International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING

ISSN:2147-6799 www.ijisae.org Original Research Paper

Framework for Sustainable Energy Management using Smart Grid Panels Integrated with Machine Learning and IOT based Approach.

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Submitted: 17/07/2023 **Revised**: 09/09/2023 **Accepted**: 25/09/2023

Abstract: Maintaining a consistent supply of power is essential for the well-being of the economy, the public, and one's own health. The generation of energy, as well as its distribution, monitoring, and management, are all undergoing fundamental changes as a result of the implementation of a smart grid (SG), which is authorised to include communication technology and sensors into power systems. There are a lot of problems that need to be fixed before the interoperability of the smart grid can be determined. The integration of renewable energy sources and smart grid technology market size and energy management is a sustainable solution to the problem of energy demand management. The importance work quickly toward the development of an efficient Energy Management Model (EMM) that integrates smart grids and renewable energy sources. When it comes to the modelling of complex and non-linear data, machine learning (ML), Internet of Things (IoT) approaches often perform better than statistical models. So, utilizing a machine learning approach for the EMM is a good option since it simplifies the EMM by generating a single trained model to anticipate its performance characteristics across all conditions. This may be accomplished via the use of an EMM created using an ML method. It was recommended that a certain flexibility sample be used as a control mechanism for incursion into the smart grid. The outcomes of the experiment indicate that the demand-side management (DSM) device is more resistant to infiltration and is enough to lower the energy usage of the smart grid.

Keywords: *Smart Grid, Machine Learning (ML), Internet of Things (IOT), Energy Management Model (EMM), Smart Grid.*

1. Introduction

The Internet of Things is the next step that will have a huge impact on the modern internet (IoT). the locations where the objects or things are located are decided by the capabilities of the node in terms of connection and processing. Even though they may be at different phases of development, devices that are linked to the Internet of Things (IoT) are able to interact with the network in a straightforward manner. The Internet of Things is the foundation for a great deal of the functionality that goes into making a city "smart," including "smart housing," "smart monitoring," "smart transportation," and "smart health" (IoT). One of the most all-encompassing Internet of Things (IoT) systems is the Smart Grid, which is nothing more than a conventional grid that has been expanded through the utilization of a variety of naturally replenished renewable energy sources as well as significant information and communication technology. The Internet of Things (IoT) smart devices have the potential to be linked with the Smart Grid (SG) in every one of the most important sectors, including production, communication, distribution, and application. In this century, the demand for energy is expanding at a speed that is most fast growing as a result of the increased population development of the communities [1].

It is essential for the country's economy, national security, and community health care that substantial front-end sources be available in order to have a reliable and flexible power supply. Even if they are reliable, ordinary power systems are unable to live up to the requirements set out by their clients. The next iteration of the grid is denoted by the letter SG. The SG will be able to make the generation that comes after it more stable if its users are able to become more involved with the system and improve their behavior as citizens. utilizing the forms provided by the request and preference systems. As a direct consequence of this, an increasing number of

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countries have begun to realize that SG may contribute to the improvement of communities. The structure of the traditional network market is centralized, in contrast to the structure of the SG market, which is decentralized, and the structure of the latter, which is open. The SG calls for a continuous connection, which might be maintained by connecting devices from the internet of things [2].

The SG is more effective than a conventional griddle in terms of the production, market, trading, distribution, and consumption of the items it produces. The number of power plants in the classical phase is much lower than in the smart phase, which contains a greater number of smaller power producers. In its current form, the process of phase transference requires a large network of energy connections and conduits. On the other hand, the smart phase is produced by the SG's small-scale transmission and regional distribution repayments. This phase is substantially more effective than the conventional grid, which was generated by the traditional grid. The fact that Singaporean customers tell businesses what their objectives and goals are demonstrates that they take a very active role in the process. In contrast to the confined and centralized nature of the market for conventional grids, which functions on a global scale, the market for smart grids is decentralized and operates on that level. It is vital to bring up the significance of this framework, which consists of a billion sensors, smart meters, smart devices, and other private or public communication networks. Before the SG compatibility could be achieved, there was a significant amount of work that needed to be done in order to resolve a number of difficulties [3].

