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IOT BASED SMART METERING SYSTEM IN SMART HOMES

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Abstract

Even while new technologies are being developed to aid in the evolution of humanity, their security systems still include holes that might be exploited by those who want to steal or damage the data of others. An example of a typical security issue is the usage of passwords for devices that are either too easy to crack or too simple for users to remember. Botnets are a method employed by hostile actors; they are networks of compromised devices that may be used to execute orders. Botnets are networks of compromised computing equipment. As a direct result, problems surrounding the security of the Internet of Things (IoT) must be addressed. According to, there can be as many as 26 billion Internet of Things (IoT) devices linked to the internet by the year 2020. Therefore, it is necessary to develop solutions for securing the Internet of Things' security (IoT) (IoT). In many network environments, intrusion detection systems act as the first line of defense for network security. In these sorts of systems, the process of tagging databases needs a considerable investment of both computing and human resources. During the dataset preparation phase, also known as step 1, this technique's algorithm picks features based on the properties of the data sets in order to organize them in decreasing order of their degree of similarity. This method is called as feature selection. DoS, R2L, U2R, and probing are among the four types of attacks that are included in the KDD CUP 99(KDD) dataset, which was intended for testing IDS. There are 41 KDD properties that are unique to every TCP connection. These aspects are traffic, basic, and content. KDD is utilized in intrusion detection data mining and machine learning research..

Keywords: DoS, R2L, U2R, TCP, IDS, KDD

AKILLI EVLERDE IOT TABANLI AKILLI SAYAÇ SİSTEMİ

Özet

İnsanlığın evrimine yardımcı olmak için yeni teknolojiler geliştirilirken bile, güvenlik sistemleri hala başkalarının verilerini çalmak veya zarar vermek isteyenler tarafından kullanılabilecek delikler içeriyor. Tipik bir güvenlik sorununa örnek olarak, kırılması çok kolay veya kullanıcıların hatırlaması çok basit olan cihazlar için şifrelerin kullanılması verilebilir. Botnet'ler, düşman aktörler tarafından kullanılan bir yöntemdir; emirleri yerine getirmek için kullanılabilecek güvenliği ihlal edilmiş cihaz ağlarıdır. Botnet'ler, güvenliği ihlal edilmiş bilgi işlem ekipmanı ağlarıdır. Doğrudan bir sonuç olarak, Nesnelerin İnterneti'nin (IoT) güvenliğini çevreleyen sorunların ele alınması gerekir. Buna göre, 2020 yılına kadar internete bağlı 26 milyar kadar Nesnelerin İnterneti (IoT) cihazı olabilir. Bu nedenle, Nesnelerin İnterneti güvenliğini (IoT) (IoT) güvence altına almak için çözümler geliştirmek gerekir. Birçok ağ ortamında, saldırı tespit sistemleri ağ güvenliği için ilk savunma hattı görevi görür. Bu tür sistemlerde, veritabanlarını etiketleme süreci hem bilgi işlem hem de insan kaynakları için önemli bir yatırıma ihtiyaç duyar. Adım 1 olarak da bilinen veri kümesi hazırlama aşamasında, bu tekniğin algoritması, benzerlik derecelerinin azalan sırasına göre düzenlemek için veri kümelerinin özelliklerine göre özellikler seçer. Bu yönteme özellik seçimi denir. DoS, R2L, U2R ve sondalama, kimlikleri test etmek için tasarlanan KDD CUP 99 (KDD) veri kümesinde bulunan dört saldırı türü arasındadır. Her TCP bağlantısına özgü 41 KDD özelliği vardır. Bu yönler trafik, temel ve içeriktir. KDD, saldırı tespit veri madenciliği ve makine öğrenimi araştırmalarında kullanılmaktadır.

