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Developing a Decision Support System for Extracting Knowledge to Improve the Quality of the Production Situation by Focusing on Big Data in Industry

Seyed Amin Fahimi[a], Ebrahim Esmaili[,b*]

[a] *Faculty of Engineering, Islamic Azad University, Mahdishahr Branch Mahdishahr, iran.*
[b] *Faculty of Economics, Management and Administrative Sciences, Semnan University, Semnan, Iran.*

Abstract

The use of energy in industry affects every single citizen directly through the cost of goods and services, the quality of manufactured products, the strength of the economy, and the availability of jobs. In addition, big data and analytics play an important role in the way of using energy in different industries. Therefore, the purpose of this paper is to extract knowledge from big data of industry by using a decision support system. The mentioned data which acquired from IOT sensors is used to improve production situation. This post-processing information, with the help of a decision support system provide valuable information for the manager in their decision-making process. The proposed system of this research can be used by managers even without the technical knowledge in order to produce better quality product with lower cost and usage of energy. Due to the growing trend of industries and their competitiveness in the world and especially in Iran, companies must pay attention to quality of production, lowering costs and reducing energy consumption in order to maintain their position and stay in competitive market. Thus, considering the purpose of this research, HORMOZGAN cement company from Iran has been studied as a case study for the implementation of the mentioned system of this research. MATLAB software is used for design GUI of this system. As a result of this research, the electrical energy data received by IOT sensors created the opportunity of the knowledge extraction. A complete set of reports, the analysis of data in dashboards, process of optimization and long-term planning and using what-if analysis are some

*Corresponding Author: Ebrahim Esmaili
Email address: seyed.amin.fahimi@gmail.com, e.esmaili@staff.semnan.ac.ir (Seyed Amin Fahimi[a], Ebrahim Esmaili[,b*])

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capabilities of this system. The results of this system compare with current method in HORMOZGAN company indicates improving quality of production, cost reduction, lower energy consumption and better planning.

Keywords: Internet of things (IOT), Big data, Decision support system, Extracting Knowledge, Energy reduction.
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1. Introduction

With the rapid growing of science and technology in recent years, especially in the cloud computing, networking and the mechanization industry, a new phase of the Internet technology is appeared. The Internet of things (IoT) is the extension of Internet connectivity into physical devices and everyday objects. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled. In recent years, by definition of the industry standard 4.0 which is included in 9 sections, one of this section, which is the Internet of Things and big data, the rapid growth of this tool in the industry and business is observed. Raw data is collected by Internet sensors and these raw data which are stored at different intervals can be stored on the Internet or stored on social networking platforms. The big data itself does not have a high value; the core value of these data can be displayed when it extracted in knowledge form from these information and data. Considering this issue which this study does not fully examine the available data, it is expected to increase the efficiency of this technology by analyzing these big data produced by the Internet without direct human intervention.
One of the challenges ahead in researching this issue is to study big data with a high number of records. These data often have defects, such as noise or damage. Also, many of these data exist in different databases with different standards, and in many cases, even their format is different. One reason that industry and industry-related companies have not been able to use these resources is the lack of familiarity and the traditional use of data, which they only use them in specific areas such as everyday routine traditional tasks. The purpose of this research is to analyze the data, to make changes in the views of managers and improving production quality.

2. Literature review

Many researchers have been considered the role of technology such as IOT in the improving quality of production in industries, for example Aly et al. [1], in their research, introduced big data as an intriguing hidden information that needed this valuable information to be extracted from these bulky data. In the new techniques of large-scale data development, valuable data can be obtained by analyzing data. Also, this research addresses the challenges and techniques of solving problems on the Internet with objects and big data and discusses them and their structure. At the end, the researcher addresses the problems that increase the amount of data, including heterogeneity of data, noise data, privacy and security issues, and solutions.
Behera et al. [2], carried out a study to improve and collect information as big data, based on the fact that its data is extracted from the Internet by objects and sensors related to them, requiring that a proper public structure for the use of Cloud computing and massive data are introduced to improve storage as well as data analysis. At the end of this research, they concluded that if they wanted to accept the Internet as objects as reality, this is not feasible except by using big data and a cloud computing model.

