialist in china that, the rate at which doctor and nurses get infected when treating patients with covid-19 was fast rising. The fear of doctors and nurses being at risk to this virus increase. So, due to this most doctors and nurses stayed back home with their families to ensure their safety.

Analysis and solution:

A solution that can be implemented to lessen the risk of doctors and nurse's exposure to this disease is the use of robots. Robots that utilize 5G technology to monitor coronavirus patients while keeping doctors in the loop from afar, and also the use of isolation pod to carry the infected patients. If this solution is critically put into action, more doctors and nurses will show up as they will not be at risk.

- 3) It was reported that in a city in Nigeria, there was excess water wastage due to running taps being left on. And from this, excess power was consumed in other to provide water. But although there were taps available to wash hands and stay

clean in this horrifying pandemic, the rate of infections increased and most people who were infected had gotten the disease from the available taps.

Analysis and solution:

A mechanical system was proposed to prevent infection and decrease water consumption in washing of hands and faces, utensils, ablution and similar operations. This study presents a suitable cost of mechanical way with easy implementation to save water and prevent infection. The proposed methods depend on controlling the water flow valve using leg-controlled pedals instead of hands because, hands are already busy while washing.

- 4) It was reported that an influenza epidemic simulation model to estimate the likelihood of human-to-human transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in a simulated Singaporean population was adopted. under three infectivity scenarios (basic reproduction number [R_0] of 1.5, 2.0, or 2.5) and assuming 7.5% of infections are asymptomatic. and then assessed the effect of four intervention scenarios compared with a baseline scenario on the size and progression of the outbreak for each R_0 value. These scenarios included isolation measures for infected individuals and quarantining of family members (hereafter referred to as quarantine); quarantine plus school closure; quarantine plus workplace distancing; and quarantine, school closure, and workplace distancing (hereafter referred to as the combined intervention).

Analysis of the model and results

Implementing the combined intervention of quarantining infected individuals and their family members, workplace distancing, and school closure once community transmission has been detected could substantially reduce the number of SARS-CoV-2 infections. We therefore recommend immediate deployment of this strategy if local secondary transmission is confirmed within Singapore. However, quarantine and workplace distancing should be prioritized over school closure because, at this early stage symptomatic children have higher withdrawal rates from school than do symptomatic adults from work. At higher asymptomatic proportions, intervention effectiveness might be substantially reduced requiring the need for effective case management and treatments, and preventive measures such as vaccines. [10]

5 CHAPTER FOUR

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Conclusively, it shows that engineering strategies are efforts that should be put forward in order to attain a healthy environment as well as sustain the economy during covid-19 pandemic. Also the use of a zero carbon method of power generation and the developed design structures of ventilations using sleep apnea should be adopted.

5.2 RECOMMENDATION

- Government should set up strict policies and standards regarding the lockdown method.
- Government should ban all public gatherings, schools and work places temporarily engaging the military force to achieve this.
- Government should provide extensively the needs of the citizens from household resources to medical kits.
- The citizens should be enlightened more on the disease and its effects.
- Schools should set up online activities to keep their students engaged during the lock down.
- Government to make proper funding to scientist and health care sectors in other to combat the disease.

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