Concerns about safety and security provide a significant obstacle for the SG, who is already working under intense time constraints. The malicious breakout on the smart grid may have a substantial influence on the dependability of the whole architecture of the smart grid. When even a single SG node is identified, the whole grid becomes visible to the outside world. The breach causes the closure of whole grids, which may result in damaged equipment in residential and commercial buildings as well as in hospitals and other medical facilities. It is also possible that the whole city will be wiped out, not to mention that it would lead to substantial financial losses. As a consequence of this, it is generally agreed upon that one of the characteristics of IoT-enabled SG implementation at a large scale that is of the utmost importance is the degree of safety. This was brought up, however the threats have been narrowed down to malware, data theft, internal assaults, denial of service attacks, and the insertion of erroneous information [4].

In today's environment, it might be difficult to find a solution to the problem of maintaining safety throughout the smart phase. There have been a variety of security problems that have been addressed, and some of the solutions that have been implemented include protected multi-party processing, encryption, and special privacy concerns. Yet, the lack of safety measures is one of the most typical types of conflict assaults, and these solutions are offered as a remedy for it. In light of this, our research on IoT-generated SG uses machine learning to investigate potential vulnerabilities in the system. This research suggests a dependable and versatile DSM machine that is connected to the internet in order to answer the issues that have been raised about the level of safety at SG. The demand-side management (DSM) device that is proposed will include an adaptive agent that makes use of classifiers that are developed from machine learning. The demand-side management (DSM) theory, which was developed in order to make the most efficient use of power [5,] is something that the home area network (HAN) that is being built is supposed to help people understand.

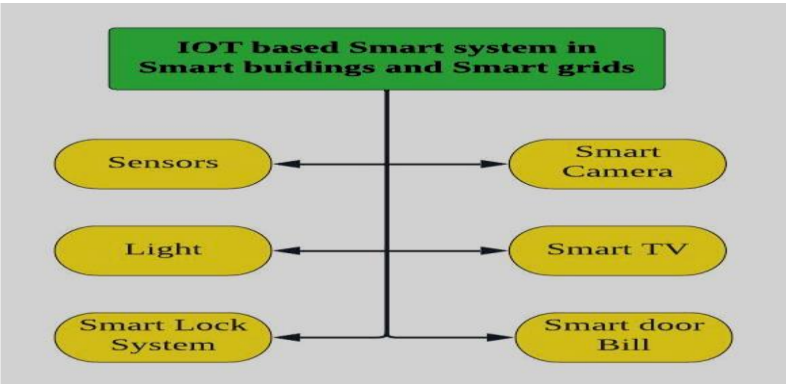

Fig 1: IOT Based Smart System in Smart Buildings and Smart Grids

We built an intelligent system for the laboratory that takes use of a free and open-source internet of things platform in order to make it possible for real-time monitoring and management of a wide range of cutting-edge home appliances. This will help us to better serve our customers. The process of doing research was simplified by the development of this approach. Every room has its own own set of sensors and cameras that monitor the day-to-day activities of the inhabitants as well as the environment's temperature, lighting, and overall level of activity. This information is then sent to a central monitoring system. If the data is discovered to be larger than the threshold, homeowners will be notified through email or text message to make improvements to the inside of their homes if it is determined that the threshold has been exceeded. The artificial intelligence is trained to notice unusual occurrences. As a result of recent advancements in big data analytics, sensor technology, machine learning (ML), and the Internet of Things, it is feasible that price cuts for SGs may become a reality in the near future (IoT). Making a few tweaks here and there to the infrastructure won't need much effort from your end of things. As a workable solution to the problem, this paradigm is offered here for consideration. We may be able to identify important clinical signs that might indicate the presence of heart disease by combining a Receiver Operating Characteristic (ROC) analysis with a three-tier expandable architecture that is based on the Internet of Things. This may allow us to diagnose heart disease earlier.

By increasing the efficiency with which natural light is used and boosting performance in areas such as occupancy detection and dimming, smart lighting reduces the amount of unneeded artificial light that is required in a given location. In public places, dim lighting is more often seen as the standard than as an exception, and this trend is expected to continue. Businesses who use step and continuous dimmer control have a better chance of seeing a return on investment from their demand-response system investments. Intelligent lighting systems are able to be completely controlled from a distance because the control systems for the lighting may be designed in such a wide variety of various ways. Customers now have access to web-based dashboards for managing lights thanks to the lighting management features, and the use of wireless controllers makes it much simpler to carry out retrofits. Customers now have access to web-based dashboards for managing lights thanks to the lighting management features. Smart grid and building technologies that are based on the Internet of Things [6].