In addition, Over the past decades, a large amount of data has been produced by Internet devices, which are not useful without analysis. Marjani et al. [3] deals with the relationship between big data and the Internet of Things, as well as a new structure as Internet data of objects, and discusses its types, methods, and data technology on big data as well.
Sun et al. [4], indicated Internet capability for providing a comprehensive network of communications devices and smart sensors for integrated and intelligent communities, as well as analyzing large potential data to move objects from the Internet to optimal control for intelligent and intelligent communities. Therefore, a case study on the Internet of objects and the analysis of big data for intelligent tourism and sustainable cultural heritage in the city of Trento, Italy has been studied in the field of tourist industry. Cai (2017) explored an application framework that deals with the acquisition, management, processing, and exploration of big data on the Internet, and then the same research in the Internet application of the objects examined, as well as the challenges and opportunities associated with bulky Internet data of objects is detected. Khan (2017), addresses the challenges and opportunities of bulky industry data in the industry shown in Industry 4.0 , With a different perspective.
Lade et al. [5], addresses the new set of analytic challenges. Unlike data analysis, traditional data, which includes a dense data set, takes on the production of bulky data sets. In addition, previous approaches were limited to analyzes in short data periods. The latest advances in large data analytics allow researchers to study bulky data over a long period of time, for example, for years to come. This paper provides some details on the challenges and methods of data extraction, modeling and visualization.
McNeil et al. [6], examines cement factories that use objects of the Internet technology. He points out in his research that the introduction of this information technology without the need for user interaction is possible. As an example of Internet devices, objects at the cement plant include thermostats (heat setting devices), rings, security cameras, industrial control machines. The local network industry and Internet connectivity control system have been developed to improve the visibility and impact of the production system in the cement industry as well as automation, resulting in great success in adaptability and efficiency. This efficiency has been linked to a large number of automation systems that extend to different parts of the plant.
Xu et al. [7], explores current research on Internet of things, powerful key technologies, Internet applications for objects in industries, and identifying research trends and challenges. The main contribution of this research is to systematically review the current state of the Internet of objects in industries. First, the models of the underlying and service-oriented architecture of the Internet introduce objects and then discuss the basic technologies that may be used on the Internet , and then some of the key industrial plans for the Internet of things is introduced.

3. Research Methodology

Decision support systems are the key term for any kind of computer-based and data-driven software that manages and supports decision-making. Basically, the flow of data from multiple sources is evaluated by models in a computer software. Data flow is usually obtained from databases and results, for example in the form of a report that is displayed in a proper manner to the user. Analysis can be defined as a combination of form-based, lessons learned, predictive models, and quantitative analyzes that are mainly used to support decision-making algorithms. In this way, analysis is part of every step, and this shows how the algorithms may work. Inside the Internet-based object ecosystem, real-time analysis and evaluation of data, including archival data from the database, is performed to achieve the best results.

At the moment, there is no standard for Internet of things model. Since Cisco is one of the most prominent network equipment manufacturers, the company's proposed template which can be used to display Internet of things levels in a visual model. The Internet of things Reference Model of Cisco is based on the flow of information (in both directions) and may be considered as a base of the understanding of the levels and the potential of Internet of things communications.
Level 1: Devices with specific sensors are not limited in any way. They produce data and can be controlled.
Level 2: Communications network creates communication between devices, other networks, and level 3. This is done by encryption, switching and routing.
Level 3: Data is converted to data storage by analyzing filters. The analysis is, for example evaluation, formatting and reduction.
Level 4: Data is stored and ready for use.
Level 5: Data is transmitted and merged into other formats so that applications can use and read them. This means they have information at the moment.
Level 6: Information is interpreted by the specific software used.
Level 7: Processes and individuals are delivered on the basis of information to carry out actions and implement them according to needs.
Therefore, by using this model, the investigation of Internet of things in Hormozgan Cement Company was also conducted, and all the steps were accordingly. Finally, as indicated in Figure 1, the stages of this research are:
In the first step, the data is received through the devices and environmental sensors, which this stage requires examinations, such as security, connectivity and accuracy on the data obtained. This information is collected by passing through these filters through the internal network in the database as big data. At this stage, four characteristics are examined:
First: the size of the available data
The input data transferred to the big data warehouse is considered in terms of volume and size.Second: the diversity of data
The data transmitted can be of great variety. These data are provided from different sources and environments, by using variety of sensors, also their structure and formats may vary. Thus, it is necessary at this stage to investigate and analyze these data.
Third: the accuracy of the data
Due to the presence of noise as well as the environmental conditions that exist in different factories and industries, the accuracy of this information should be verified and preventing the transmission of incomplete, incorrect and inadequate data to the database. Therefore, at this stage, the accuracy of data will be checked.
Fourth: the value of the data
Due to the fact that the data in the database is prepared from different parts and there is a great variety, it is necessary to be valued that in the next steps it will be determined by the same valuation for the decision of the priority and importance of the data.After passing the data collection process on the Internet and collecting this data in the database, using this data, which is now being converted into information, requires the use of this information to help managers. Therefore, it that can be used to help them in their decision making using the decision support system (DSS) .
The Decision Support System (DSS) of this research is consists of five stages:
First stage : Define Problem
It is necessary to define the process and problem that want to decide on it, and at this stage all the hidden factors are addressed.
Second stage: Development of operational alternate phases