Anahtar Kelimeler: DoS, R2L, U2R, TCP, IDS, KDD

1. Introduction

It is projected that the world of the Internet of Things will see unprecedented alterations. They are capable of communicating with one another on a far larger scale, exchanging information, and reacting and adapting to their surrounding environment. The Internet of Things (IoT) is commonly referred to as the third wave of the revolution in new information technologies, after the Internet's debut in the 1990s and Web 2.0's in the 2000s. Because IoT links common devices to the internet, this is the case [1]. As a consequence of this revolution, it is much easier to create intelligent things. Home automation is merely one of several industries that the Internet of Things has substantially impacted (IoT). As a direct consequence of the emergence of new communication technologies and information processing solutions, our daily lives are in turmoil. To meet the requirements of today's intelligent living environment, housing must be able to accommodate new technologies that are aimed to simplify daily life, enhance the number of available alternatives, and achieve a higher degree. Internet connectivity, telecommuting, monitoring of consumption, information search, and many services and conveniences are included There are just a few apps that are now operating and have been widely disseminated, despite the fact that there are several companies working in this field [2]. The most common commercial home automation solutions are automated lighting and thermostats; nevertheless, the ordinary consumer cannot afford a complete smart home system owing to the high cost and complexity of these systems [3]. The most common commercial home automation items are automated lighting and thermostats. There are issues with the compatibility of the vast majority of these solutions with already-built homes. The availability of microcontrollers (AVR, PIC…) and low cost embedded systems like Arduino, BeagleBone, Raspberry PI, with their own Open Source platforms, has captured the attention of electronics inventors, experts, and small engineering firms. Automation. These tools are applied to create new concepts in this field by providing a large development space with very wide implementation possibilities and exceptional diversity, and possibly the appearance of a new type of these solutions which are call the home automation box in the market. With one goal, to guarantee comfort and improve the quality of life [4].

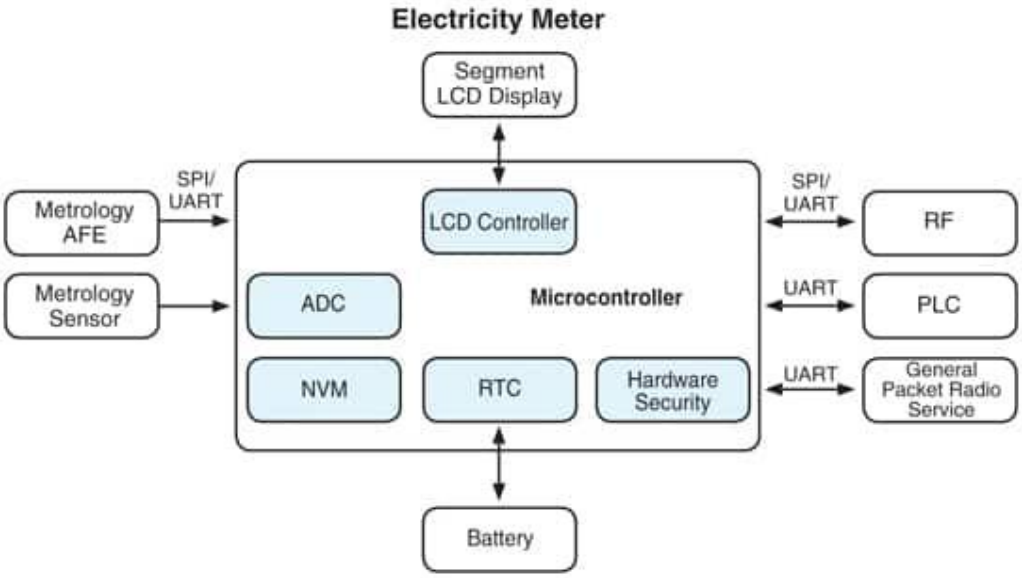

Figure 1: Schematic view of microcontroller in smart meters

But despite the involvement of many companies in the field, it is clear that few applications are currently operational and distributed on a large scale. Commercial solutions in the home automation market are dominated by smart control gadgets like automatic light or smart thermostat, but the complete home automation solution called smart home, remains inaccessible to the common consumer due to cost and expense. incompatibility of the majority of these solutions with the houses already built [5]. The availability of microcontrollers (AVR, PIC…) and low-cost embedded systems like Arduino, BeagleBone, Raspberry PI, with their own Open Source platforms, has captured the attention of electronics inventors, experts, and small engineering firms. Automation. These tools are applied to create new concepts in this field by providing a large development space with very wide implementation possibilities and exceptional diversity[6], and possibly the appearance of a new type of these solutions which are call the home automation box in the market. With one goal, to guarantee comfort and improve the quality of life.