2. Review of Literature

Distribution of electricity that is both secure and reliable is essential to the nation's economy, as well as its security and healthcare systems. The incorporation of communication technologies and sensors into power infrastructure marks the beginning of a new era in the production, distribution, monitoring, and management of energy. This is referred to as the "smart grid." Before the smart grid can be utilized in a practical capacity, there are a number of obstacles that need to be overcome. Protecting the smart grid from potential threats is an important and challenging task. A secure demand-side management (DSM) engine for an Internet of Things (IoT)-enabled grid is proposed in this piece of writing. According to the priorities, the DSM engine that is planned will be in charge of ensuring that the amount of energy used is as efficient as it can possibly be. The management of intrusions into the smart grid is shown via the use of a novel resilient paradigm. The resilient agent makes predictions about the dishonest entities by using the ML classifier. It is advised that sophisticated energy management and interface regulating agents be used in order to assess information about energy usage and to enhance energy utilization. In order to determine whether or not the proposed tactic will be successful, an effective simulation will be carried out. The results of the study indicate that the suggested DSM engine is less susceptible to invasion and has the capacity to reduce the amount of electricity that the smart grid consumes [7].

The Internet of Things is an innovative concept that has surfaced as a direct consequence of the significant development that has taken place in embedded systems as well as information and communications technology (ICT) (IoT). With the help of technologies based on the Internet of Things (IoT), a number of different objects and components may be connected to one another and communicate with one another via the internet or other modern communication platforms. Embedded systems are specialized computer devices that are designed to carry out a single function. Examples of embedded systems include advanced controllers, sensors, and meters that are able to convey information by exploiting IT infrastructures. They find applications in high-tech items as well as in intelligent buildings, aircraft, and automobiles. The word "internet" in this context may refer to any kind of server-based or peer-to-peer network; it is not restricted to the World Wide Web. In this study, we explore how the Internet of Things may be used to smart grids. As a result, an introduction that begins with a high-level summary of the need of incorporating IoT into smart grids is provided. After then, three layers of creation, transmission, and dissemination are recommended for use in applications related to the Internet of Things. Applications of the internet of things for thermal producing, energy storage facilities, and renewable energy sources, in particular wind and solar, make up the generation level. The management of power system congestion and the protection of the system are both made possible with the use of IoT at the transmission level. At the distribution level, an analysis of the implications of the Internet of Things on active distribution networks, smart cities, microgrids, smart buildings, and the industrial sector is performed [8].

Learning algorithms used in machines make it feasible for difficult tasks to be carried out completely independently. In a smart grid, the use of personal computers and mobile devices may make it easier to control the temperature inside, monitor the level of security, and carry out routine maintenance (SG). Internet of Things connections are used to facilitate communication between the many components in smart buildings (IoT). As the notion of the Internet of Things takes hold, SGs are being merged into larger networks. The Internet of Things is an essential part of smart cities because of the life-improving services it provides to all of its users. It has been shown that the systems that are now in place for keeping life going are safe and effective. The primary purpose of this investigation is to identify the motivating reasons behind the deployment of Internet of Things (IoT) devices in smart buildings and on the grid. When seen from this vantage point, it is essential to recognize the significance of the infrastructure that supports Internet of Things devices as well as the components that compose those devices. It is possible that the remote installation of smart grid monitoring systems will result in an increase in both the residents' sense of security and their level of comfort. In order to run and monitor any form of gadget, sensors are required. This includes anything from consumer electronics to SGs. Devices that are linked to a network ought to consume less power, and they ought to be able to be monitored from a distance. The goal of the authors is to provide assistance in the development of solutions that make use of SGs, IoT, and AI. SG, networking, and artificial intelligence are a few of the other topics the authors investigate. In the latter part of this article, we will discuss the SG and IoT research. Some components of the IoT platform have been the subject of heated debate. In the first part of this investigation, we take a look at some of the most common approaches to machine learning that are used to forecast the amount of energy that a building would use. The authors next discuss the Internet of Things (IoT) and how it operates after having discussed the Smart Grid (SG) and smart meters, both of which are required in order to get real-time data on energy use. Second, we investigate how the various components of SG, IoT, and ML work together by using a simple architecture that is composed of layers that are organized into entities and are connected to one another [9]. These connections allow the layers to communicate with one another.