After defining the purpose of decision making, all existing solutions for the decision-making system must be defined so that the system's choices are scientifically and operationally evaluated.
Step Three: Select the best solution
After defining the solutions in the system, the analysis of these solutions has been conducted with attention to the affecting factors in a real problem, also the use of existing information that has been taken from the environment by Internet of things. Finally, the best solution is supposed to select .
Step Four: Review the selection
In order to increase decision accuracy, decision is made, or the approved solution is re-evaluated using rules and strategies for the second time.
Step Five: implementation
At this stage, the solution is presented to senior executives of the company and, if it is decided, it can make a change in the system conditions after the user's approval is implemented.

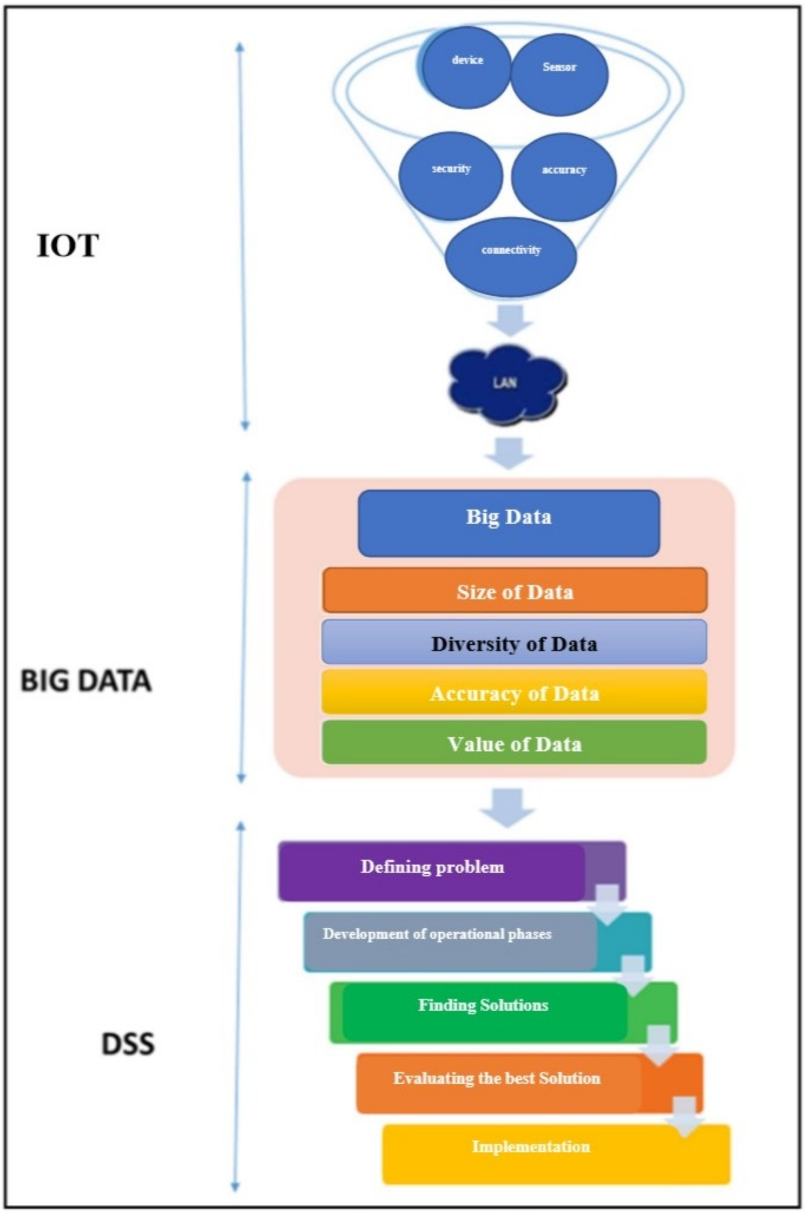

Figure 1: Conceptual Framework of this research

The main achievement of this research is to propose a decision support system that is unique in its nature. This part of the program that is used by the CEO or other managers of different parts of company is designed as user friendly as possible whith following capabilities:
1- Indicating the proposed table for special day with features
2- Displaying the average performance of different departments as dashboards for the user
3- Capability of displaying the operating information to the required hour for each device
4- Extracting knowledge from the proposed plan, where the text is displayed as an alarm for the manager, which gives the manager a general reason for the proposed plan.

4. Results and Findings

In this section after examining the practical steps of the cement production process, the process of providing final information for the developing of the decision support system is expressed and finally the proposed system, using the MATLAB software is demonstrated and explained how the knowledge is extracted to improving the quality of production.
In general, the cement and clinker production process is divided into four sections as follows:
1- crusher (crushing)
2- Milling materials
3- Furnace process
4- Cement mill
In addition, the process of forming information to provide a decision support system is as follows:
1- Energy Information Survey
2- Investigation, normalization and analysis of Big data. Figure 2 indicates an example of the departmental data surveyed.

Figure 3 also indicate the monthly energy demand report for the department of cement mill 2. Following Figure also indicates daily energy demand report for the department of crusher 1:
3- Review existing information and conditions for reaching the decision support system.
For better design of the system, it is necessary to study more on factors affecting energy consumption, production and cement production processes.
