SEIZURE SHIELD

STEM 6th of October - G12 - 2023/2024

Group: 338

Paula Alfons
David Elkes
Tony Ashraf

MINISTRY OF EDUCATION AND TECHNICAL EDUCATION
وزارة التربية والتعليم والتعليم الفني

STEM EGYPT

Table of contents

Chapter I

Presenting and Justify a Problem and Solution Requirements

Introduction

Egypt is one of the third world countries, which means it is one of the developing countries, but unlike other third-world countries, Egypt has the potential to have great achievements and be a first-world country. Like many other countries, Egypt is facing some problems that need to be solved to achieve greatness, and these problems are called Egypt's Grand Challenges, which are various issues affecting the economy, ecology, social life, and long-term viability. These issues are a roadblock in the way of its progress. To tackle these problems, we must view them as challenges that we are attempting to solve with difficulty, and we must think about and come up with innovative solutions to such problems.

Figure 1.1: Shows Egypt's grand challenges.

Egypt Grand Challenges

Work to eradicate public health issues/diseases

Public health is concerned with monitoring the health of citizens and preventing the spread of diseases. It forms a vital challenge for both developed and developing countries, including Egypt. The challenge aspects differ depend on the local conditions of the country. For Egypt. According to The Center of Disease Control and Prevention (CDC), around 84% of total mortality cases in Egypt are non-communicative diseases, such as ischemic heart disease, stroke, and cancer. Statistics have shown that 21% of deaths in Egypt are from ischemic heart disease. Following it stroke with 14% of deaths. The whole list of deaths leading to diseases is **mentioned in figure 1.2**. It can be also concluded that around 84% of the total mortality cases in Egypt are non-communicative diseases, and around 61% of leading diseases to deaths are chronic with 21% of them from the ischemic heart disease.

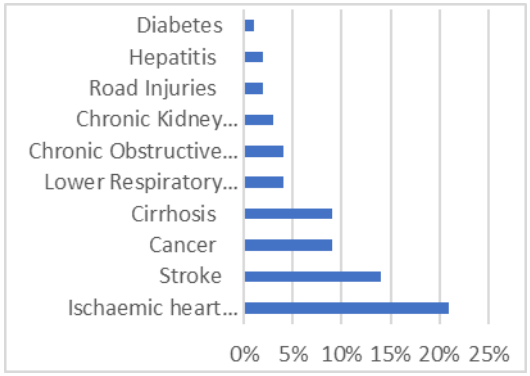


Figure 1.2: Top Leading diseases to Death in Egypt according to CDC

Through the past years, Egypt had the heights rates of Hepatitis C Virus, with around 10% of population infected. Around 400,000 deaths, which represents 7.6% of total deaths in 2015, was caused by the virus. Due to the country's efforts in eliminating the virus through "100 million Seha" campaign, the rates were significantly reduced from 300 victim per 100,000 in 2014 to 9 victims per 100,000 in 2022.

COVID- 19 pandemic was unforgettable struggle for Egypt as well. From 2020 to 2022 around half a million victim was confirmed with the virus. According to the WHO, the virus accounted for 24,830 deaths throughout the same period. Due to the country's efforts in spreading the vaccine among citizens, both cases and deaths was significantly reduced by the end of 2022**, as shown in figure 1.3**.

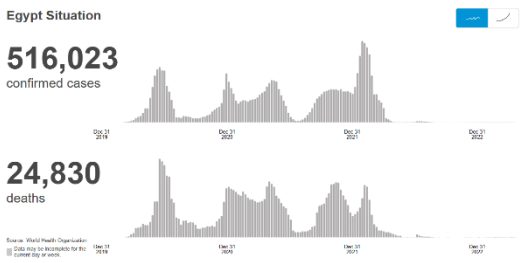


Figure 1.3: Chronological diagram of cases and deaths by COVID-19.

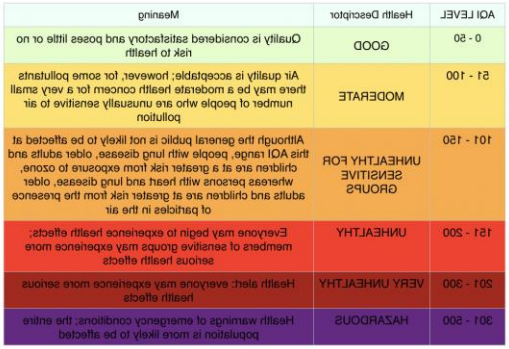
Causes

❖Population growth

Egypt's population is estimated to reach 113 million citizens in 2023, but that is not the challenge. The true challenge is found to be the population density, as only 77,041 km^2 of Egypt's land is inhibited. Leading to a population density of 1200 people per km^2. This density helps in the spread of communicative diseases, such as virus C and COVID-19. Which put loads on Egypt to extends the inhabited land to preserve a risk-free future with communicative diseases.

❖Pollution (Air, Water, and soil)

Air pollution is one of the lading causes of chronic diseases in Egypt. According to the World Health Organization (WHO) 2018 report, air pollution is the leading cause for non-communicative diseases with the following percentages: heart disease (57.9%), stroke (17.7%), and pulmonary and lower respiratory diseases and cancer (24.4%). Egypt also is ranked the ninth in the worst air quality ranking in 2022, with AQI (Air Quality Index) of 128, which is considered unhealthy for sensitive groups, and can lead to chronic diseases according to **the standard scale of air quality index shown in figure 1.4**.



AQI LEVEL	Health Descriptor	Meaning
0 - 50	GOOD	Quality is considered satisfactory and poses little or no risk to health
51 - 100	MODERATE	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution
101 - 150	UNHEALTHY FOR SENSITIVE GROUPS	Although the general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air
151 - 200	UNHEALTHY	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
201 - 300	VERY UNHEALTHY	Health alert: everyone may experience more serious health effects
301 - 500	HAZARDOUS	Health warnings of emergency conditions; the entire population is more likely to be affected

Figure 1.4: The standard scale of air quality index

Water pollution and lack of clean water resources form many risks for public health. According to UNICEF, there are 8.4 million people don't have access to clean water resources mostly in coral reefs. This polluted water made diarrhea the second cause of death among under 5 years children in Egypt. With average deaths between 3,500 to 4,000 under 5 years children annually. Another report made by the WHO shows that 5.1% of all deaths, and 6.5% of all disabilities are resulted from unsafe drinking water.

Soil pollution can result from irrigation with unclean water or the overuse of chemical pesticides and fertilizers. According to much research polluted soil can contain higher amounts of heavy metals, such as zinc, cadmium, copper, and lead, which increases the risk of cancer, respiratory issues, and skin diseases.

❖Unhealthy Lifestyle habits

Bad lifestyle habits of Egyptians can lead to the spread of chronic diseases. According to World Population Review, Egypt is one of the top 10 countries in obesity, with an obesity rate of 29.6%. Obesity forms a great risk on the population, and increases the possibility of heart diseases, and type two diabetes.

Smoking is also considered the leading cause of lung cancer, and respiratory diseases. Lung cancer is found to be the top leading cause of deaths with ratio of 25% among all cancer cases. In 2022 it was estimated that smoking rate for 2022 is 24.30% which is less than 2021 rates by .1%, **as shown in figure 1.5.**

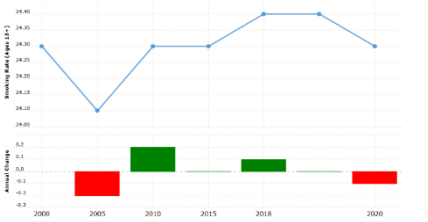


Figure 1.5: Smoking Cases annual report.

Impacts

❖Economic Consequences

GDP (Gross Domestic product), which indicates the monetary value of all goods and services within the country, is significantly influenced by public health issues. Through the previous COVID-19 pandemic and the partial shutdown, Egypt's GDP declined in 2020 by 2% compared to 2019. Then it declined again in 2021 by 0.26%. After the end of the pandemic and the spread of vaccines, the GDP increased by 3.30%, **as shown in figure 1.6**.

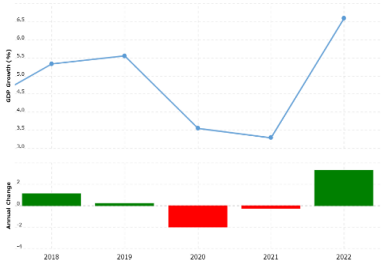


Figure 1.6: Rate of change in GDP in Egypt from 2019 to 2022

❖Increment in mortality rate

The first notable impact of any public health issue is the increase in mortality rates. In Egypt, this can be seen through many diseases. in 2015 Egypt was the heights country in Hepatitis C Virus, which lead to about 400,000 deaths on the same year. COVID-19 also caused over 24,830 recorded deaths through 2020 to 2022. Therefore, the country should put efforts into solving public health issues to reduce mortality rate.

❖Strain on healthcare system

Public health issues are usually followed by strain on the healthcare system. Followed by extra funding from the government to it. This scene can be seen through the COVID-19 pandemic. One of the major challenges was the shortage of medical oxygen, which lead to be extremely expensive or not found at all. Besides the high demand on hospitals due to the increment of victims. All of these factors can worsen the issue, and have further consequences.

Increase the industrial base of Egypt

Egypt has a rich and diverse industrial base that plays a crucial role in its economy and development. Situated at the crossroads of Africa and the Middle East, Egypt has a long history of industrial activity dating back to ancient times when it was known for its craftsmanship in areas such as pottery, textiles, and construction. In modern times, Egypt has continued to build on this foundation, developing a wide range of industries that contribute significantly to its "GDP" (Gross Domestic Product), and employment.

As shown in Figure 1.7 the distribution of the gross domestic product (GDP) across economic sectors in Egypt from 2011 to 2021. In 2021, agriculture contributed around 11.83 percent to the GDP of Egypt, 30.79 percent came from the industry and 52.23 percent from the service sector. The industry is the most important factor in improving the Egyptian economy. There are around 26,000 formally registered industrial establishments employing nearly 2.4 million workers and around 1.5 million workers in informal industries.

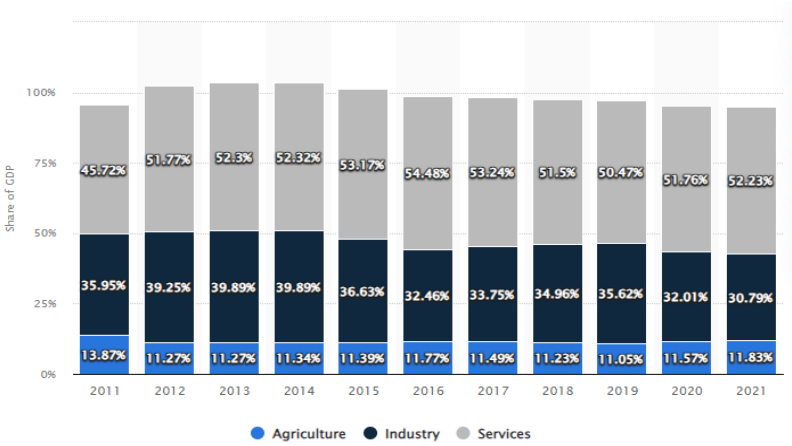


Figure 1.7: Shows the distribution of the gross domestic product (GDP) across economic sectors in Egypt.