we will propose an architecture and a design, of a smart house in the form of a low-cost home automation box, which takes a Raspberry Pi card as an intelligent element, and Arduino cards as control cards. communications and control, detailing the operation of the radio frequency layer of the system, the algorithms and protocols proposed, the technologies used, and explaining a little about the proposed circuits and the hardware used[7][8].

2. Literature Review

Maven Systems [9] is able to collect data from smart meters connected to GSM networks utilizing a wireless connectivity module known as WiArt. This information is currently being transmitted via GPRS to the data concentrator. They are capable of generating a variety of management reports and storing collected data in the cloud. ISM bands are used by Maven systems in order to communicate over a mesh topology [10].

Kevin Laubhan and his coworkers [17] devised a framework for transmitting sensor data to the cloud with minimal power consumption. A low-power microcontroller is responsible for collecting sensor data in the node architecture, and the regional hub is responsible for collecting data from that node. By utilizing a cloud-based architecture, data processing can be performed in a more efficient and straightforward manner. To maximize the coverage area while minimizing the amount of energy consumed, the algorithms for node deployment and scheduling must be enhanced.

An Internet of Things (IoT) framework for a smart water meter reading system was proposed by Neeharika Cherukutota et al. [10]. In order to connect water meters to the cloud, they have utilized a Mediatek cloud sandbox in conjunction with RESTful web services.

According to Enrique Carrillo and colleagues, the provision of computational power from cloud services can enable the development of a framework for intelligent systems [11]. The proposed framework utilizes the integrated development environment provided by Arduino for the management and monitoring of the network. The Raspberry PI serves as the primary gateway controller for all Arduino projects, while Microsoft Azure's cloud services provide the computational power. Mohammed ShahanasK. and Dr.BagavathiSivakumar P. [25] propose a framework for an intelligent water management system, situating their work in the context of smart city initiatives in India.

They have made an effort to identify a cost-effective and cloud-based solution for the transmission and management of data. In Sanchez, Tomas, and others' work [24], they implemented an Adhoc network with clustering of objects and proposed a framework for increasing the network's lifetime in data collection.

Lloret, Jaime, and their colleagues [18] also suggested the use of a three-layered communication architecture. According to the authors, the lack of standardization in communication protocols renders proprietary meter communication solutions inapplicable to all types of smart meters. These solutions are intended to communicate with particular smart meter types. The smart grid is one of the Internet of Things applications considered to be of the utmost significance. Sensors and actuators are used to connect real-world consumer goods to the internet and give them the ability to communicate with one another [23][26].

Internet of Things is a new hybrid paradigm emerging in the field of wireless telecommunications (IoT). For a very long time, the "anytime, anywhere, any media" vision has been the driving force behind the advancement of communication technologies. In this context, wireless technologies have played a significant role, and as a result, the radio-to-human ratio is approaching one-to-one [27]. The Internet of Things consists of three distinct yet interconnected concepts: things-oriented, internet-oriented, and semantics-oriented. [28] Things Oriented refers to a wide range of ubiquitous objects, including tags, sensors, actuators, RFID, and NFC [29].

3. Methodology

Initially, only a small number of wealthy persons had access to electricity [32]. These persons were mostly wealthy. As technical improvements were made, it became less difficult to accommodate the needs of the global populace. Researchers from the past had a significant contribution in the evolution of the electricity meter. In the early 1870s, telegraphs and arc lights were the only technologies in widespread use. The creation of the electric light by Thomas Edison in 1879 made it feasible for the general public to enter the market for electrical energy. Oliver B. introduced the world to Shallenberger's alternating current ampere-hour meter in 1888. The further advancement of metering technology will significantly enhance the quality of life for a huge number of people [30][31][33].