Considering this issue, the best way to get these facts is to get information from the experts, with various interviews with different mangers and experts , including the highest level of management of the company , operational staffs, factory engineers the following facts are extracted:
1. Stoppages must be based on principal and regular, these stoppages must be planned.
2. In the standby time, the machines may not work, but connected devices and machines have to work and this will increase the energy consumption without producing. (Some machines cannot be turned off and should be constantly on)
3. The time of entry of raw materials and its input volume affects energy.
4. The main engine of the crusher is one of the largest fossil fuel consumers.
5. Frequency converter influences energy consumption.
6. The clinker cooling process has a high energy consumption in the furnace department.
7. Calculating and applying the optimal departmental. The lower the amount of energy consumed per unit of product, the better economic efficiency of the product, and therefore the SEC is compared to the similar industries in the standard.
8. Detection Hours Departed: There were no production hours, but the department was active for repair purposes, for example.
9. Study the effect of applying the optimal work point for each department. Electromotor behavior: Electromotors used in industry are designed with optimum efficiency in nominal power. The optimal

Date	DepCM3	AvrCM3
2014 April	Cement mill 3	44.2910
2014 May	Cement mill 3	45.7608
2014 June	Cement mill 3	33.1371
2014 July	Cement mill 3	35.3279
2014 August	Cement mill 3	37.5334
2014 September	Cement mill 3	34.9214
2014 October	Cement mill 3	35.0219
2014 November	Cement mill 3	36.5629
2014 December	Cement mill 3	35.3014
2015 January	Cement mill 3	36.0829
2015 February	Cement mill 3	33.6595
2015 April	Cement mill 3	41.7479
2015 May	Cement mill 3	48.1235
2015 June	Cement mill 3	39.5001
2015 July	Cement mill 3	39.7396
2015 August	Cement mill 3	38.7002
2015 September	Cement mill 3	39.9247
2015 October	Cement mill 3	34.6126
2015 November	Cement mill 3	14.5122
2015 December	Cement mill 3	35.6208
2016 January	Cement mill 3	32.1438
2016 February	Cement mill 3	0
2016 April	Cement mill 3	0
2016 May	Cement mill 3	40.7758
2016 June	Cement mill 3	43.3641
2016 July	Cement mill 3	38.4031
2016 August	Cement mill 3	40.0337
2016 September	Cement mill 3	42.6481
2016 October	Cement mill 3	47.5115
2016 November	Cement mill 3	35.0246
2016 December	Cement mill 3	36.9987
2017 January	Cement mill 3	36.9351
2017 February	Cement mill 3	38.6628
2017 April	Cement mill 3	41.6742
2017 May	Cement mill 3	44.8283
2017 June	Cement mill 3	50.3778
2017 July	Cement mill 3	40.4172
2017 August	Cement mill 3	43.4793
2017 September	Cement mill 3	41.7470
2017 October	Cement mill 3	47.1496
2017 November	Cement mill 3	41.2717
2017 December	Cement mill 3	45.4038
2018 January	Cement mill 3	39.4904

Figure 2: Sample of department data surveyed

work point in each department will occur in the optimal SEC, which means that the electromotor operates near the work point.