In recent years, there has been notable progress in the integration of Information and Communication Technology (ICT) within various sectors in Egypt, notably in healthcare. According to the World Bank, Egypt's ICT sector has experienced substantial growth, accounting for approximately 3.5% of the nation's total exports and exerting a substantial influence on the country's economic expansion.

In the realm of healthcare, there has been a noteworthy surge in the utilization of telemedicine services. According to the Ministry of Health and Population of Egypt, telemedicine consultations have exhibited a remarkable growth rate, surpassing 200% within the preceding three years. This surge has enabled millions of Egyptian citizens to access healthcare services from remote locations. This heightened accessibility assumes particular significance for individuals with disabilities, as it alleviates the difficulties they may encounter when attempting to physically visit healthcare facilities.

Causes:

❖Lack of infrastructure

Critical infrastructure in Egypt is consistently underfunded, which hinders economic development and puts local companies and communities in serious danger. A growing population imposes significant pressure on physical and digital infrastructures, which are also threatened by cyberattacks, severe weather, and climate change, in addition to the pressure imposed by population growth. The infrastructure began to deteriorate beginning of 2016, **as shown in Graph 1.8.**

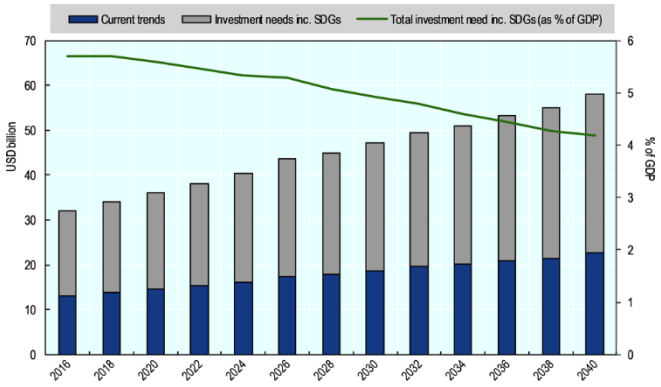


Figure1.8: Shows the beginning of infrastructure deteriorate.

❖Economic challenges

Egypt is dealing with a number of economic issues, such as extreme poverty, and inflation. The

International assistance and remittances. The government has attempted to solve these issues by enacting economic reforms and encouraging the expansion of the private sector, but the results have been patchy and gradual.

❖Arid areas

The ratio of aridity in Egypt is 86 % **as shown in Figure 1.9**. It's a high ratio that caused difficulty in transportation and agriculture, which in turn wastes more money, so factory managers don't prefer building factories in arid areas, and this causes a decrease in the industrial and agriculture base.

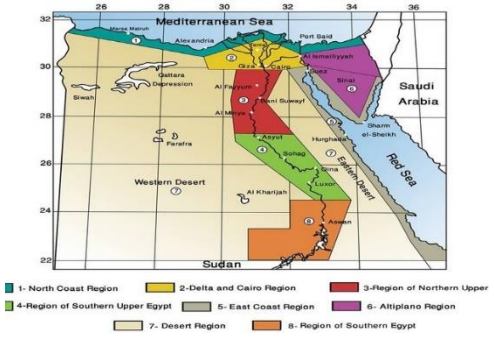


Figure 1.9\Shows the ratio of aridity.

❖Population challenges

With an estimated population of over 100 million, Egypt is the most populous Arab nation and the 14th most populated country overall. Nonetheless, the country's population density is an issue because less than 5% of Egypt's entire land area is occupied by 95 percent people. This has put pressure on the infrastructure and resources of the nation. This has made it challenging for the government to offer companies essential assistance and services, and it has also made it difficult to provide worker education and training.

Impacts:

❖Lots of importing

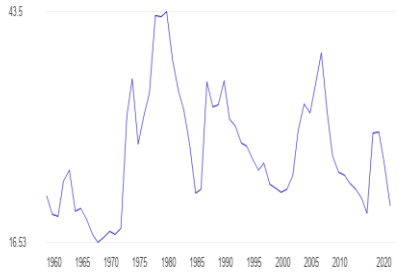


Figure 1.10: This graph shows the ratio of importing.

Decreasing industrial base in Egypt caused increased imports because of the increase in people's demand for products without having many factories. The latest importing value of Egypt in 2020 is 20.77% **as shown in Figure 1.10**. Egypt imports primarily mineral and chemical products (which account for 25% of total imports), agricultural products, livestock, and foodstuffs (which account for 24% of total imports, primarily wheat, maize, and meat), machinery and electrical equipment (15%), and base metals (which account for 5% of total imports). Raw hides, timber, paper-making goods, textiles and footwear (9.5%), artificial resins and rubber (6%), and cars and airplanes are among the other imports (5.5%).

❖Increase unemployment

Long durations of unemployment, inconsistent work, and increasing underemployment are common outcomes of deindustrialization and job losses. **Figure 1.11 shows the unemployment rate between 2000 to 2016**. The ratio of unemployment in Egypt was 10.45% in 2020, up 0.72% from 2019. Egypt's unemployment rate was 9.73% in 2019, down 0.09 percent from 2018.

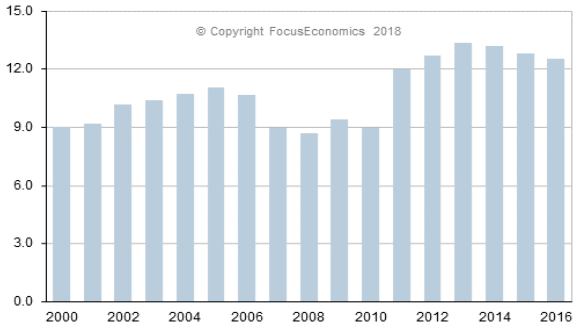


Figure 1.11: shows the unemployment rate between 2000 to 2016.

❖Increase poverty

With a sizeable fraction of the population living below the poverty line, poverty has been an ongoing problem in Egypt for many years. The amount of money required to meet basic food and non-food requirements is referred to as the poverty line. Egypt's poverty level for 2019 was set at EGP 8,827 (or $560) per year or EGP 735 (or $47) monthly. Egypt's poverty rate was 29.7% **as shown in Figure 1.12** according to CapMas.

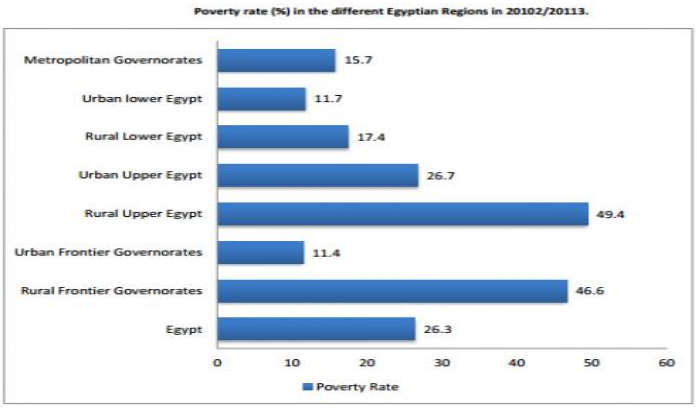


Figure 1.12/ Shows Egypt's poverty rate.

Address and reduce pollution fouling on air, and water

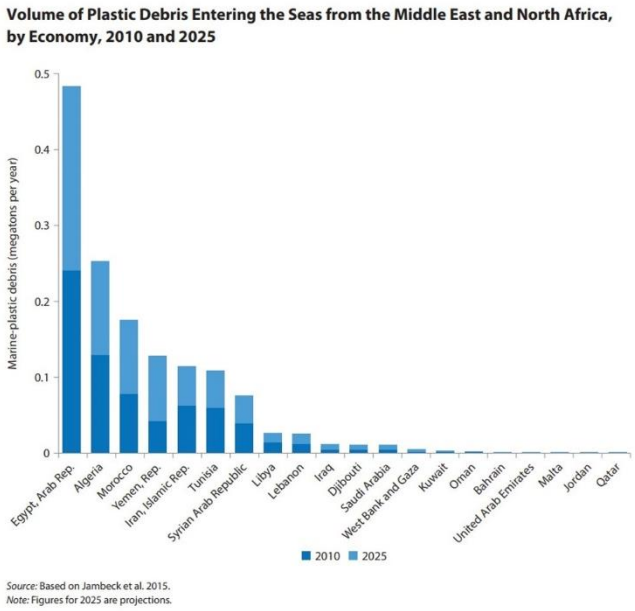
In Egypt, there are a lot of environmental issues that have several negative impacts on the environment, which can be attributed to many problems. One of these serious problems is pollution. There are more than 9 million premature deaths attributed to environmental pollution, of which the majority are due to air pollution that has become a major contributor to diseases and premature deaths. Pollution in Egypt has a variety of causes, including. Among 117 countries surveyed last year, Egypt was ranked as the 27th most polluted country in the world, with a reading of small and hazardous airborne particles known as PM2.5 at 29.1 per million per year, according to the World Health Organization.

- Water pollution:

Egypt suffers from a 7 billion cubic meter deficit of water each year because of widespread pollution of its water sources, according to a UNICEF report from 2021. 97% of Egypt's water comes from the Nile. The rest is derived from winter rainfall and non-renewable groundwater aquifers. Approximately 350 industries discharge their sewage water directly into the Nile or through the municipal system. Industrial waste is the largest source of pollution in Egypt.

Each year, the Mediterranean is estimated to receive 720,000,000 tons of sewage, 142,000 tons of mineral oil, 66,000 tons of mercury, 4,200 tons of lead, and 40,000 tons of phosphates.

In the MENA region, Egypt is the country with the highest levels of marine-plastic pollution, as well as the seventh most polluted nation in the world. **As shown in Figure 1.13**, Egypt accounted for 3% of plastic waste discharged into the world's oceans and seas in 2010.

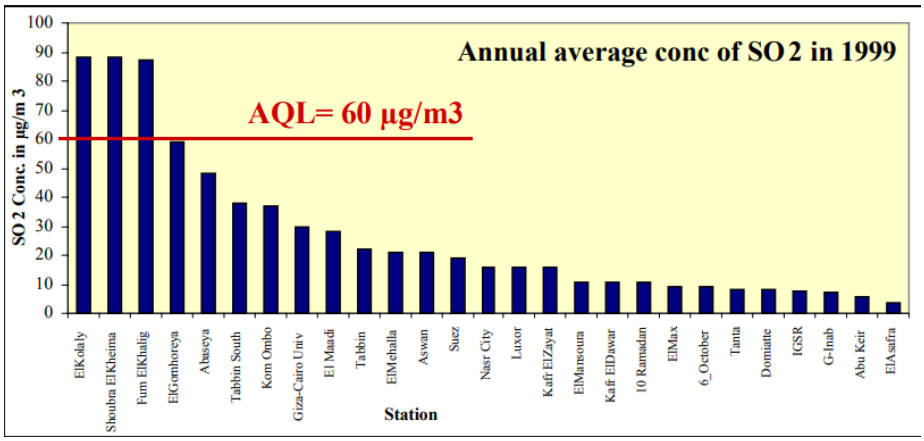


Graph 1.13/ Volume of Plastic Debris Entering the Seas from the Middle East and North Africa, by Economy, 2010 and 2025

- Air pollution:

Egypt has been suffering from high levels of air pollution for decades, especially in large cities such as Cairo. The level of fine particulate matter PM10 and PM2.5, which pose the greatest risk to the health of Egyptians, is particularly high in Greater Cairo.