3.1. Smart Meters

The kilowatt-hour-based "Smart Meter" is an energy meter that was designed to minimize its environmental effect (Kilowatt - hours). Customers who wish to save money on their monthly electricity costs may instantly profit from using this equipment. One of their roles as part of the Advanced Meter Infrastructure division is to guarantee that the energy provider gets automated readings from the meters [34][35]. An image of a smart meter is seen below. Due to its capabilities, the Smart Meter will be able to deliver totally accurate meter readings. They measure the amount of food and fluids they eat less often, such as every hour. This kind of meter has tamper detection, remote connection and detachment, non-volatile data storage, and bidirectional communication capabilities. They use the Internet to transfer the collected data to the central meter. This central meter is responsible for Smart Meter monitoring. The use of smart meters improves operational administration and control of the grid [6]. The following are some of the advantages associated with the use of smart meters:

- The benefits-to-costs ratio
- Both utility users and utility companies save time when transferring meter readings to energy suppliers due to the time savings.
- It is possible to pay your power bill online.
- Using intimidation, it may be feasible to dramatically reduce power use during periods of peak demand.
- When appliances are not in use, they may be configured to automatically shut down [39].

The Smart Meter can monitor and record each and every unit of energy used by a residence. Readings from meters let energy providers to have a better knowledge of their customers' habits [36][37], which in turn allows customers to make modifications to their general energy use patterns. Last but not least, the amount of information provided by smart meters will be used in the construction of future citizens.