Demand for energy that varies at random almost always leads in an imbalance between supply and demand for energy and unstable grid functioning. One kind of energy management is called as incentive, and it is designed to encourage prosumers (small-scale energy producers and consumers, also known as Energy Districts, or EDs) to plan their load at specific times of the day (demand-side management). However, the incorporation of renewable energy sources into pre-existing power grids may lead to irregular and intermittent power supply for a variety of reasons. These include the variable wind speed in the case of wind power generation and the variable solar irradiance in the case of solar power generation. Maintaining a healthy equilibrium between the supply and demand of energy is another critical component in maximizing the benefits that may be shared by all stakeholders. Since restricting the amount of energy exchanged is preferable to reducing the amount of money spent on energy, an objective function for maximizing the equilibrium between energy demand and supply was developed. The authors developed phasor measurement units with the intention of bringing more attention to the demand-supply situation present in the distribution system. a process that begins with the organization of a large dataset of phaser measurement units into information and continues with the mapping of that information to an actual-world situation. In order to determine the likelihood of failure for power systems and the components that make up such systems, a generic machine learning model was developed with the use of historical data from the Indian power grid [10].

3. The Proposed Safe Requirement for the Smart Grid is the Side Management Engine

The DSM is the most important part of the smart phase because it enables developers or manufacturers to efficiently respond to user input on the power use of programs and also enables users to provide feedback on the power usage of programs. The user is responsible for paying the cost of the current in a number of different electrical applications. Figure 2 depicts the demand-side management (process) for the service provider and the predicted safety status of the home area network. (HAN). These home area networks, also known as HANs, are linked to the Smart Phase's SG division, which is in charge of DSM. The HANs are also referred to in common parlance as HANs. They consist of energy efficiency and demand response, both of which are essential components of having a fundamental grasp of in order to operate the smart grid in an appropriate manner. A home area network (HAN), which controls a house's users and smart devices within the framework of smart meters and is used to monitor and control how much power the home's dedicated network consumes, is used to monitor and control how much electricity the home requires. The use of a local area network provides comprehensive monitoring of the system [11].

Since their definitions have been provided, the phrases "smart phase," "HAN," "the market's home sector," and "smart houses" are now used often in everyday conversation. The pursuit of strategies to carry out demand-side program implementation has directly resulted in an increase in the number of contacts with providers carried out via the use of SG-HAN. The effective and risk-free functioning of the DSM machine in the SG may be preserved via the use of the safe DSM machine, which takes into account preferences and energy requirements. When high-power-consumption devices are needed, those that meet the requirements are chosen and made available as soon as it is practicable to do so with authorization. During this process, load and price restrictions are strictly adhered to. Figure 2 depicts the overall system model of the proposed secure DSM engine. There is not a model solution that has been provided that is being offered [12].

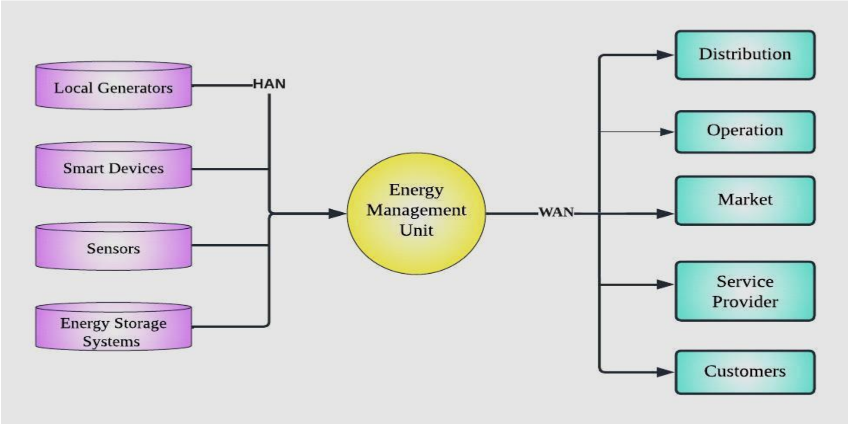

Fig 2: DSM engine position

The SG was established to guarantee that consumption is both safe and effective, while also taking into account individuals' distinct tastes and the necessary amount of critical energy. If there is a need for devices with a high power consumption, such devices are chosen and given as soon as it is practically possible with authorization, all while sticking to load and pricing constraints. On display in Figure 2 is the system model of the recommended secure DSM engine. There is not yet a modeled solution that is being given for consideration [13]. IoT-enabled The suggested safe demand-side management (DSM) machine gets its information from Hans. This information is sent to the recipient of the message on the DSM computer, who is then presented with the option to conceal it from prying eyes. When a smart grid is in place, private data may be evaluated to come up with options that are tailored to the requirements and tastes of individual customers. In order to get the most out of the available resources, the results of the information processing are sent back to the local area network (HAN). The use of a technique known as trend analysis to derive inferences from the data may also be done in order to make projections about the future [14].