In most polluted areas, concentrations of SO2, NO2 and CO exceed the Air Quality limit values from time to time **as shown in figure 1.14**. There is a tendency for most of the violations to occur near industrial areas and in areas with congested streets. During certain weather conditions, such as those that are occurring in the Middle East, large metropolitan cities, such as Cairo, experience air pollution episodes that exceed the limit values during certain episodes of air pollution.



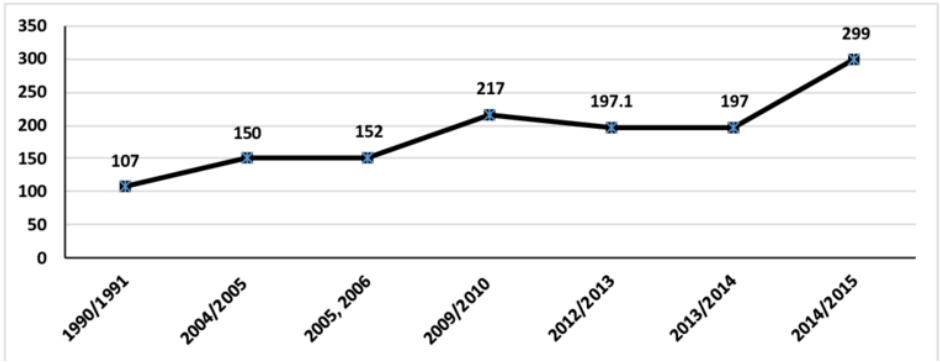
Graph 1.14/ Annual average concentration of SO2

Causes:

❖Burning of fossil fuels

Fossil fuel combustion contributes significantly to air pollution in Egypt, as well as in many other parts of the world. The combustion of fossil fuels, such as coal, natural gas, and oil, is a common process for generating electricity, transporting goods, and manufacturing products.

As a result of the consumption of oil products and gas, about 197 million tons of carbon dioxide equivalent were emitted in 2014. This was up about 0.1% from about 197.0 million tons in 2013 **as shown in graph 1.15**. The amount reached 299 million tons in 2015, equal to about 0.58% of all emissions in the world.



Graph 1.15: The amount of CO2 emissions in Egypt

❖Agricultural slash and burn

The second highest concentration of PM2.5 is found in the city's slash-and-burn agriculture. This practice has increased in the Nile valley cities as the demand for real estate on agricultural land has increased. Farmers in the Nile Delta and Cairo burn rice straw after harvesting due to lack of access to technology. This creates an annual black cloud across the area.

The government reported collecting 500,000 tons of straw in 2020, which is 90% of the total production.

❖Discharging of industrial wastes in the Nile River

Industrial waste is discharged directly into the Nile River by many factories. About 39 industrial point sources are located along the Nile River, according to the Nile Research Institute. Industry wastes include heavy metals, organic compounds, chemicals, fertilizers, and metals, all of which are harmful to humans and cause a variety of diseases, as well as toxic for aquatic life. These industries include sugar, oil, chemicals, fertilizers, and metals.

❖Getting rid of Agricultural wastes in the Nile River

Around 72 agricultural drains discharge their waste directly into the Nile River, according to the Nile Research Institute.

Drains from agricultural operations tend to be loaded with nutrients (e.g., nitrogen and phosphate), pesticides (e.g., insecticides, herbicides), suspended solids, salts. In agriculture, pesticides accumulate in the food chain, especially those resistant to hydrolysis, eventually causing cancer in humans.

Water with high levels of phosphates and nitrates causes excessive growth of aquatic plants, which causes undesirable effects and limits water use.

Impacts:

❖Deteriorating public health

A direct threat to public health, air pollution reduces the life expectancy of Egyptians by two years on average due to morbidity and disabilities. There were 90,559 premature deaths in Egypt in 2019, accounting for more than 12% of all deaths.

In 2016, air pollution-related illnesses caused 57.9% of premature deaths in Egypt, 17.7% of strokes, and 24.4% of cancers and respiratory diseases. Among the leading causes of death in Egypt, noncommunicable diseases account for 82% of fatalities and 67% of premature deaths.

Every year, 3,500 to 4,000 children under five dies of diarrhea due to water pollution, and 10-20% of Egyptians suffer from chronic diseases, such as kidney failure, cancer, and hepatitis C.

❖Economic burden

In 2016-17, according to the World Bank, the economic burden of air pollution in Greater Cairo alone would amount to EGP47 billion, or 1.35% of GDP, as a result of the health burden caused by air pollution.

In 2018, it was estimated that the cost of the toll on health caused by air pollution caused by the burning of fossil fuels was more than EGP100 billion, or about 2.8% of the country's GDP.

Problem to be solved

Lack of the provision of first aid to Generalized epileptic seizure patients.

An epileptic seizure is an abrupt and uncontrolled surge of electrical activity within the brain, giving rise to alterations in behavior, movements, emotions, and levels of consciousness. In Egypt, there is a prevalence of 6.8 per 1,000 people, totaling 81,600 individuals affected by epilepsy. Among these seizures, generalized onset seizures represent a particular type characterized by simultaneous initiation and impact on both brain hemispheres. These seizures manifest in a variety of ways, each with its own distinctive features. The most common manifestations include absence seizures, resulting in brief episodes of altered consciousness and fixed gazes; tonic-clonic seizures, marked by loss of consciousness, muscular rigidity, and convulsive movements; and atonic seizures, which lead to sudden loss of muscle tone and the potential for falling. The underlying causes of generalized onset seizures may stem from genetic predisposition, cerebral anomalies, or other medical conditions. They can lead to significant physical and psychological consequences, including injuries from seizure-induced falls and cognitive impairments due to disrupted brain function.

Consequently, neglecting to offer assistance to individuals experiencing generalized epileptic seizures can result in dire consequences. Epileptic seizures encompass a spectrum of intensity, ranging from mild to severe. While many seizures are brief and pose minimal immediate risk, some can escalate to life-threatening situations that demand urgent intervention such as generalized onset seizures. Neglecting to provide first aid and proper follow-up care can potentially lead to injuries, complications, or even fatalities, as the number of deaths has increased in recent years **as shown in Figure1.16**, emphasizing the importance of being informed and prepared to assist during epileptic episodes.

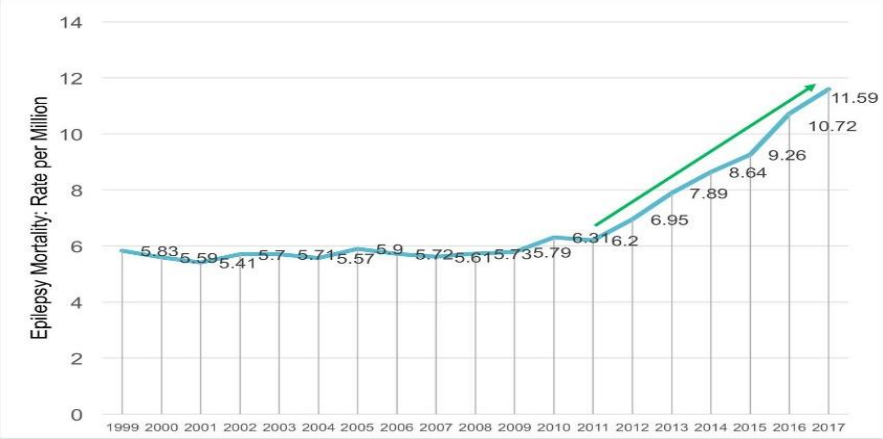


Figure 1.16: shows an increase in the number of deaths in recent years as a result of epilepsy.

Positive impacts if solved:

❖ Medical Cost Savings

Addressing the matter of inadequate prompt provision of initial medical assistance to individuals encountering epileptic seizures in Egypt has the potential to yield substantial reductions in healthcare expenditure. As per statistics provided by the World Health Organization, epilepsy stands as a prevalent neurological condition in Egypt, impacting approximately 1.6% of the populace. The timely administration of first aid measures can significantly mitigate the necessity for emergency room admissions and hospital stays, thereby generating heightened cost-efficiency in the healthcare system.

❖ Reduce risks and injuries

Promptly administering first aid to an individual undergoing a generalized epileptic seizure can substantially reduce the associated risks and potential for harm. It is imperative to respond swiftly and knowledgeably in such circumstances. During a seizure, the individual's body may convulse uncontrollably, leading to injuries such as head trauma or fractures. There is also a significant risk of suffocation due to airway blockage. Therefore, adhering to correct first aid protocols, which encompass ensuring an unobstructed airway, cushioning the head, and monitoring the duration of the seizure, can mitigate these risks and prevent lasting damage. Immediate attention and assistance are vital for the safety and well-being of individuals experiencing epileptic seizures.

❖ Minimizing the Fatality Rate

The prompt provision of first aid to an individual experiencing a generalized epileptic seizure is crucial in minimizing the fatality rate. Epilepsy affects a significant portion of the population in Egypt, with statistics indicating that approximately 20 million Egyptians are impacted by the condition, translating to millions of individuals. While the mortality rate due to epilepsy is relatively low, the risk of accidents and complications during seizures remains a concern. Swift and appropriate first aid can help prevent injuries and mitigate these risks.

Negative impacts if not solved:

❖ Myoclonic seizures

Neglecting to provide appropriate first aid for individuals experiencing myoclonic seizures can have significant consequences. Myoclonic seizures are characterized by sudden, uncontrollable muscle jerks, and they may indicate an underlying neurological condition. Without immediate first aid, individuals are at risk of self-inflicted injuries during a seizure, potentially leading to head trauma or other bodily harm. Furthermore, prolonged or uncontrolled seizures can result in oxygen deprivation, which may lead to brain damage or even be life-threatening.

❖ Atonic seizures

Atonic seizures, also known as drop attacks, characterize a distinct form of epileptic episodes marked by sudden loss of muscle tone. In these seizures, an individual experiences a rapid and unexpected loss of muscle strength, leading to a sudden collapse or "drop." This can result in the person falling to the ground without warning. Atonic seizures are unique in that they lack the convulsions typical of other seizure types. The loss of muscle tone can affect various parts of the body, including the head and limbs. Due to the abrupt loss of postural control, individuals experiencing atonic seizures are at risk of injury from falls.