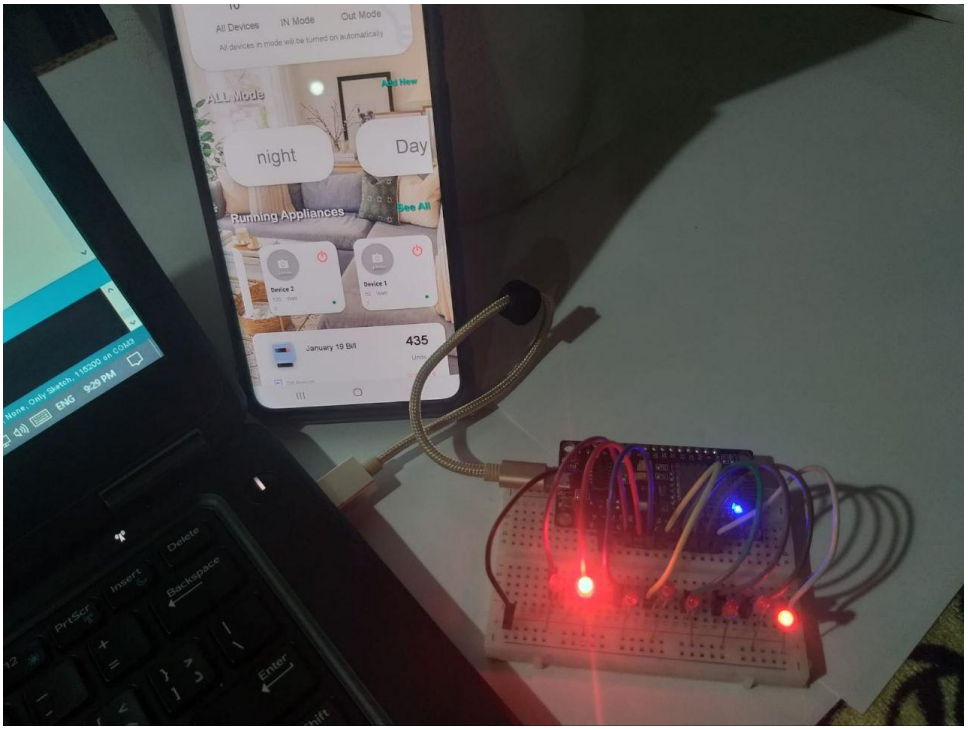

Figure 2: Image of the proposed smart meter

This gadget has a power usage of 4.4 Watts per hour. The word "electricity consumption" refers to the entire quantity of energy utilized inside a single dwelling. Utilization is of the highest significance in terms of energy accessibility. People must be aware of the need of energy conservation in order to conserve it for future generations. Because energy is required for even the most fundamental tasks, energy patterns have evolved throughout history. This variation in consumption patterns may be attributable to weather fluctuations or reckless energy usage by humans. Some folks, for instance, do not turn off the lights or the television when they are not using them. They might have a more significant effect on the user in the long run. As a consequence of the huge amount of energy supplied by energy suppliers, the great majority of individuals are unaware of the need of energy conservation. Utilities are beginning to diminish the significance of use in their operations. Customers must be made aware of the negative

consequences of their existing consumption levels, and utility firms must play a crucial role in the development of smart meter technology.

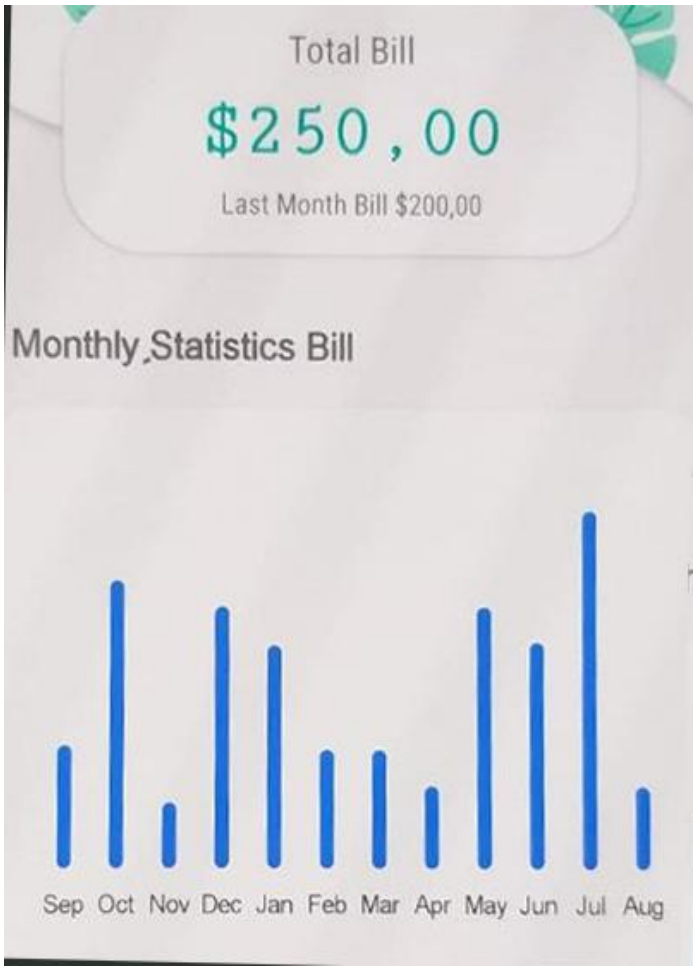

Figure 3: Monthly statistics of the proposed system

Consumer behavior refers to the habits and choices that consumers make about the usage of household equipment. Consumption by consumers is indicative of how often and for how long customers use equipment, and because this is the case, it follows that the cost is directly proportionate to the frequency and duration of usage. It is crucial that energy providers adhere to the criteria established by their customers. In actuality, the majority of customers rely on the next monthly payment they are required to make. The great majority of people are ignorant of which of their home appliances uses the most energy, much alone how to limit this consumption effectively. The client's behavior is significantly affected by these factors. The only way to get a more comprehensive understanding of human behavior is to investigate how people use their energy. When using their equipment, customers must be persuaded in a style that demonstrates consideration [38]. Figure 4.3 is an example of a Smart Meter being used to measure household appliances. This specific Smart Meter was put in the home. The graph above depicts the data collected by a Smart Meter on the daily energy consumption of a residence's appliances. Installing a Smart Meter outside the home and monitoring its hourly power use statistics might help homeowners reduce their energy costs. Even a modest house has the potential to be transformed to a smart home by using these measuring capabilities.