4. Methodology

In this part, the results that were acquired via the application of the model that was provided are fully explored and analyzed. The efficiency of the robust DSM engine that is now being provided is shown with the help of an environment for simulation that has been meticulously constructed. The examinations were split into two distinct groups, and their compositions were as follows:

- Tests of the dependable model that are based on training and make use of Naive Bayes methods. The model is trained with the assistance of a particular dataset that can be relied upon to be authentic and real. This helps the model learn how to differentiate between instances or components of secure and unsecure communication.
- By using high-level programming in C# and simulating a range of scenarios involving a specific HAN and fixed WIFI APs, an analysis was performed to determine the overall energy efficiency of the DSM engine. In addition, the stream processing makes use of a dataset that can be relied upon.

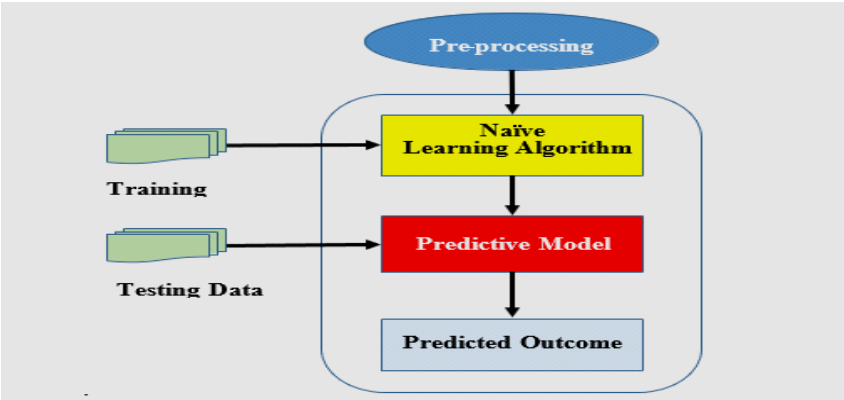

Fig 3: Model Training

The evaluation of a resilient agent is made possible by the production of a specific habitat. The recommended resilient agent was trained using the 340*900 matrix, which is a representation of the ratings that 340 clients had submitted for 900 different types of services. Naive Bayes algorithms operate on the presumption that a feature that is present in one class will not also be present in other classes. This assumption underlies the usage of these algorithms. The assumption that underlies this argument is that. The training method for the Nave Bayes classifier is shown in Figure 3.

The confusion matrix, which is shown in Table 1, is used in order to perform an evaluation of the performance of the suggested classifier by a resilient agent. An evaluation of the correctness is performed with regard to the two separate categories of "secure" and "insecure." We went with the confusion matrix because we believe it gives a more accurate portrayal of the categorization model. In addition, the performance measurement technique is the one that is applied the majority of the time for algorithms that are based on machine learning.

Table 1: Confusion Matrix

		Predicted	
Actual		Secure	Insecure
	Secure	TP	FN
	Insecure	FP	TN

If the S value is higher than or equal to 0.51, then the system is considered to be safe to use. On the other hand, the system is seen to be dangerous if the S value is 0.5 or lower, or if it is equal to 0.5 or higher. These phrases are taken into consideration in the same manner that the preceding ideas were. In other words, the same process was followed. The results of using the model that was provided are shown in Table2. The following words were included on the list of candidates for inclusion in the confusion matrix:

- The trustworthy perimeter is the set of values that the recommended resilient agent, which based 95% of its judgements on the model described, thinks to be acceptable for safe communication. This model forms the basis for 95% of the agent's decisions.
- When the encrypted communication exceeds a specified range of values known as the TN, the resilient agent flags it as unsafe. The TN, or the threshold at which this occurs, has an estimated value of 8% according to the recommended model.
- At the FP, which is a collection of values, the recommended resilient agent, which has a value of 9% when the specified model is used, can tell the difference between an unsafe communication and a secure communication.
- The resilient agent that was recommended, which has a confidence level of 96% when using the model that was supplied, defines the TN as the range of values at which it deems an unsafe communication to be secure. This level of confidence was achieved by utilizing the model that was provided.