10. Application time management plan: Due to the fact that intermediate, peak and low tariffs are different, one of the ways to reduce electricity costs is to shift costs from peak to midrange and low load.

11. High-power motors are used for jobs that require less power and can be used to reduce energy consumption by replacing these motors.

12. On the conveyors, the weight sensor is installed, so that if the raw material, such as large rocks, is not resting on it, this will reduce energy consumption.

13. Upgrading equipment that works with new technologies. These devices are designed to work less energy efficiently.

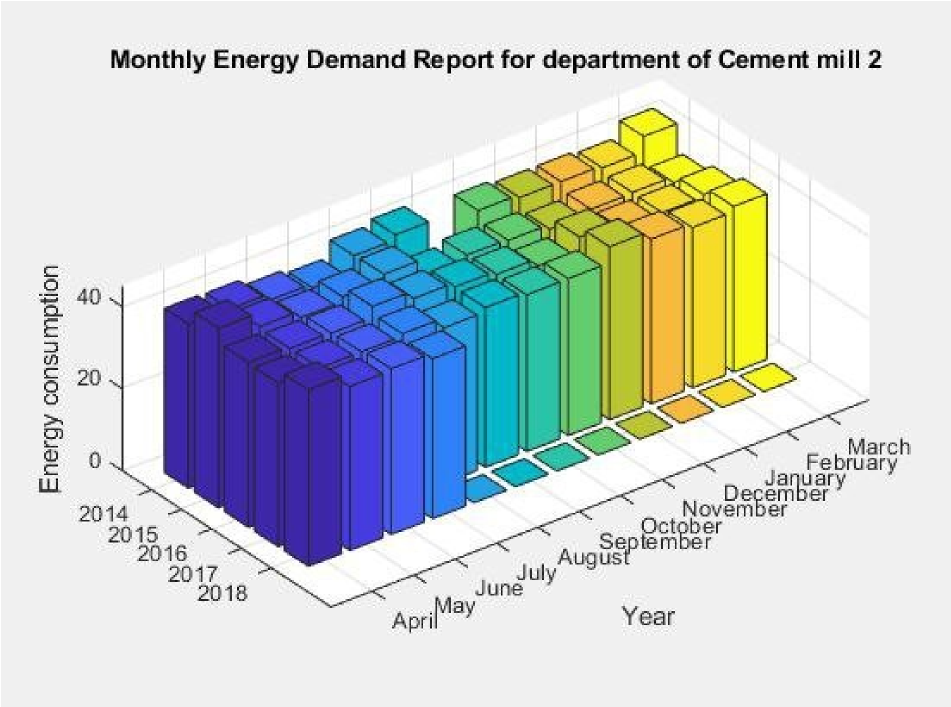

Figure 3: monthly energy Demand report for the department of cement mill 2

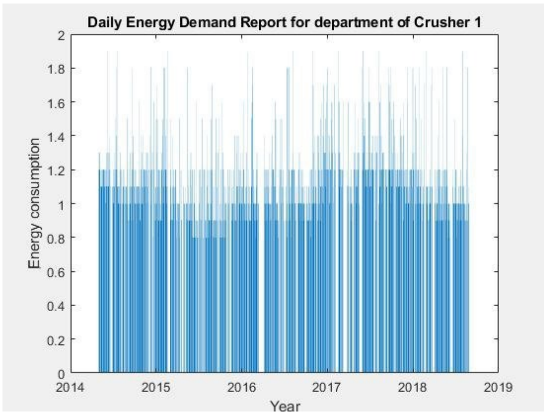

Figure 4: Daily energy demand report for the department of crusher 1

14. The lighting and wiring system is changed; the lighting paths can be intelligent and only light on.
15. Energy expenditure coefficients ranging from 11 o'clock to 6 o'clock in the morning to 0.25 o'clock and 6 o'clock to 7 o'clock as a low load with a coefficient of 1 and peak hours from 7 o'clock to o'clock 11 nights is calculated with coefficient 3.3.
17. Old electrical panels replaced with new electrical panels. Old and depreciated electric appliances have high consumption and high energy consumption.
18. Use of gas instead of mazut (although this option will lower energy costs)
19. How to produce and manage it can reduce energy consumption. A good production manager can produce at a lower temperature, which reduces energy.
20. Dust is not good in the process of production of cement . In the cement factory, after the production of clinker and the production of cement, a lot of dust is produced from the furnace to

the exhaust air. By controlling the dust and preventing its release, we can increase consumption and control the energy consumption.