3.2. Concerns regarding the economic climate

Before and after the implementation of In-Home Display, the daily patterns of power usage in two cities are compared. The average daily electricity consumption is affected by temperature.

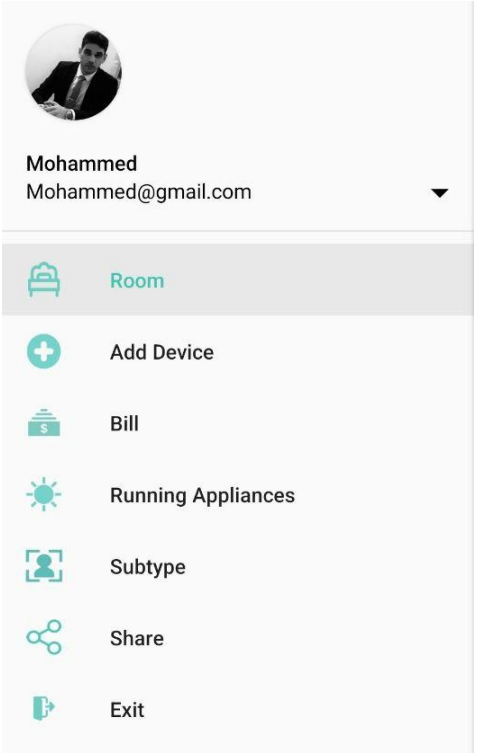

Figure 4: UI of the proposed HEMS

Utilizing the Home Energy Management System, it is possible to predict expenditures in [12][13]. According to the findings of the research, it is feasible that the experiment will result in a 22,2 percent reduction in the daily cost of electricity. Numerous pricing models have been described in depth, including real-time pricing, day-ahead pricing, time-of-use pricing, and critical peak pricing. XML is used to develop the client interface data model for energy usage. In addition, there is a comparison of actual and predicted expenses, as well as the peak hours of energy use (i.e., peak hours) [14]. The Home Energy Management System (HEMS) test bed is intended to enable the testing of different home energy management systems [15]. The simulation model indicates that it is feasible to establish flat rates by generating the load profiles of individual homes (see [21]). This article investigates the effect of variable rates and energy-efficient household equipment on the monthly electricity cost of a family. The cost savings estimates for utilities and other costs are derived from field experiments [16]. Users might save money by reusing the functions of different items of domestic equipment. The load curves for working days, Saturdays, and Sundays are provided here. A side-by-side comparison is made between the load curves for flat rates and time-based tariffs. This study's findings provide light on how hypothetical pricing changes can influence consumers' purchase choices. As described in [22], an ARIMA model that accounts for the likelihood of forecasting mistakes may be used to predict the short-term price of energy. Using data from the California electricity market as historical input, the ARIMA model is used to examine daily average prices. Here are graphical depictions of both single and double

error predicting curves. In order to make a price estimate for the state of California [19], statistical metrics such as the mean, variance, Mean Square Error, and Maximum Absolute Error are provided after two error corrections. Utilizing the European Energy Exchange's data, [20][26] was able to anticipate the spot price of power. It was determined that modeling the experiment yielded the most accurate findings. The maximum and average absolute percentage errors produced by the model were rounded based on the data. This study considers information from the Spanish and Californian marketplaces [27]. To assess the differences between the two markets, the ARIMA model was used. Using time series analysis, the prediction powers of the model are shown. The projections for the Spanish market take five hours, but the forecasts for the Californian market take just two. The approach used by the Provincial Electricity Authority of Thailand to project monthly energy data deconstructs trend cycles and seasonal trends. You may find this information in the report. In time series forecasting, the decomposition approach is used; the accuracy of fitting is assessed using correlation coefficients and mean absolute percentage errors.

4. Discussion

It is a case study in which data analysis is conducted using a specific research approach. We took a number of processes while conducting the case study we used for this study. The necessary activities are as follows:

In the early phase of our research, a regional energy supplier who requested anonymity supplied us with information from smart meters. This data has been forwarded to our management.