❖ Tonic seizures

A tonic seizure is a type of generalized epileptic seizure characterized by sudden, excessive muscle stiffness or rigidity. During the tonic phase, the muscles contract and stiffen, leading to a loss of postural control. This stiffness can affect various muscle groups, causing the person to fall if standing. Tonic seizures are often brief, typically lasting for seconds, but they can be followed by a clonic phase involving rhythmic jerking movements. Individuals experiencing tonic seizures may exhibit altered awareness or consciousness. While the exact cause varies, abnormalities in brain function contribute to their occurrence. Proper diagnosis and management are essential for those affected by tonic seizures.

Research

Topics Related to the problem:

❖Epilepsy in children

A considerable number of young individuals in Egypt are currently grappling with epilepsy, presenting a substantial concern, particularly among children. Within the Egyptian demographic, the incidence of epilepsy among children and adolescents stands at 9.7 per 1000, with a notably higher prevalence observed among 12-year-olds (10.8 per 1000) in comparison to adolescents. The prevalence peaks in early childhood at 12.01 per 1000 and diminishes to 7.2 per 1000 during adolescence. Failure to administer timely first aid may precipitate numerous health, economic, and social complications. Effectively addressing this issue necessitates a comprehensive strategy, encompassing enhancements to medical infrastructure, heightened public awareness, and educational initiatives aimed at fostering a deeper understanding and support for children afflicted by epilepsy.

❖Lack of public awareness

According to the survey, only 36.4% of the respondents were aware of how to provide assistance to an epileptic patient during a seizure attack. Furthermore, only 34% knew that they should leave a person who was having a seizure in a safe place if the seizure continued. 47.1, 47, and 46.7% of participants favored incorrect measures such as presenting eau de cologne or onions for the patient to smell, putting a little water on his face, and holding the extremities of the patient to cease the seizures by putting water on their faces, respectively. One of the major dangers in administering first aid to a patient is putting a spoon or cloth in his or her mouth (27.3%) as a measure to deal with the immediate health crisis. A significant part of the reason for these practices is that they are based on cultural beliefs and misconceptions regarding epilepsy in that society.

❖ Educational Challenges

Generalized epilepsy exerts a considerable influence on the educational landscape in Egypt, given its propensity to induce recurrent seizures and cognitive impediments, thereby impairing a student's capacity to focus and engage effectively within educational settings. The prevalence of stigma and a dearth of epilepsy awareness additionally contribute to instances of social seclusion and discriminatory practices, thereby compounding the obstacles encountered by affected students in their pursuit of academic endeavors. Furthermore, the accessibility of specialized medical care and support services remains constrained, thereby presenting substantial challenges for students with epilepsy in attaining the essential accommodations and educational resources required for their academic achievement. Notably, it is estimated that children constitute approximately 10% of the population of individuals with epilepsy in Egypt.

Topics related to the solution:

❖ Ketogenic diet

The Ketogenic diet is high fat, low carbohydrates diet. It is found to be effective in reducing epilepsy seizure in epilepsy patients. The diet works by inducing a metabolic state named ketosis. Ketosis occurs when the body uses fat for energy instead of carbohydrates and glucose, which produces ketones. Ketones can make anticonvulsant effect on the brain. This diet was found stabilize blood sugar levels, which can help reduce the frequency and intensity of seizures.

Figure 1.17:shows the structure of ketogenic diet

The keto diet is high in fat, moderate in protein and low in carbohydrates. **As shown in figure 1.17**, the standard keto diet consists of 70% to 80% fats, 10% to 20% proteins and 5% to 10% carbohydrates. Many nutrient-rich foods contain high amounts of carbohydrates. This includes whole grains, fruits and vegetables. Carbs from all sources are restricted on the keto diet. Fat food are included in the diet, such as eggs, meats and fish.

The keto diet has many benefits, but it may come with some side effects. One of the signs of ketosis may include “keto flu,” which includes symptoms such as upset stomach, headache, fatigue, and bad breath.

❖ Antiepileptic medications

Antiepileptic medication aims to prevent seizures, not cure epilepsy. They can also be referred to as antiseizure medications, as they don’t change the underlying cause of seizure, instead they help reduce the frequency, intensity, or duration of seizure. Antiepileptic medication affects ion channels or neurotransmitters in neurons by decreasing the excitation or enhancing inhibition that happens between neurons to communicate with each other, **as shown in figure 1.18.** Eventually, that helps in reducing or controlling seizures.

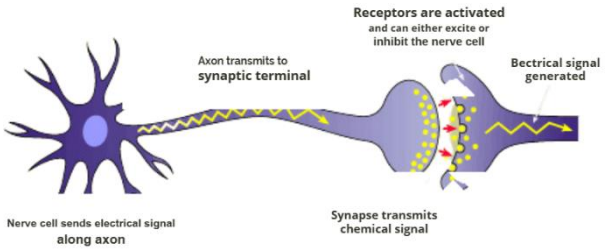


Figure 1.18: shows the structure of the communication system between neurons

Antiseizure medication is swallowed by mouth and goes to the stomach, then it is absorbed in the blood stream and reaches the brain via liver. They function on the nerve cells to prevent seizure. Then they are removed from the blood by the liver during metabolism, or the kidney during excretion. The effect may have different dosing frequency depending on how fast it is removed. Many side effects may also be included.

Although there are diverse types of antiseizures, their effect is still limited to 70% in reducing seizure. As a result, it may require some patients to seek for other medications, such as surgeries, or smart monitoring devices.

❖ Vagus nerve stimulation (VNS):

VNS therapy is used to treat drug resistant epilepsy which are focal or partial seizures that do not respond to seizure medication. It aims to reduce seizures by sending regular mild pulses of electrical energy to the brain via the vagus nerve. VNS therapy is approved by the U.S. Food and Drug Administration (FDA) as an add-on therapy for adults and children 4 years and older.

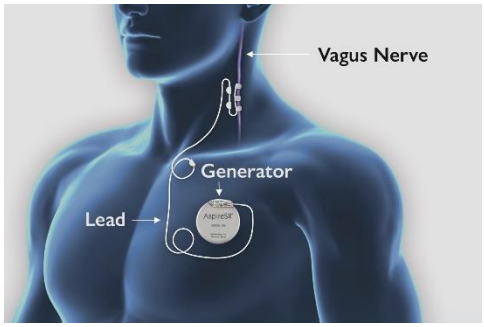


Figure 1.19: shows Vagus nerve stimulation (VNS) structure.

The therapy consists of a device that is implemented under the skin in the left to chest area. An electrode or wire is attached to the generator device and placed under the skin, **as shown in figure 1.19**. The wire is attached around the vagus nerve in the neck.

The device is designed to change how the brain cells work by giving electrical stimulation to certain areas involved in seizure. The vagus nerve is a vital part of the automatic nervous system, which controls the function of the body that are not under voluntary control, such as heart rate and breathing. Research has found that the VNS may help control seizures by increasing blood flow in key brain parts, which increases substances called neurotransmitters that help in controlling seizures.

Other solutions already tried

The Responsive Neurostimulation system (RNS)

The Responsive Stimulation system RNS**, as shown in figure 1.20**, is a surgical solution to treating seizures that are not controlled by medication. It was estimated that around 30% of epilepsy patients don't respond to seizure medication. In 2013 The RNS system has been approved by the U.S Food and Drug Administration (FAD) making it a choice for victims who don't respond to medications.

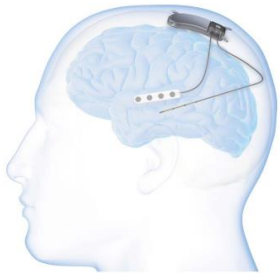


Figure 1.20: shows the structure of the RNS system

The RNS system is a device implemented surgically in the skull, as shown in figure X, then its connected to the part of brain responsible for seizure in the victim. The system monitors brain signals**, as shown In figure 1.21**. if abnormal signals can develop to seizure are detected, the system automatically send small pulses to prevent the seizure from happening.

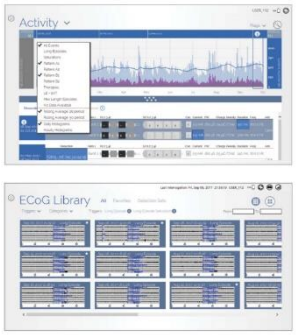


Figure 1.21: shows the electrical signals recorded from the RNS System

The system was tested on 130 patients, and it was found that out of every four patients three of them got their seizure reduced to half within 2 years of using the system, making the system a great choice for patients who are not responding to medications.

Mechanism

The RNS consists of a neurostimulator placed under the scalp and within the skull, and it is connected to 2 electrodes of lead placed either on the surface of the brain, into the brain, or a combination of both, depending on where the seizure begins in the victim. The RNS function in three main ways:

1- Monitoring Brain waves at the seizure focus all the time, even during sleep.

The system is designed to automatically record brain signals and monitor even during sleep. These signals can be monitored on other devices which can help doctors and specialists monitor the epilepsy victim.

2- Detecting unusual electrical activity in brain that can develop to seizure.

As the system is programmed to differentiate between normal brain signals and abnormal patterns. It can early detect the beginnings of any seizure.

3- Responding quickly to prevent seizure by giving small pulses of stimulation.

When the RNS system detects unusual signal activity that led to seizure. It responds quickly in milliseconds by giving small bursts or pulses of stimulation to the brain. The goal is to help is to help brainwaves return to normal, even before it could turn into a seizure.

Strengths:

❖High efficiency in reducing seizures

The RNS system is an effective treatment for reducing seizures. A study was done on 130 patients with the RNS system finding that about 3 out of 4 people (77%) had their seizures reduced to half after 2 years of using it. Another study made on 191 people with the RNS system found that the average decrease in seizure was 67% after 1 year, 75$ after two years, and up to 82% after 3 or more years of using RNS.

❖Reduction of medication

the RNS System can help reduce the amount of medication needed to control seizures. A study of 191 people with the RNS System found that 60% of people were able to reduce their seizure medication by at least 50%. Which makes RNS System a good solution for overcoming side effects of medications by reducing it.

❖Personalized treatment

The RNS System automatically learns what is going on in the victim's brain and settings can be adjusted for each victim. This is crucial as everyone's seizure are different, either in type, number, or pattern. That can become useful for epilepsy cases that can not be treated with medication. Although there are 20 antiseizures medication, one third of epilepsies remain drug resistant.

❖Improved quality of life

A study of 191 people with the RNS System found improvements in quality of life aside from seizure control. These benefits did not appear due to changes in seizures or medicines. These included: Physical health, Cognitive functioning, Emotional health or mood, less worry about seizure.

Weakness:

❖High Cost

The average cost of the RNS System is around 40,000 dollars, which make it expensive and a barrier to access for some people. In addition, not all insurance companies can cover it.

❖Surgery complications

The RNS System is implemented in the skull and then it is connected to the brain. This can be risky and cause many complications, such as infections, bleeding or seizure. A study of 191 people with the RNS System found that 5% of people had a serious adverse event related to the device or surgery.

❖Limited effectiveness for patients

According to a study made on 191 people, about 1 in 4 people (25%) didn’t have a significant reduction in seizures. This can make the RNS System useless for many patients with epilepsy.

❖Side effects

The RNS system has been shown to have side effects such as headaches, tingling and numbness. According to the same study done on 191 people, 10% of people had side effects related to the device or stimulation.