21. At the peak of energy consumption or consumption peak, devices should not be used because they have a very high cost.

22. The sampling unit consists of several departments that carry conveyor material that uses many engines to the departments but is reduced by installing an analyzer. This department and all its equipment and motors that consume energy from Exit.

23. There are waste in the mine that by choosing the right mine, we can reduce the energy used to remove the waste.

24. Due to the specific soil material that is powdered, using a sieve can be used with less power crusher, which reduces energy consumption.

25. Due to the fact that, the system is closed, and all material transfers are carried out by air suction, preventing leakage of the air will reduce energy consumption.

26. Since the burner system of the department has been around for 20 years, the use of torch systems can reduce energy consumption.

27. Crushed stone can only be used from 6 am to 11 pm, because the contractor for this part only works during these hours.

28. The design of the plant's Imperator fan is about 20 years ago, which can reduce the energy consumption of the fan impeller if new designs are used.

29. The use of new additives in the cement mill will reduce the friction energy of the cement and consequently the energy consumed by.

30. By changing and designing the shape of the cement mill armor, you can reduce energy consumption per tone of cement.

31. The furnace heat output of the furnace can be used for energy production (energy recovery), power generation (turbine), or even use in the production line to preheat materials.

32. For sensitive equipment, instead of using ordinary UPSs, modular UPSs can be used. These UPSs, as much electricity as possible, now adjust their power levels and all the time with Full power is not working.

33. Updating computers from desktop to All in One, which reduces power consumption by up to 5 times.

34. Corrupted parts in the system create a lot of load. Eliminating these failures and lubricating devices can reduce energy consumption.

35. Devices with high vibration increase energy consumption. These devices should be vibrated.

36. Stopping devices that work in parallel, which in most cases are considered as a tugboat.

37. Insulation of material passage ducts due to the lack of heat loss and no need for more heat, which reduces energy.

38. The average monthly consumption of departments can be used to determine the amount of labor consumed by the devices so that we can use the devices that are less consumed.

After acquiring consulting from different aforementioned experts, the following DSS is developed to solve the mentioned problem and improved the quality of production. Following figures indicates different phases of proposed Decision support system of this research.

Figure 4, 5 and 6 indicate Analysis, DSS and Report interface of this system accordingly.

The process of What-IF analysis and extracting knowledge is indicated in Figure 7.