The supervisor of our team shares this information with us so that we may independently study and evaluate it. Since the information acquired by smart meters is given by a utility company, it may be depended upon.

There were Microsoft Excel spreadsheets included with the material that was sent to me.

In order to comprehend the real data from the smart meter, a fresh Excel sheet must be created. It has been organized on a sheet from 1:00 a.m. to 24:00 a.m. in terms of time, price, energy consumption, and cost, as well as the lag 1 autocorrelations and correlations of each variable. This was accomplished with regard to time, cost, energy use, and expense.

Graphs demonstrating time vs. consumption (kWh), price, cost, and cumulative cost are generated with research-derived data. On the x-axis and y-axis, respectively, graphs illustrating time consumption, price, time cost, and time cumulative cost are shown.

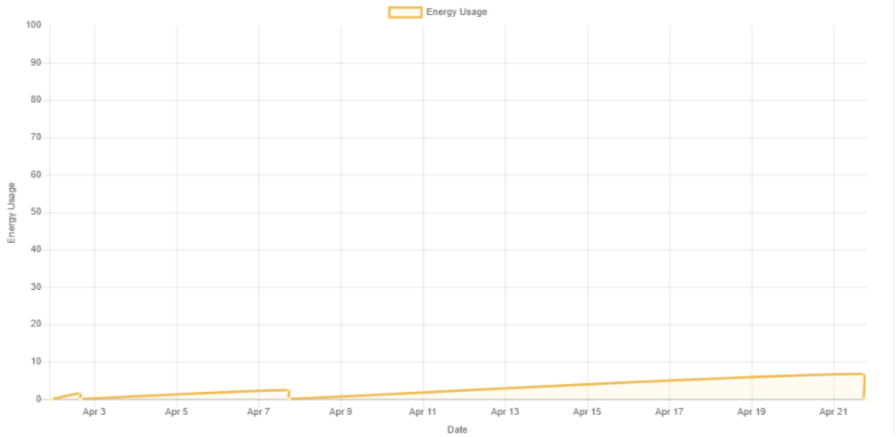

Figure 5: Time range of energy consumption

Correlation is one of the most essential statistical measures for examining the connection between two variables. It is possible for the value to go from +1 to -1. There are two unique kinds available. It is said that the correlation between two variables is positive when one variable drops and the other one rises. When this happens, the connection between them is said to be moving in the same direction. In terms of statistics, the number +1 [29] denotes the highest possible positive correlation. When one variable decreases, the other variable increases, and when one variable increases, the other variable decreases, we get what is known as a negative correlation between the two variables in issue. A negative correlation in statistical analysis may have a maximum value of -1. In addition, correlations between price and cost, consumption and cost, as well as averages, standard deviations, and coefficients of variation are calculated.

February 28, 2019 23:56:34	798.00000000	BDT667.00
February 16, 2019 00:00:00	60.00000000	BDT72.00
February 15, 2019 00:00:00	42.00000000	BDT8.00
February 14, 2019 00:00:00	40.00000000	BDT32.00
February 13, 2019 00:00:00	32.00000000	BDT4.00
February 12, 2019 00:00:00	31.00000000	BDT24.00
February 11, 2019 00:00:00	25.00000000	BDT20.00
February 10, 2019 00:00:00	20.00000000	BDT8.00
February 9, 2019 00:00:00	18.00000000	BDT4.00
February 8, 2019 00:00:00	17.00000000	BDT4.00
February 7, 2019 00:00:00	16.00000000	BDT12.00
February 6, 2019 00:00:00	13.00000000	BDT12.00
February 5, 2019 00:00:00	10.00000000	BDT8.00
February 4, 2019 00:00:00	8.00000000	BDT8.00
February 3, 2019 00:00:00	6.00000000	BDT8.00
February 2, 2019 00:00:00	4.00000000	BDT8.00
February 1, 2019 00:00:00	2.00000000	BDT8.00

Figure 6: Usage timetable

This process is performed everyday for the whole month for each individual family. This trend is seen in each of the sixteen distinct families. To complete the analysis, an additional classified sheet is required. As a result of the investigation's success, we gave those sheets a moniker that related to the home represented by the number 1. This determined sheet was used to compute the actual cumulative cost, the average cumulative cost, and the difference between the average cumulative cost and the actual cumulative cost.