Table 2: Proposed Model Results using Confusion Matrix

	Predicted		
		Secure	Insecure
	Secure	95%	8%
Actual	Insecure	9%	96%

It was anticipated that the market for smart grid technology would be worth 26 billion US dollars in 2017, and it is anticipated that this market will increase at a compound annual growth rate (CAGR) of 8.7 percent until 2026, at which point it is anticipated that this market will be worth 56 billion US dollars. The term "smart grid" may refer to a number of different technologies and sectors, some of which include network and distribution management, advanced metering infrastructure (AMI), and power supply security. These are just a few examples. Examples of smart grid technologies include electrical supply systems that increase energy efficiency by using connectivity, demand response, and renewable energy sources.

Table 3: Grid Market

	2017	2018	2019	2020	2021	2022	Total
Market size	26	33	48	50	54	60	45.17
Smart grid technology market size	46	51	58	66	67	72	60
Global smart grid market size	51	54	60	72	75	77	64.83
Energy Management - Worldwide	40	48	55	59	75	84	60.17
Total	40.75	46.5	55.25	61.75	67.75	73.25	57.54

Grid technology may be seen of as a subset of the larger movement toward intelligent technologies. The computer power, data collection, and other cutting-edge technologies are being used to improve operations in the industrial, medicinal, and agricultural sectors respectively. The collection of such huge volumes of data requires internet networks with a high upload and download speed. To bring the existing infrastructure up to date will need significant investments, but such investments are expected to be profitable in the long term. In order to successfully operate unmanned aerial vehicles (UAVs) and self-driving autos, smart cities are needed to offer the ubiquitous connectivity that is necessary for their operation. But, they do raise concerns regarding the collecting of people's data, which raises the possibility that individuals' private information, location data, and health data might be used by others who have access to it. Misuse of data is something that is hoped to be reduced by the implementation of policies such as the European Big Data Protection Act.

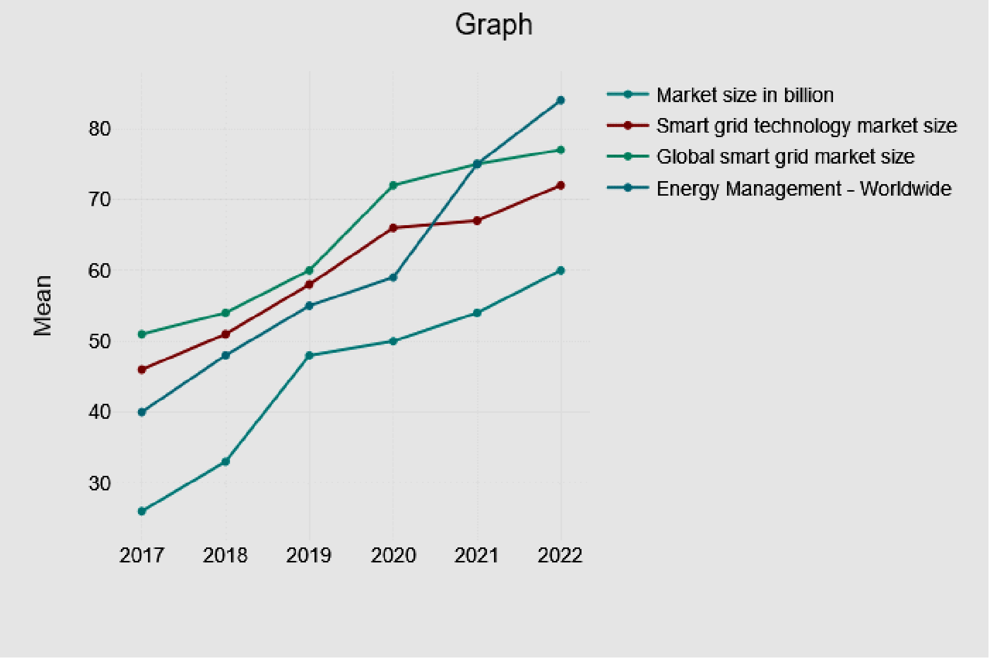

Fig 4: Grid Market

5. Analysis and Interpretation

Between the years 2017 and 2022, it is anticipated that the global demand for smart grid technology would double, reaching a total of over 61 billion US dollars. The use of technology that uses smart grids is rapidly increasing all around the world. The most populous regions in which smart grid technologies are being implemented are North America, Europe, and Asia Pacific. The smart grid technology sector is expected to expand at the fastest pace in Asia Pacific, which is expected to have the highest growth rate overall. Even whole cities are eventually going to be connected to the Internet of Things thanks to the proliferation of measurement equipment. It is anticipated that the number of connected devices,[13-14]. such as wearable technology, would see a substantial expansion as a result of the Internet of Things.