EMFIT

Emfit Seizure Monitor is an essential medical device designed to enhance the safety and quality of life for people with epilepsy by providing them with information on seizures and how they can prevent them. The condition known as epilepsy is characterized by recurrent, unpredictable seizures that can occur at any time. A person with epilepsy needs to be continuously monitored to ensure their well-being, especially during sleep **as shown in figure 1.22** when seizures can be particularly dangerous. This need has led to the development of the Emfit Seizure Monitor. Both the epilepsy patient and their caregiver can benefit from real-time seizure detection and monitoring.

Figure 1:22:shows EMFIT epilepsy monitor

Mechanism

In order for the Emfit Seizure Monitor to work, a series of sensitive sensors are placed underneath the user's mattress or cushion. It is a combination of pressure sensors and accelerometers that are used in these sensors to detect subtle movements within the body and changes in its position. The device also continuously monitors vital signs, such as heart rate and breathing rate, in the form of continuous vital signs monitoring. During a seizure, a seizure detection device can detect irregular or violent movements, as well as anomalies in vital signs, which may indicate an impending seizure. An alert is sent through various communication methods, such as a smartphone app or remote monitoring system, when a detection is detected. Providing caregivers or family members with immediate notification can reduce or prevent the risks associated with seizures by responding promptly to provide assistance. Furthermore, the device's monitoring capabilities provide healthcare providers with valuable information when managing epilepsy treatment plans, such as seizure documentation and tracking

Strengths:

❖Real-time Monitoring Accuracy

A major feature of Emfit's seizure monitor is the high accuracy it has in detecting seizures. Detection of seizures by this system has been reported to be 95% to 98% accurate, reducing the risk of false negatives significantly and reducing the price of false positives.

❖Customizable Alert System

In order to minimize false alarms, the alert thresholds can be customized to reduce false alerts based on movement and vital signs. There are several sensitivity settings that can be adjusted to trigger an alert when a specific movement or change in vital signs surpasses a predefined threshold, for example.

❖Data Documentation and Reporting

Seizure events are recorded by the device and detailed information is provided, such as the seizure duration and intensity. As a result of this data being analyzed over time, healthcare professionals are able to gain valuable insight on how to optimize treatment plans based on this information.

Weakness:

❖Cost

It is usually estimated that the Emfit Seizure Monitor will cost between $400 and $800, depending on what model you choose, and which features it includes. This cost may pose financial challenges for some families. Around 60% of users reported that the cost of the service was a concern in a recent survey.

❖Connectivity Issues

Wi-Fi and cellular connectivity are often used by the device, so it is possible to encounter problems with it. It has been reported that approximately 20% of users have experienced delays in alert delivery in regions with unstable network coverage.

❖Limited Portability

In terms of portability, the Emfit Seizure Monitor is designed to be used on a specific bed, so it cannot be used anywhere else. The lack of a fixed bed at home may be inconvenient for users who are frequently on the move or who do not have one at home.

❖Privacy Concerns

A portion of users, about 25%, have expressed concerns about the privacy of their personal information as a result of the data collection. They are very concerned about the security of the information they provide to the company, ensuring that no unauthorized users will be able to access the data they provide.

Brain Sentinel

Brain Sentinel is a leading medical technology firm actively engaged in combatting epilepsy. The company's primary dedication lies in the development of innovative solutions aimed at the surveillance and identification of epileptic seizures, with the overarching objective of enhancing the quality of life for individuals afflicted with epilepsy and bolstering the capabilities of healthcare practitioners in diagnosing and managing the disorder.

Figure1.23: Shows SPEAC system that made by Brain Sentinel

The linchpin of Brain Sentinel's product portfolio is the "SPEAC System," an acronym signifying "Subcutaneous EEG Analysis and Control." The SPEAC System **shown in Figure1.23** is an intricate, FDA-approved medical apparatus meticulously designed for continuous electroencephalogram (EEG) monitoring within clinical environments, particularly in intensive care units and specialized epilepsy monitoring units. This sophisticated system harnesses advanced algorithms to perform real-time analysis of EEG data, thereby detecting abnormal brain activity associated with seizures and other neurological events. In the event of a seizure, the system promptly dispatches notifications to healthcare professionals, empowering them to take swift and well-informed actions, which may encompass adjusting medication or instituting appropriate treatment protocols.

This technology emerges as invaluable within the realm of critical care for epilepsy patients, augmenting patient safety and facilitating more efficacious intervention during seizure episodes. Furthermore, the SPEAC System allows for the recording and scrutiny of EEG data, thereby offering insights into a patient's seizure patterns and overall neurological well-being, thus contributing to more informed and discerning decisions regarding treatment.

The overarching mission of Brain Sentinel is to equip healthcare providers with the lrequisite tools to achieve a better comprehension of epilepsy and its effective management, ultimately elevating the overall welfare of those grappling with the condition. While the SPEAC System is principally tailored for utilization by healthcare professionals in clinical settings, its profound impact on the care and treatment of epilepsy patients renders it an indispensable component in the broader campaign against epilepsy.

Mechanism

The Brain Sentinel SPEAC System is a sophisticated medical device designed to monitor and analyze brain activity to detect epileptic seizures and other critical neurological events. The system's mechanism involves continuous EEG (electroencephalogram) monitoring, enabling real-time analysis of electrical brain signals.

The SPEAC System uses subcutaneous electrodes to measure brain activity, making it less invasive and more comfortable for patients. It records EEG data, which is continuously transmitted to the system's software for analysis. Advanced algorithms within the software scrutinize the EEG data, looking for abnormal patterns associated with seizures. When such patterns are detected, the system promptly sends alerts to healthcare professionals or caregivers.

Strengths:

❖Data Analysis

The Brain Sentinel SPEAC System utilizes sophisticated algorithms to conduct precise analysis of EEG data, effectively differentiating between typical brain activity and patterns associated with seizures. The extended duration of data acquisition and analysis facilitates the development of individualized treatment strategies, empowering healthcare professionals to make well-informed decisions and modifications in the epilepsy management process, thereby enhancing the quality of patient care and ultimately yielding improved clinical outcomes.

❖Real-Time Seizure Detection

The Brain Sentinel SPEAC System offers a pivotal advantage in real-time seizure detection. It promptly identifies epileptic seizures as they occur, allowing swift healthcare intervention. By analyzing EEG data and using advanced algorithms, it accurately distinguishes between normal brain activity and seizures, alerting medical professionals or caregivers upon detecting anomalies. This enhances patient safety, especially in critical care settings, by enabling timely actions during seizures, potentially reducing risks.

❖Long-Term Monitoring

One of the notable benefits associated with the Brain Sentinel SPEAC System pertains to its capacity for the prolonged monitoring of epilepsy patients. This system has the capability to consistently acquire and archive electroencephalogram (EEG) data over extended durations, thereby facilitating healthcare professionals in the monitoring and analysis of seizure patterns, alterations in neurological activity, and the efficacy of treatment approaches over an extended period. This protracted monitoring capability facilitates a more comprehensive comprehension of a patient's medical condition, consequently fostering the development of well-informed and individualized care plans that are tailored to their evolving requirements.

Weakness:

❖Clinical Setting Requirement

The Brain Sentinel SPEAC System, while a valuable tool for seizure detection and monitoring, is primarily designed for use in clinical settings, such as intensive care units and epilepsy monitoring units within healthcare facilities. This limitation restricts its application to hospital environments, making it less accessible for individuals who may benefit from at-home monitoring or those residing in areas with limited access to specialized medical facilities. The system's effectiveness relies on the presence of trained healthcare professionals, which can be a logistical challenge for non-clinical settings.

❖Patient Discomfort

While the subcutaneous electrodes used in the Brain Sentinel SPEAC System reduce discomfort compared to traditional EEGs, some patients may still experience mild discomfort or inconvenience during the monitoring process.

❖False alarms

One notable disadvantage of the Brain Sentinel SPEAC System is the potential for false alarms. Factors like patient movement, muscle artifacts, or non-epileptic events can occasionally trigger erroneous seizure alerts, leading to unnecessary interventions and patient anxiety.

SeizAlarm application

SeizAlarm is a cutting-edge mobile application that was developed as a means of providing support and assistance to individuals who suffer from epilepsy and seizures, as well as providing caregivers with an invaluable resource. SeizAlarm has carved out a position for itself among the world's best healthcare technology companies as a beacon of empowerment that makes optimal use of the capabilities of modern smartphones to rethink how we will monitor and manage seizures in the future.

By offering real-time detection, comprehensive data tracking, and user customization options, this app addresses the complexities of seizure disorders in a powerful and innovative way. With the help of this program, the users and their support networks can feel a sense of security and confidence. In exploring SeizAlarm's features, we uncover its potential strengths and areas for improvement, recognizing the dynamic interplay between technology and the human experience of living with seizures.

Mechanism

SeizAlarm's core functionality is the detection of seizures. The app utilizes the sensors on a smartphone to identify abnormal movements associated with seizures. An automatic alert system can be triggered when a seizure is detected, letting pre-designated contacts know, for instance, family members and caregivers. When an individual is experiencing a seizure, this real-time alert feature is invaluable for ensuring the appropriate response. In addition, the app can be used to record information related to seizure events, including their date, time, duration, and any accompanying symptoms **as shown in figure 1.24**. Medical professionals and caregivers can use this recorded data to better understand the condition and tailor their care accordingly. Using the app, users can adjust the sensitivity of seizure detection and select their preferred notification methods.

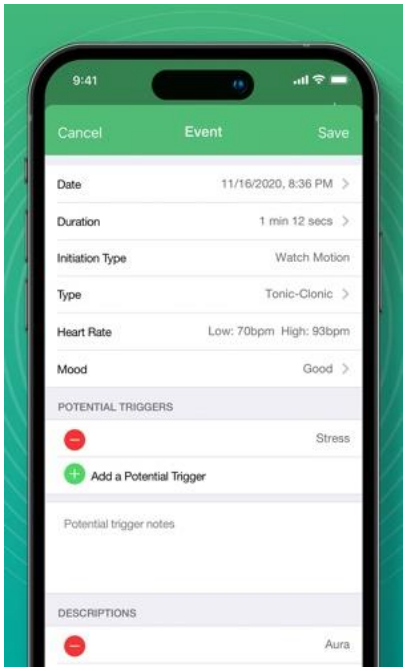


Figure 1.24: shows SeizAlam recordings.

Strengths:

❖Robust Real-time Seizure Detection

A robust real-time seizure detection system is a feature of SeizAlarm. In this application, sensors within a user's smartphone are used to monitor and detect abnormal movements commonly associated with seizures by exploiting the sensors within the device. With this feature, the response time during seizure events could be significantly reduced, which could possibly improve the individual's overall level of safety during seizure episodes.

❖Comprehensive Seizure Data Logging

Seizure data can be recorded in an efficient and user-friendly manner with the application's comprehensive and user-friendly interface. Inputs such as the exact date, time, and duration of the seizure can be made, along with any symptom or observation that may accompany it. Professionals can utilize this comprehensive record to better understand and manage the condition.