Since it is predicted that a positive correlation between price and consumption would lead to an increase in the cumulative cost, the correlation between price and consumption is explored. By comparing the hourly rate to the average cost of the service being rendered, this indicates the circumstances in which customers are placed in a disadvantageous or advantageous position. Both the connection and the difference are shown on separate plots. The first graph illustrates the number of days on the x axis and the connection between price and consumption on the y

axis, while the second graph depicts the actual cumulative cost vs the average price and the number of days as difference graphs.

The cost is determined by adding the purchase price to the total amount of energy used. We use the numerous monetary denominations as a unit of measurement. Since p is the cost per KWh given in monetary units and e is the amount of energy utilized in KWh, we may conclude that c = p. Following a thorough examination of the data, the following visualizations have been created. As they add to the overall persuasiveness of the information, the chosen images will be included in the final report.

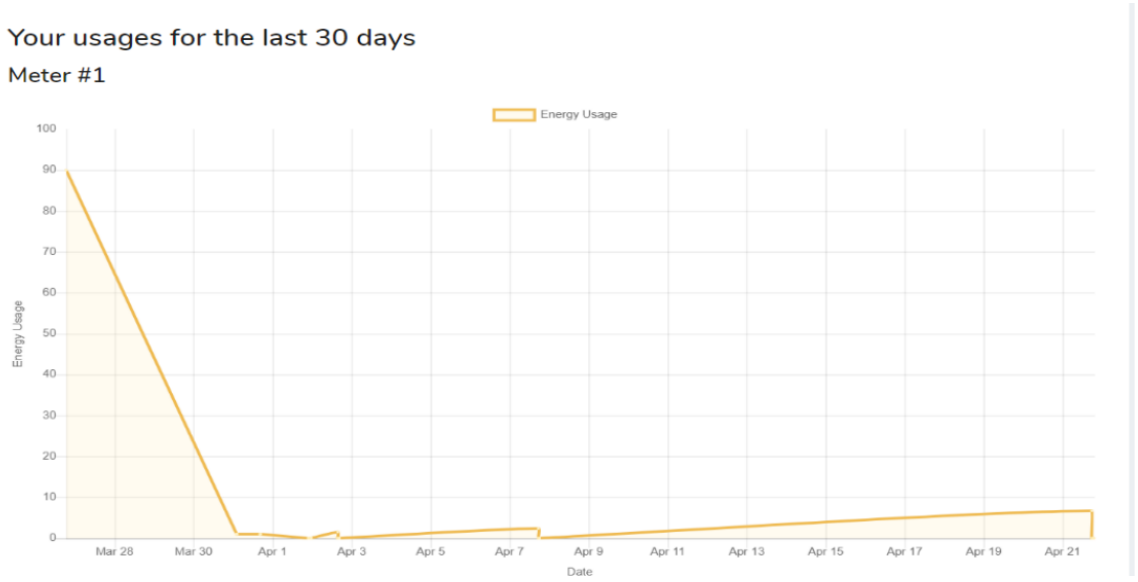

Figure 7: Final report of the energy usage

In terms of their energy use, the families shown in the following graphs consume 24 hours' worth of kilowatt-hours every day. The y-axis of the graph that follows shows price, while the x-axis represents time (24 hours). This graph compares the expenses and prices of different households.

5. Conclusion

The models and research presented in this study have the potential to convince users to alter their patterns of consumption and to make better use of the funds that are available to them. In this section, the findings that were obtained from the investigation into the research questions are presented. When conducting data analysis, Excel spreadsheets are used to perform calculations such as correlation, autocorrelation, and standard deviation. The process of hourly billing and the capacity to make cost reductions both make use of cross correlation in various ways. An uncomplicated examination of the structure, accompanied by an original statistical presentation, has the potential to put the reader in the limelight by drawing attention to them.

6. Acknowledgements

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