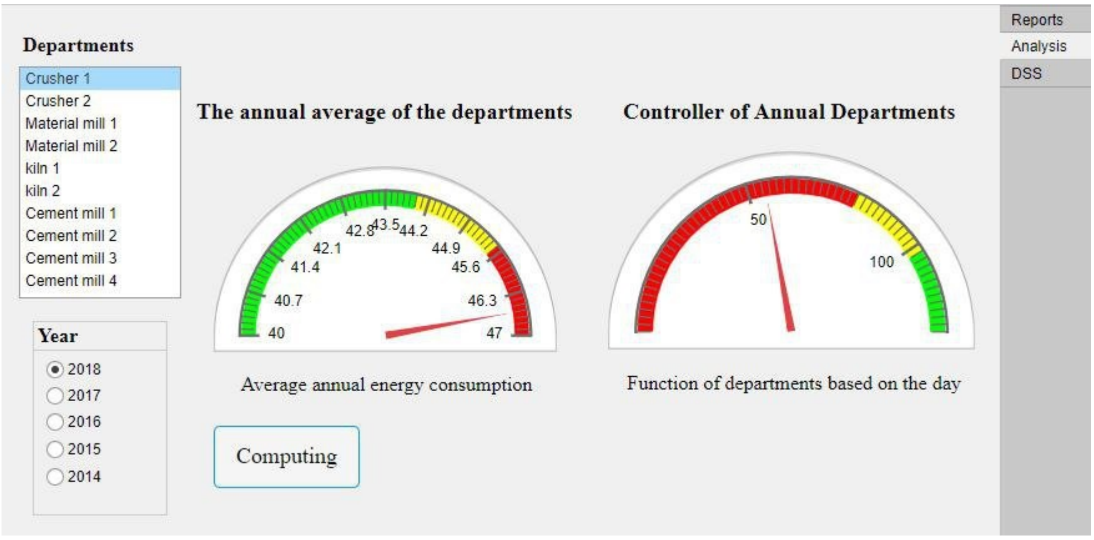

Figure 5: Analysis Menu interface

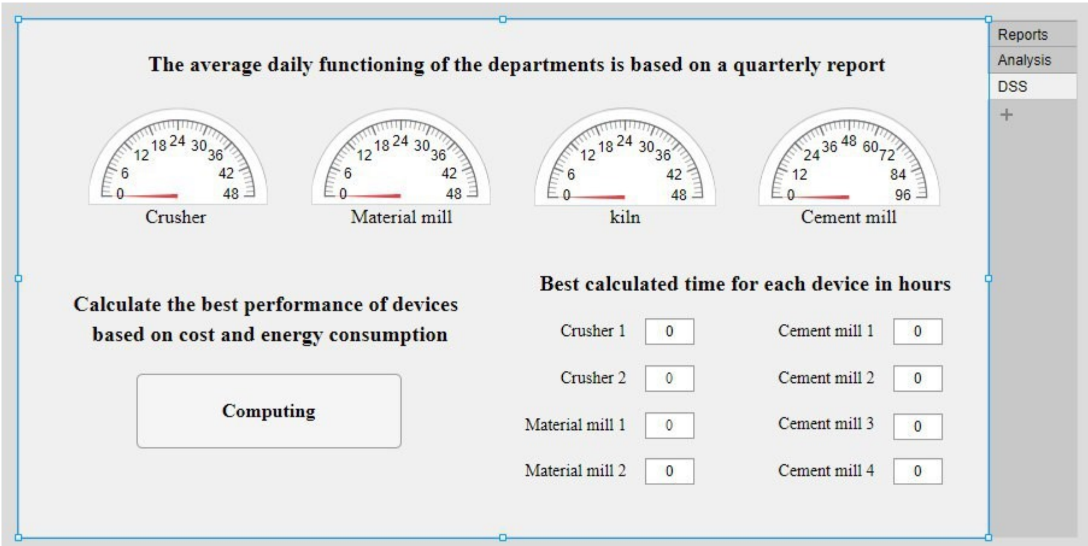

Figure 6: DSS menu interface

5. Conclusion and Discussion

This research seeks to extract knowledge to improve the quality of production by focusing on the big data extracted form IOT sensors in the industry through the developing a decision support system. Various data is obtained by sensors of IOT, including the weight of trucks at loading time, electrical energy consumption, the weight of materials produced in different departments, the weight of the product, and other data which these data are based on sensors on and stored in the local database. After analyzing the initial data, it found that the best focusing part for this research for improving quality situation is the use of electrical energy data. The accuracy of this information is more than all of the same data and has a great impact on the production and cost of the plant.
Therefore, after collecting data of 52 previous months of company operation, it found that the volume of data was very high due to the time spent in the 4 departments, which included 10 units. These data are aggregated departments per hour and per day. The main reason was the need for decision support system to be designed and provide information on a daily basis. In the next step, initial