❖Highly Customizable Features

The versatility and adaptability of SeizAlarm make it a standout. The app can be customized by users according to their needs and preferences. The seizure detection mechanism can be adjusted for sensitivity and notification methods selected. By customizing, the user experience can be tailored to their needs.

Weakness:

❖Variable Seizure Detection Accuracy

Detecting seizures with SeizAlarm can be inaccurate at times. There may be times when the app suffers from false alarms or missed detections due to the reliance on smartphone sensors, which impacts the overall reliability of the application.

❖Not a Substitute for Medical Guidance

The most important thing to note is that SeizAlarm should not be used in place of professional medical advice or treatment. In order to attain comprehensive care and guidance for the user, it is recommended that they continue to seek regular medical checkups and consultations with their healthcare providers.

❖Reliance on Smartphone and Contact Responsiveness

It is crucial that the app is installed on a smartphone that is compatible with the app and that the designated contacts are willing to respond to notifications promptly in order for the app to function. As a result, its overall effectiveness can be affected if these elements are absent.

Chapter II

Generating and Defending a Solution

Solution and Design Requirements

Solution Requirements

❖Sustainability:

Materials used within the solution should have a long lifetime and be durable, so that they can withstand the wear and tear of daily use. This would reduce the amount of damage that might compromise the functionality of the solution, as well as the amount of money spent on repairing or replacing the damaged parts.

❖Safety:

Ensuring electrical safety for the solution is crucial to prevent injuries from any electric shock and burns of the internal components of the prototype. Effective electrical safety measures, minimizing electromagnetic interference, and maximizing device durability are all vital for user satisfaction, as well as the reliability and longevity of the solution.

❖Flexibility and Usability:

The solution should provide the patient with user-friendly and customizable features that make it easy to use the prototype and achieve the maximum benefit. The patient should be able to review sensor readings in real-time on a responsive and accessible website. The system response should also be adaptable and clear so that the hospital and the patient's family can review sensor readings and serve help when a seizure occurs.

❖Scalability:

The project's scalability depends on the availability of the solution components at affordable costs. If the components are too expensive, the project may not be able to grow or adapt to changing needs. Therefore, the solution components should be designed in a way that minimizes their prices and maximizes their efficiency. This will enable the project to scale up or down as required, without changing quality or performance.

Design Requirements

- system response time:

For epilepsy seizures, every moment is crucial for saving the life of the patient, especially during the first few minutes of the seizure. Neglecting immediate help can lead to severe complications, including sudden death. Therefore, the prototype should be able to detect epilepsy seizures and respond by sending a message to the hospital or patient family members within 10 seconds, to swiftly help and rescue the patient.

- Accuracy in detecting epilepsy seizure:

The prototype should be able to respond to a variety of inputs and respond appropriately by detecting epilepsy seizure cases and alerting them. Therefore, the system would be trained on different scientific datasets of epilepsy patients' readings and evaluate its accuracy of detecting these cases. The overall accuracy of the system should be higher than 80%.

Selection of solution

The growing problem of inadequate first aid for people who experience epileptic seizures calls for an urgent solution. A strategic approach that integrates Information and Communication Technology (ICT) and Artificial Intelligence (AI) has been proposed as a possible way to address this issue

To tackle the challenge effectively, the development of specialized gloves connected to a webpage has been implemented as a feasible solution. As shown in **the flowchart in Figure 2.1**, the glove is equipped with sensors such as GSR (Galvanic Skin Response), which measures the electrical conductivity of the skin, temperature, and accelerometer sensors. The data from the sensors, along with the location of the patient, is updated instantly on the website.

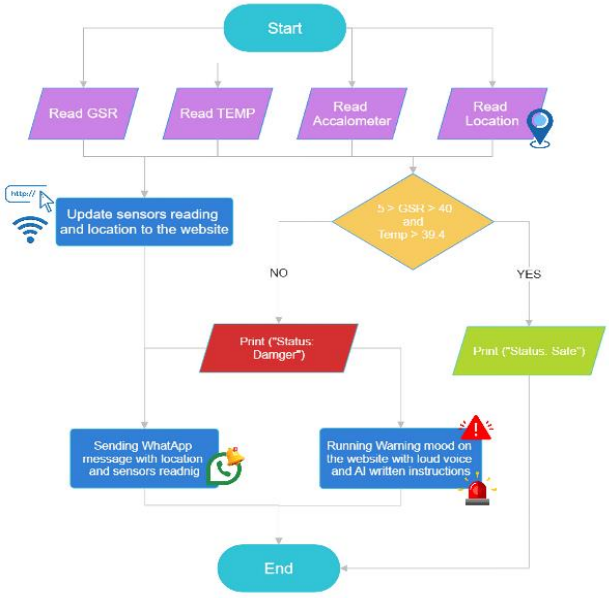


Figure 2.1: The flowchart of the chosen solution

The solution constantly monitors if the GSR and temperature values exceed the normal range (GSR > 40 or GSR < 5 and Temp > 39.4 °C), which can indicate the occurrence of an epileptic seizure. The system automatically responds by sending a WhatsApp message to the victim's family members and the hospital with the exact location and sensor readings for quick help.

During an epileptic seizure event, the patient's web app is activated, ringing to alert the people around the patient, and simultaneously displaying instructions generated by artificial intelligence on how to properly handle the situation. An AI chatbot is also implemented on the website to provide regular feedback to the patient and answer questions from the people nearby when a seizure occurs.

This comprehensive solution aims to enhance the efficiency of managing epileptic episodes by leveraging cutting-edge technology, ensuring timely assistance and informed actions in critical moments.

Selection of prototype

The designated prototype involves the development of an intelligent glove, as illustrated **in Figure 2.2**. This glove incorporates three distinct sensors for comprehensive health monitoring. Firstly, galvanic skin response (GSR) sensors are strategically positioned on the fingertips to measure skin resistance. The second sensor, a DS18B20 temperature sensor, is situated beneath the glove to accurately gauge body temperature. The third sensor employed for motion detection during generalized epileptic seizures is the accelerometer sensor ADXL345, placed on the glove.

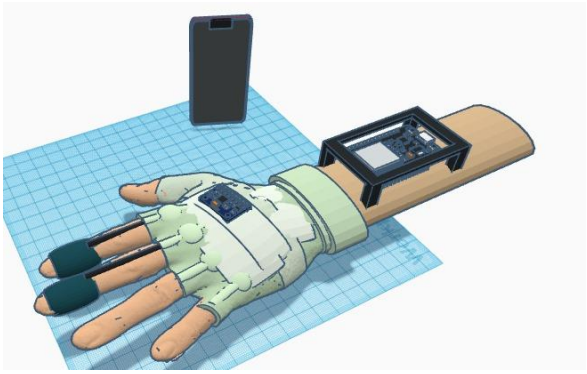


Figure 2.2/ shows a 3d model for gloves.

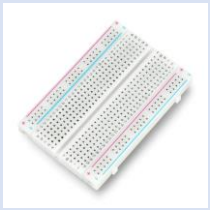
The control module for these sensors is an ESP32, powered by two lithium batteries and a battery shield to ensure sustained functionality. The ESP32 module establishes connectivity with a web platform via ThingSpeak, where sensor readings are visually represented in graphs. This web platform is integrated with a chatbot mechanism, facilitating real-time communication.

In the event of a seizure, the web platform triggers an alert mechanism. Simultaneously, a message is dispatched to the designated family member, including the patient's location and concurrent sensor readings. This alert system not only informs the family but also aware individuals in close proximity of appropriate measures to undertake during such situations.

Chapter III

Constructing and Testing a Prototype

Materials and Methods

Item	Picture	Description	Quantity	Usage	Cost	Source of purchase
Half finger glove		A glove made of wool	1	Used to install sensors on it	50 L.E	Commercial store
ESP32S board		a chip that provides Wi-Fi and (in some models) Bluetooth connectivity for embedded devices.	1	Used to enable IoT, Wi-Fi, and Bluetooth in projects.	350 L.E	Electronic public shop
Bread bord		A temporary circuit board made of thin plastic	1	Used to to connect the electrical components of the prototype with the ESP23S board	23 L.E	Electronic public shop
galvanic skin response (GSR) sensor		Galvanic skin response sensor measures skin conductivity.	1	Used to measure - the electrical conductance of the skin.	650 L.E	Electronic public shop
Accelerometer ADXL3345 sensor		Small, triaxial, high-resolution sensor measuring acceleration accurately.	1	used to detect the motion at x, y &z directions	145 L.E	Electronic public shop
ds18b20 temperature sensor		Digital, waterproof, precise, one-wire, temperature sensor.	1	used to measure the body temperature.	65 L.E	Electronic public shop

Item	Picture	Description	Quantity	Usage	Cost	Source of purchase
Battery shield		Charger for lithium batteries	1		250 L.E	Electronic public shop
Jumpers		Plastic, small wires for esp and sensor	23	Used to Connects items on the breadboard to the header pins of the ESP23S board	23 L.E	Electronic public shop
Lithium batteries		Compact, lightweight, rechargeable energy storage with high capacity.	2	Used to powerup the prototype	60 L.E	Electronic public shop

Methods

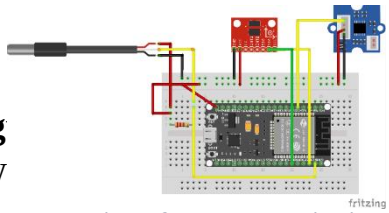


Figure 3.1: Prototype circuit model

1. A circuit model for the project has been made **as shown in Fig**
2. The Accelerometer ADXL3345 was interfaced with the ESP w subsequently affixed onto the gloves.
3. The Galvanic Skin Response (GSR) sensor is positioned at pin 34 and affixed to the middle and index fingers, **as shown in Figure 3.2**.
4. The DS18B20 temperature sensor was integrated into pin 23 and positioned between gloves and fingers, **as shown in Figure 3.3**.
5. The conditions for detecting seizure were set in the code of the ESP32.
6. The ESP32 was connected to ThingSpeak server to update and visualize sensor data in graphs.
7. A website was coded using HTML, CSS, and JavaScript to display sensor readings and record user's precise location.
8. The WhatsApp messaging system was set to send warning messages with website sensors' readings and precise location when seizure is detected.
9. A warning mode with audible alerts and customized instructions generated by AI was added to the website. AI ChatBot was implemented, **as shown in Figure 3.4** to compose reports on seizures and answer questions.

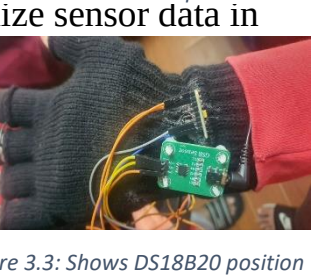


Figure 3.2: shows where GSR and accelerometer placed.