Table 4: Correlation and significance

		2017	2018	2019	2020	2021	2022
2017	**Correlation**	1	0.99	1	0.99	0.83	0.67
	p (2-tailed)		.013	.001	.014	.167	.332
2018	**Correlation**	0.99	1	0.99	0.95	0.89	0.77
	p (2-tailed)	.013		.01	.054	.108	.231
2019	**Correlation**	1	0.99	1	0.98	0.83	0.68
	p (2-tailed)	.001	.01		.019	.166	.324
2020	**Correlation**	0.99	0.95	0.98	1	0.76	0.55
	p (2-tailed)	.014	.054	.019		.244	.445
2021	**Correlation**	0.83	0.89	0.83	0.76	1	0.96
	p (2-tailed)	.167	.108	.166	.244		.041
2022	**Correlation**	0.67	0.77	0.68	0.55	0.96	1
	p (2-tailed)	.332	.231	.324	.445	.041	

An investigation into the impacts of the years 2017, 2018, 2019, 2020, 2021, and 2022 on the variable Category was the focus of a logistic regression study that was conducted in order to provide an estimate for the value "Market size in billions." According to the findings of the logistic regression analysis (Chi2(6) = 4.5, p.61, n = 4), the overall significance of the model cannot be said to be significant.

b = 16.06 is the value in the positive range of the coefficient that corresponds to the variable 2017. This suggests that a growth in 2017 is connected to an increase in the possibility that the dependent variable, "Market size in billions," will also rise at some point in the future. This influence, on the other hand, has a p-value of 1, meaning that it is not statistically significant. According to the odds ratio of 9406399.68, there is a 9406399.68 times greater probability that the dependent variable, "Market size in billion," would increase by one unit in 2017.

The value 1.75 is the positive coefficient that should be applied to the variable 2018. This suggests that a rise in 2018 is connected to an increase in the possibility that the dependent variable, "Market size in billions," will also grow at some point in the future. This influence, on the other hand, has a p-value of 1, meaning that it is not statistically significant. According to the odds ratio of 5.73, a one-unit increase in the variable 2018 will result in a 5.73-fold increase in the likelihood that the dependent variable, "Market size in billion," would see growth in the next year.

The value of b, which represents a positive coefficient for the variable 2019, is 32.57. This suggests that an increase in 2019 is associated with an increase in the chance that the dependent variable, "Market size in billions," would also see an increase. This influence, on the other hand, has a p-value of 1, meaning that it is not statistically significant. According to the odds ratio, a one-unit increase in the independent variable 2019 will result in a 139661534649148.19 times increase in the likelihood that the dependent variable "Market size in billion" will take place.

The value b = -49.69 is the negative coefficient that should be applied to the variable 2020. This shows that there will be a decrease in the possibility that the dependent variable, "Market size in billion," will increase in value in the year 2020. This influence, on the other hand, has a p-value of 1, meaning that it is not statistically significant. A odds ratio of 0 indicates that the likelihood of the dependent variable, "Market size in billion," growing by one unit by the year 2020 will not increase at all due to the fact that the odds ratio is 0.

The value 44.86 serves as the positive coefficient for the variable 2021. Thus, the chance that the dependent variable "Market size in billions" would rise in 2021 is enhanced as a result of this. The p-value of aN illustrates the degree to which this influence is statistically significant. According to the odds ratio of 30485527700955742000, the likelihood that the dependent variable, "Market size in billion," would occur will grow by 30485527700955742000 times for every unit increase in the independent variable, 2021.[10-12]

The value b = -42.29 was determined to be the negative coefficient for the variable 2022. This shows that there will be a reduction in the probability that the dependent variable, "Market size in billion," will increase in 2022. The p-value of aN illustrates the degree to which this influence is statistically significant. A odds ratio of 0 indicates that there is no increase in the likelihood of the dependent variable, "Market size in billion," rising by more than one unit for every one unit that the odds ratio rises by.

6. Result and Discussion

It was determined, with the use of a two-factor analysis of variance with repeated measurements, whether or not there is a

- a change in the dependent variable that is statistically significant between the groups determined by the first factor, "2017, 2018, 2019, 2020, 2021, and 2022." (repeated measurements).
- a difference in the dependent variable between the groups defined by the second factor Category that is statistically significant.
- In terms of the dependent variable, there is an interaction between the two components "2017, 2018, 2019, 2020, 2021, and 2022" and Category. This interaction can be seen in the table below.