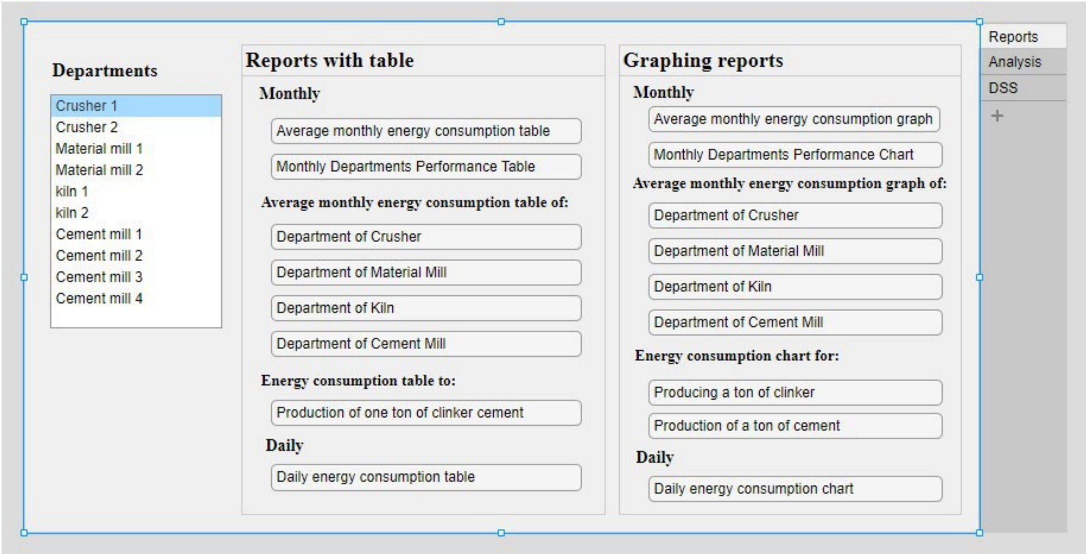

Figure 7: Report Menu interface

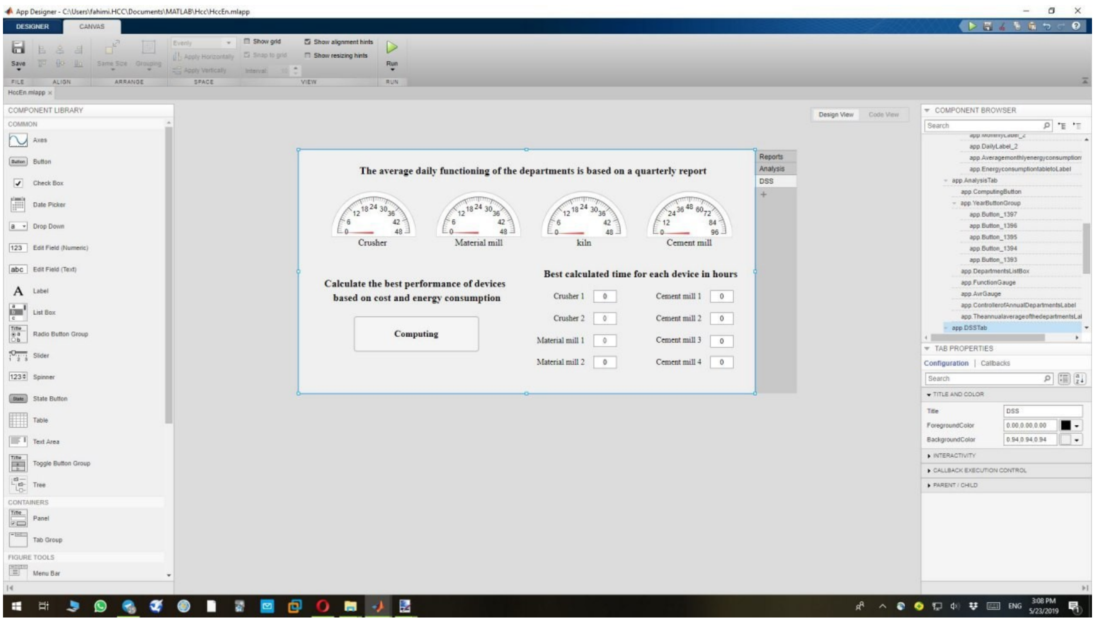

Figure 8: What-IF analysis in DSS

data investigated, in the error or noise is eliminated from data, by normalizing these data.
In the next stage, it used the experiences of experts and managers of different departments, factory directors and specialists, by interviewing and observation. Therefore the main base and conceptual framework of developing a decision support system is created after these stages.In addition, since the main objective of this research is to improve the quality of production, by reducing the amount of used energy and therefore decreasing the energy consumption costs, the analysis part focused on what-if analysis technique and knowledge extracted from this and previous mentioned stages. The developed system includes functional reports, analytical sections, DSS section and knowledge extracting section.
This research is the beginning of a way that can be continued in different fields in different ways. The proposed suggestions are presented in various areas as follows :

1. This research has been conducted on the use of electrical energy that can be considered in total energy consumption.
2. This research does not focus on increasing the volume of production during the optimal use of energy, which can be considered by future researchers.
3. It is possible to predict future energy consumption using different algorithms, such as neural networks, genetic algorithm or other techniques which has not been investigated in this study.

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