Figure 3.3: Shows DS18B20 position

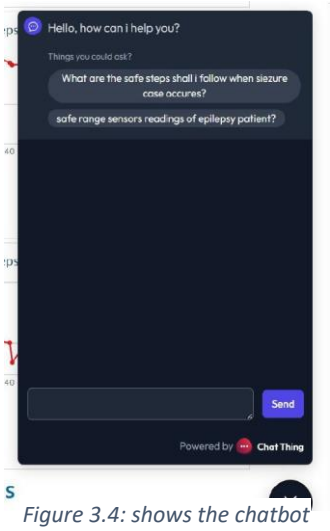


Figure 3.4: shows the chatbot implemented in the website.

Safety precautions:

1. Anti-electric insulating gloves were used while measuring electricity during the test plan. Protection gloves were used also during the soldering process of sensors.
2. The compatibility of sensor voltage levels with the ESP was confirmed to prevent overvoltage issues.
3. Adequate insulation was implemented for exposed wires to prevent short circuits and enhance safety.

Test plan

The prototype has undergone the following steps to determine if it meets the design requirements or not:

1- Seizure conditions were simulated by immersing the temperature sensor in hot water, elevating the temperature to surpass 37.8 °C.
2- The system's response time was measured by initiating a stopwatch, **as shown in Figure 3.5,** when the temperature rose until the warning message was transmitted via WhatsApp, and the website activated the alerting mode.
3- Five trials were conducted, and the average response time was calculated.
4- To evaluate the system's accuracy, data values from a dataset containing information about epilepsy patients were tested into the system code, **as shown in Figure 3.6.**
5- The accuracy was determined by counting detected and undetected calculating the accuracy percentage.

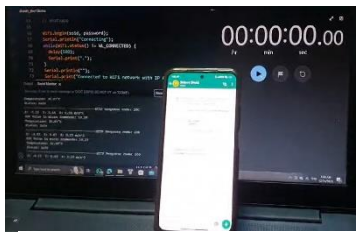


Figure 3.5: shows way of measuring time response.

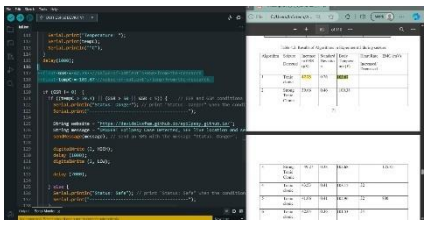


Figure 3.6: shows the testing of patient's dataset value sin the code.

Data collection

Negative Results

The test plan revealed many negative results that affected the prototype.

- Initially a GSM sensor with SIM card was used to send the warning message, but it was extremely slow that required immediate replacement with another method.
- The webserver (ThingSpeak) used to update data to the website in its free plan only updates sensors reading every 15 seconds, therefore it is only used in displaying reading not in detecting seizure conditions.

Positive results

- The system demonstrated great performance in terms of detecting seizures and time responding with an average time of 5.658 **as shown in Table 1**.
- When the system is tested on 12 patient datasets from a research paper, it could detect 10 out of 12 with an accuracy of 83.3%., **as shown in Table 2**.

Trials	Time (s)
First	4.45s ± 0.10
Second	5.52s ± 0.10
Third	8.93s ± 0.10
Fourth	5.27s ± 0.10
Fifth	4.12s ± 0.10
Average	5.658s ± 1.309

Table 1: Shows the average system's responding time.

Patients	GSR	Temperature	Detection
1-	43.78	39.6	Detected
2-	44.62	39.1	Detected
3-	48.99	39.51	Detected
4	39.51	37.9	Not Detected
5	40.36	39.03	Detected
6	49.77	39.31	Detected
7	42.73	39.81	Detected
8	39.66	37.98	Not detected
9	49.27	39.26	Detected
10	43.53	39.52	Detected
11	41.06	39.42	Detected
12	42.04	38.62	Detected

Table 2: shows the data set of epilepsy patients.

Chapter IV

Evaluation, Reflection, Recommendations

Analysis and discussion

Generalized epilepsy, as studied in BI3.03, is a neurological disorder characterized by recurrent unprovoked seizures that affect the entire brain, **as shown in Figure 4.1**. This condition arises from abnormal electrical activity in the brain, disrupting the delicate balance of neurotransmitters and signaling pathways.

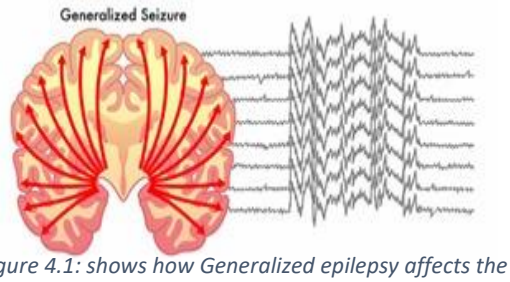


Figure 4.1: shows how Generalized epilepsy affects the entire brain.

Genetic determinants exert a significant influence, with specific genetic mutations potentially predisposing individuals to generalized epilepsy. Moreover, perturbations in neurotransmitter concentrations, particularly those of gamma-aminobutyric acid (GABA) and glutamate, exert a contributory influence on the pathophysiology of seizures. Recent scientific inquiries have elucidated encouraging results in discerning physiological changes associated with epileptic seizures by employing sensing methodologies such as galvanic skin response (GSR), temperature sensors, and accelerometers.

Galvanic Skin Response (GSR)

The GSR sensor can detect generalized epilepsy by measuring the electrical conductance of the skin, which changes due to sweat gland activity and skin moisture. These changes are influenced by the autonomic nervous system, which is altered during seizures. Seizures cause sympathetic nervous system activation, which increases skin conductance. GSR sensors can identify abnormal patterns in skin conductance during seizures, and combining GSR data with other physiological parameters can improve seizure detection systems. GSR sensors provide a non-invasive and potentially real-time way to monitor and manage generalized epilepsy.

The GSR is an analog sensor that measures skin conductivity by directing a microcurrent of electricity through closely positioned electrodes**, as shown in Figure 4.2.** The ensuing current fluctuations are then amplified and recorded. This variability arises due to factors such as skin humidity (perspiration), epidermal thickness, and vasoconstriction.

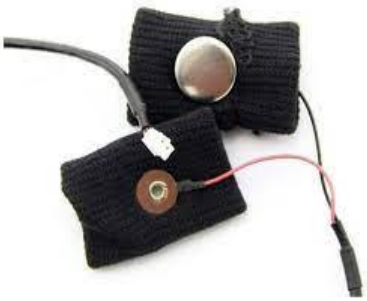


Figure 4.2: shows GSR sensor electrodes .

The conventional human GSR range falls within 5-40 micro-Siemens (µS). Analog readings are converted to micro-Siemens (µS) by using this equation **shown in Figure 4.3** which VCC= 5 (operating voltage), ADC= sensor analog readings, and "n" denotes the channel's bit count, set at 10.

$$EDA(\mu S) = \frac{\frac{ADC}{2^n}.VCC}{0.132}$$

Figure 4.3: shows how to convert from GSR analog readings to micro-Siemens (µS)

Temperature Measurement

Temperature is an important parameter for the identification of seizures. Seizures frequently cause physiological symptoms including high change in body temperature, heightened muscle activity, and augmented metabolic requisites of the brain during seizure may induce localized hypothermia. Scientific studies have shown a clear link between the start of seizures and changes in skin temperature, where some people show temperature rises before, during, or after seizure events.

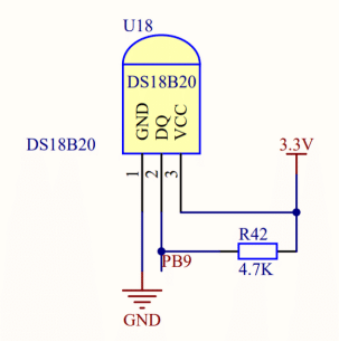


Figure 4.4: Internal structure of the DS18B20 temperature sensor

The DS18B20 sensor, **as shown in Figure 4.4**, is a device that measures temperature in Celsius with an accuracy of ±0.5°C, As studied in **PH2.15**, it works by detecting the voltage difference between the transistor and the emitter terminals of the diode. When the temperature rises, the voltage difference increases. A resistance of 4.7 is used to pull up the data line and limit the current flow.

Accelerometer

The ADXL 345 uses a MEMS (micro-electro-mechanical system) structure that consists of fixed and moving plates that form capacitors. When the sensor experiences acceleration along an axis, the capacitance between the plates changes due to the displacement of the moving plates. The change in capacitance is converted into an analog voltage signal by capacitance-to-voltage circuit. The sensor comes with some built in sensing functions such as free-fall detection, tap detection, and activity/inactivity detection.

Researchers have found that generalized seizures involve characteristics and rhythmic body movements. These movements can be measured using the accelerometer sensor. The method used to identify seizure is by using the concept of local maximum and local minimum, as studied in **MA3.02,** A local extremum is a point that has the highest or lowest value in its neighborhood, **as shown in Figure 4.5**, and its derivative is zero. A seizure can be detected by detecting four or more consecutive local extrema, which can indicate the rapid vibrations of the body during a seizure.

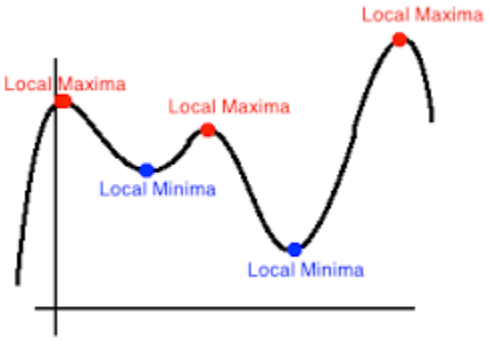


Figure 4.5: local maximum and local minimum withing a graph

ESP32 code flow and website code

Based on the previous parameters, the project ESP 32 code was developed to follow the **flowchart in Figure 4.6**. The system takes four parameters (GSR, Temperature, Accelerometer, and location) and continuously checks for seizure conditions (GSR > 40, Temp > 37.8, and 4 consequent local extrema in position graphs). If it occurs, it sends a warning message with the patient's website link to view the sensors readings and location. The system also enables alerting mode followed by a loud sound and custom AI written instructions. The working mechanism in each step is discussed in the following points.

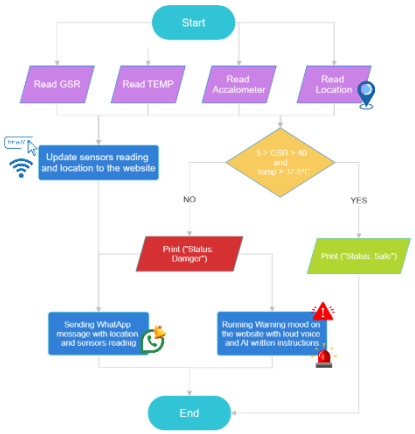


Figure 4.6: A flowchart of the implemented ESP32 and website code

ThinSpeak Live data server

As studied in **PH3.03** and **PH3.04** about communication systems. WI-FI communication system is used to upload and update sensors readings from the ESP 32 to an IOT platform called ThingSpeak. It offers visualization of sensors data. It consists of channels each channel consists of multiple fields each representing a sensor reading **as shown in Figure 4.7**. The graphs can be easily implemented in the website and update sensors data every 15 seconds, which is a drawback of using Thingspeak.