The two-factor analysis of variance with repeated measures showed that there is

- Significant differences were found between the groups of the first factor Category and the groups of the dependent variable "2017, 2018, 2019, 2020, 2021 and 2022" in relation to the dependent variable, p=aN
- significant differences were also found between the groups of the first factor Category and the dependent variable "2017, 2018, 2019, 2020, 2021 and 2022" in relation to the dependent variable
- significant interactions were found between the two variables Category and "2017, 2018, 2019, 2020, 2021 and 2022" in relation to the dependent variable.

Table 5: Test Result

	Statistics	p
Kolmogorov-Smirnov	0.1	.957
Kolmogorov-Smirnov (Lilliefors Corr.)	0.1	.867
Shapiro-Wilk	0.98	.87
Anderson-Darling	0.24	.763

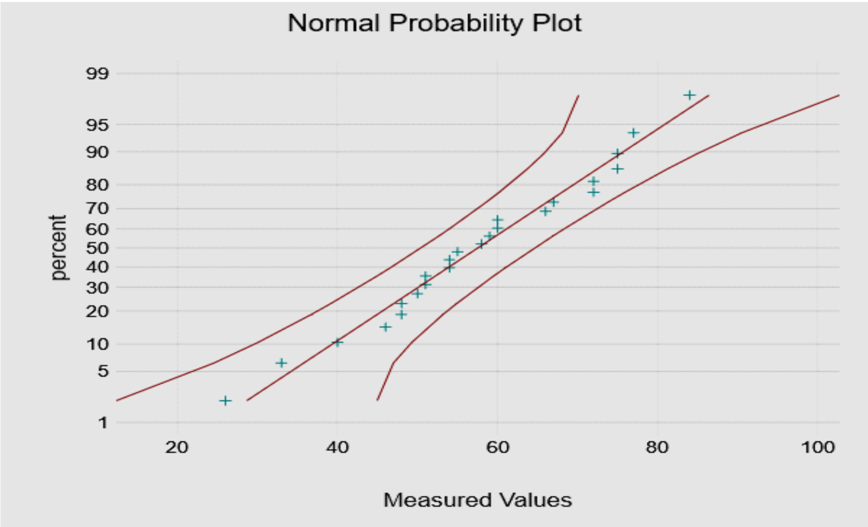

Fig 5: Normal Probability Plot

Table 6: Hypothesen

Null hypothesis	Alternative hypothesis
There is no distinguishable difference between the groups of the first factor for the dependent variable 2017, 2018, 2019, 2020, 2021, and 2022. (measurement repetition).	In terms of the variable that is being controlled by the dependent variable, there is a significant divide present across the categories that constitute the first

	factor for the years 2017, 2018, 2019, 2020, 2021, and 2022. (measurement repetition).
There is no visible variance between the groups that are defined by the second factor Category in terms of the variable that is being measured (the dependent variable).	There is a significant gap in performance between the groups that are defined by the second factor Category in regard to the variable that is being measured.
There is no interaction whatsoever between the factor Category and the years 2017, 2018, 2019, 2020, 2021, and 2022.	An interaction influence will be exerted on Category by the variables in 2017, 2018, 2019, 2020, 2021, and 2022.

7. Conclusion

The phrase "smart grid" may also be used to refer to a power distribution network that makes use of sensors and other forms of electronic communication. The issue of security is among these pressing challenges and is one of the most crucial difficulties as well as one of the largest impediments to the adoption of the smart grid. According to the findings of this research, a secure and reliable demand side management (DSM) engine that is built on machine learning would be an effective solution to defend an IoT-enabled smart grid from malicious intrusions. This responsibility, which is based on needs and priorities, is assigned to the DSM, which is responsible for maintaining an efficient level of energy consumption. The use of a particular model of a resilient agent that is equipped with the DSM of the smart grid has been proposed as a method for the prevention of invasions. The reliable agent makes use of a machine learning classifier in order to make predictions about the dishonest entities. The value b = -49.69 is the negative coefficient that should be applied to the variable 2020. This shows that there will be a decrease in the possibility that the dependent variable, "Market size in billion," will increase in value in the year 2020. In addition, the effective simulation is carried out so that the effectiveness of the proposed strategy can be evaluated. We are constructing a private HAN that will have an always-on WiFi connection. The outcomes of the research reveal that the recommended DSM engine is less susceptible to intrusion and that it is adequate to minimize both DSM's power consumption in the smart grid and the power consumption of its associated HAN devices.

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