Figure 4.7: ThingSpeak live sensors graph (GSR, Temperature, accelerometer)

Website Development and location permission

The website is coded using HTML, CSS, and JavaScript programming languages. ThingSpeak sensors graphs are implemented in the website. The website asks for location permission for the first time, As studied in **PH3.04,** updating location depends on satellite communication between the patient's phone and satellites, then it uses WI-FI to update and display the location on the website.

The website automatically displays and updates precise locations every 10 seconds on a backend database using NodeJs (Javascript framework), **as shown in Figure 4.8**. The website was hosted online using GitHub webpages, which allows anyone by entering this URL (https://seizureshield.github.io/project) to access the website from anywhere.

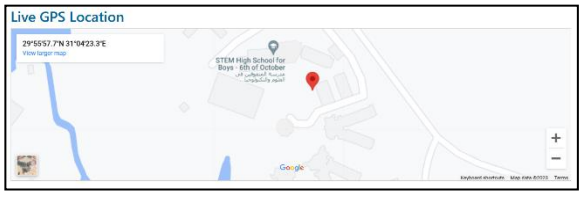


Figure 4.8: A screenshot of real location displayed and updated on the website.

Automatic Sending Warning Messages on WhatsApp

To send alerting messages on WhatsApp, the Call Me Bot API was used. It is a free service on WhatsApp that can be integrated with the code through its application programming interface (API), which is an example of WI-FI wireless communication, as studied in **PH3.04.** It works by enabling the ESP32 to send a GET HTTP request containing the specified number and message content.

Figure 4.9: A screenshot of the WhatsApp warning message

Using Arduino IDE, the HTTP request is modified to send the warning message with a website that includes the patient's precise location and sensor readings to the chosen number, when a seizure occurs, **as shown in Figure 4.9**. The Call Me Bot API has shown impressive results in its speed for sending warning messages. The website also enables warning mode followed by loud sound and AI written instructions.

Artificial intelligence chatbot

An artificial intelligence chatbot is implemented inside the website. It can be used in two ways: firstly, normal chatbot mode which can answer questions of the patient and give him health advice. The second use is to automatically write a report about the patient's status.

The Chatbot works by connecting ChatGPT with the website through the API, **as shown in Figure 4.10**, which allows the bot to send messages to ChatGPT and receive responses. The chatbot was trained on dozens of questions and articles about epilepsy seizure and first aid.

Figure 4.10: Mechanism of sending and receiving messages of the ChatBot

Conclusion:

A lot of work has been done while defining the problem, researching, designing the prototype, and testing it to fulfill the design requirements. According to the results obtained above, the project contributes to providing high accuracy in detecting generalized epileptic seizures and fast responding in dealing with them. The Solution, which consists of a glove that contains GSR, temperature, and accelerometer sensors has successfully achieved the design requirements. The project is expected to help the development of Egypt's public health by establishing a secure environment for individuals with generalized epilepsy.

Recommendations

- Raspberry pi4:

Instead of using ESP32, it is recommended to use Raspberry Pi 4, **as shown in Figure 4.11**; since it has great computational powers in terms of its processer (quad-core ARM Cortex-A 72 1.5Ghz) with the ability to execute 1.5 billion instructions per second, while ESP32 executes 500 million instruction per second. In terms of random-access memory (RAM), Raspberry Pi 4 comes with 4GB of RAM and up, while The ESP32 comes with 0.5GB, which means extremely fast sensor reading and warning compared to the ESP32. It is also counted as a fully integrated computer that offers the capability of connecting a small screen and monitoring sensors readings and vital health information in an isolated operating system hosted on the board.

Figure 4.11: Raspberry Pi4 board

- Satellite communication:

On a real-life scale, it is recommended to use satellite communication instead of WI-FI; due to its high coverage area compared to Wi-Fi communication, which allows users in remote areas and challenging terrains where WI-FI signals are limited especially in African countries that record the height rates of epilepsy worldwide. Satellite communication offers a more reliable communication in terms of the speed of transiting data and reducing the risk of signal interruptions, which can occur through WI-FI communication, therefore, satellite communication provides a more robust and reliable future enhancement to the project.

- EEG (Electroencephalogram) sensor:

EEG is more effective than a GSR sensor in epileptic seizure detection since it directly measures electrical activity in the brain, **as shown in Figure 4.12**, providing vision into which neurological patterns are occurring during seizures. On the other hand, GSR sensors that measure skin conductance are affected by various factors when it comes to detecting seizure events, EEG sensors can safely and accurately detect seizures in a way that is more precise and accurate. Also, EEG data can be analyzed quantitatively, which allows the characterization of seizure types, based on the analysis of the EEG data.

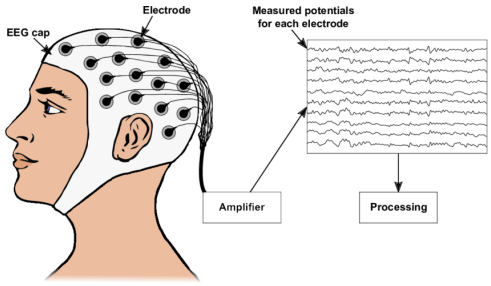


Figure 4.12: EEG directly connected to the brain.

- ThingSpeak Premium Edition:

It is recommended to use the premium version of ThingSpeak to update data from the sensors to the website. ThingSpeak premium offers advantages in terms of the speed of transmitting data as it updates the data instantaneously without the 15-second limit of the free version. In addition, it also offers a high level of data storage capacity and unlocks more in-depth analysis of the data. All these factors enhance the overall effectiveness of the project monitoring system.

What would we tell another team who wanted to start where we stopped on your solution to help them?

In fact, this project is not that tough to finish, but unfortunately, some wrong decisions have been made concerning time management, judging things, and responsibilities. Regarding time, no balanced time has been given to each task resulting in not completing them in due time. Another important point to be considered is misjudging things. Using an improper component has led to less voltage. So, choosing the right materials will save a lot of effort and money.

Working on the project helped us in becoming better STEM students in the following ways

Engaging in this project significantly enhanced our skills as STEM students by fostering hands-on application of theoretical concepts. The practical challenges we encountered demanded critical problem-solving and analytical thinking, refining our ability to approach scientific problems systematically. Collaborating with team members not only strengthened our communication skills but also exposed us to diverse perspectives, enriching our understanding of STEM fields. The project's multidisciplinary nature encouraged us to integrate knowledge from various disciplines, cultivating a holistic approach to problem-solving. Additionally, the experience improved our adaptability, as we navigated unforeseen obstacles and adjusted our strategies accordingly. Ultimately, this project served as a catalyst for our growth as STEM students, instilling in us a deeper appreciation for the real-world applications of our academic pursuits.

Learning Outcomes

Subject	Learning Outcome	Skills	Connections
Biology	BI	1.Explain the process that results in the generation of an action potential. 2. Predict how altered ion concentrations could influence an action potential. 3. Describe the action of neurotransmitters at a synaptic cleft.	In this LO we learnt about that the cause of the epilepsy is mutations affecting sodium channels in the brain
Biology	BI	1. One function of each major of brain region. 2. Biological clock regulation. 3. Arousal and sleep.	In this LO we learnt that r patients with epilepsy that is not responsive to drug therapy, functional imaging can pinpoint the region of abnormal function, increasing the effectiveness of surgery and enhancing recovery.
Chemistry	CH3.0	1. Elements of robust experimental design. 2. Experimental Design 3. Analytical methodology 4. Laboratory reporting	It helped plan, conduct, and report a scientific experiment of the test plan. By choosing and measuring factors, levels, and responses, designing, and analyzing the experiment, and communicating the results.

Physics	PH1.01	1- Identify and describe systems of measurement. 2- Convert units between different systems of measurement 3- Determine sources of measurement errors 4- Use basic measurement tools to measure/compute length, area, volume and time 5- Use dimensional analysis to verify or predict a physical law.	It was used to measure using SI units, and to convert to different. measurements. It was also used in writing the results to measure the error in measurement and the propagation in error.
Physics	PH2.15	Analyze simple DC and AC circuits containing diodes. 1. Diodes as one-way devices 2. Threshold voltage 3. non-ohmic device 4. Voltage Rectification 5. Breakdown voltage	It helped in understanding the working mechanism of the temperature sensor, as it depends on the variance of voltage within the diode to measure temperature

Math	MA2.07	1. Given the equation of a function, apply the derivative of that function to solve real-world problems. 2. 3.	4. They were used in analyzing sensors' graphs and their rate of change when epileptic seizure occurs.
Math	MA3.02	5. Analyze the behavior of functions by investigating critical points using first and second derivatives. 6. 1. Local max or min 7. 2. Point of inflection 8. 3. Critical point 9. 4. Concavity	10. It was used in the condition of detecting seizure in terms of position graphs, by detecting four or more subsequent local extrema with derivative of zero
Math	MA2.08	11. Analyze the rates of change of a function in real-world problems.	12. They were employed to analyze sensor graphs and their changing rates during epileptic seizures.
Computer Science	CS1.05 - CS1.06	13. Create electronic documents (called web pages) that are displayed on the World Wide Web. 14. Identify and explain the add a style to web site by using cascading style sheets (CSS).	They were used in creating the basic structure of the website using HTML and adding attractive layout using CSS .

Computer Science	CS2.02	1. Students identify Database and its types. Students identify Entity Relational...expand more	It was used in creating a backend database that stores sensors' readings, and patient's location and update them instantaneously.
English	ENW.1.3.5	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate information while avoiding plagiarism and following a standard format for citation, APA	It was used while researching for information to use credible and trusted sources such as peer reviewed research papers. Also, it was used to cite the sources used in APA format. Lastly, it helped in writing the portfolio and poster with no plagiarism

Research resources:

1. *World Air Quality Report - greenpeace. (n.d.-a). https://www.greenpeace.org/static/planet4-romania-stateless/2021/03/d8050eab-2020-world_air_quality_report.pdf*
2. *Air pollution in Egypt - nilu.com. (n.d.-a). https://www.nilu.com/wp-content/uploads/dnn/02-2001-bs-clean-air.pdf*
3. *Reducing air pollution in Greater Cairo involves switching from private vehicles to improved public transport. World Bank Blogs. (n.d.). https://blogs.worldbank.org/arabvoices/reducing-air-pollution-greater-cairo-involves-switching-private-vehicles-improved-public*
4. *Water issue in Egypt: Resources, pollution and protection endeavors. (n.d.-b).* https://www.researchgate.net/publication/299579941_Water_issue_in_Egypt_Resources_pollution_and_protection_endeavors
5. *Barriers to industrial energy efficiency - department of energy. (n.d.).* https://www.energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_v2.pdf
6. *Assessing and strengthening the manufacturing and defense industrial ... (n.d.-a).* https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF
7. *The shift to the service economy: Causes and effects - UW faculty web ... (n.d.-c).* https://faculty.washington.edu/karyiu/confer/seoul06/papers/kim_hj.pdf
8. *Egypt unemployment rate 1991-2023. MacroTrends. (n.d.).* https://www.macrotrends.net/countries/EGY/egypt/unemployment-rate
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