Specialized and research articles

Modeling for Energy Saving by Web-based GIS

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Abstract
Quick turn-based geo-reference information is a new technology that has a positive impact on the performance and efficiency of facility systems including Heating, Ventilating, Air-Conditioning & Refrigeration (HVAC&R's). The technology of signal detection through remote reading system, provide the management of facility HVAC&R through the geo-reference world area network (Web-based GIS) based on geographic information system (GIS). This method as a new concept in the control science and optimize energy consumption can be an effective factor in design, maintenance, energy consumption management, and commissioning of the facilities and building industry. Also, this method provides online control of energy consumption of the facilities and building industry. So in this work, the model of control of HVAC&R in the context with GIS and Web-based GIS were investigated. The empirical results besides the regression mathematical analysis show that this model is able to predict and evaluate energy consumption.

Key words: Geographic Information System, Energy Saving, HVAC&R Facilities.

1. INTRODUCTION

The country's mapping organization is the first entity to formally use GIS in our country, in accordance with a resolution adopted by the Islamic Consultative Assembly.

The project for the creation of the GIS began in April 2004 and is currently widely used in connection with its activities. The National Council of Geographic Information System Users was established in January 2008 with the aim of policy making, planning and coordinating GIS activities, needs analysis and utilizing the scientific, technical and human resources capacity to create and deploy GIS in accordance with the responsibilities of the country mapping organization specifically, the creation of national GIS systems.

In the 21st century, the international energy-saving attitude of the international community necessitated the use of GIS in the management of various industries including the thermal, refrigeration and air-conditioning industries:

The Heating, Ventilating, Air-Conditioning, and Refrigerating (HVAC & R) engineering emphasizes on intelligent operation method. So that the installations have the right time, proper operation, useful efficiency and minimum cost. The purpose of operation is to make proper use of the equipment over their useful life. Scientific utilization of the facilities requires updating the facility's map information in the form of GIS. Due to the large volume of exploitation information, while updating the facility map information in GIS format, different data can be extracted in the least amount of time. A robust, efficient database of servers as the primary server can solve many of the problems of social life. If the information about the facility is in the memory of experienced people, it will be out of the system over time. GIS is not just software, but a science that classifies and locates geographic and urban information by different software. This science has recently found its place in urban sciences and is being used by urban sciences and urban planners. The use of GIS in urban development plans by employers is also on their agenda, and the Iranian Urban Development Association has for the first time used GIS in urban development plans, providing training to urban professionals and urban utilities. Therefore, experts should first prepare scanning, editing, and layered facility maps. It also needs to reflect subsequent changes to these maps so that they do not lose their performance over time. Up-to-date facilities

and equipment components are reflected in GIS maps, mainly including:

•Pipes: In the computer maps prepared, the pipes in the grid are carefully updated and reflected on the maps by gender and diameter in GIS format.
•Valves: The location of the valves in GIS format is reflected on the facility maps.
•Meters: The location of metering equipment such as barometers and flowmeters, etc. are reflected in the GIS in the facility maps.
Facility maps are updated to suit GIS requirements and are implemented as follows:
•Exchange graphical information from CAD space to GIS space
•Fixes errors in CAD space
•Convert graphics data from DWG format to SHP
•Completing the descriptive and spatial information layers and fixing the errors in the GIS space (descriptive and spatial).
•Eliminate tolls that are in the wrong place.
•Create primary and external keys for the toll table.
•Creating appropriate tolerances and exchanging effects from spaghetti to topology.
•Preparation of conceptual model for modeling network in GIS space
•Creating a proper ground database.
•Establishment of traceability and execution of facility analysis.

In the management of heat and cooling facilities based on metadata management, the development and application of new and advanced technologies in all areas of software and hardware in the facility can have a positive impact on system performance and efficiency. The application of state-of-the-art technologies such as IoT can also provide scientific guidance and enhance the technical and hygienic safety factor of the installation systems. IoT is a new concept in the world of technology and communications, but IoT was first used by Kevin Ashton in 2007, describing a world in which everything, including inanimate objects, is used to Have a digital identity and allow computers to organize and manage them. The Internet now connects all people, but with the Internet of Things all things are connected. Prior to that, however, Kevin Kelly in his book The New Economic Law in the Age of Networks in the Year 4 addressed the issue of small smart nodes (such as open and closed sensors) that are connected to the World Wide Web. The present study shows that the management of HVAC & R HVAC & R air conditioning installations in the GIS field is a new topic in the field of control and optimization of energy consumption internationally, and awareness of this is especially important for facility engineers [1-5].

2. RESEARCH METHOD

In this research, the role of the rapid flow of location-based information in the management and analysis of data related to the control and optimization of energy consumption through remote reading technology was investigated. Therefore, identifying the types of complications, classes, and subclasses of facilities was on the agenda of this research. Finally, the implementation of these operations led to the introduction of the intelligent facility management model as follows [6].
GIS is a GIS system consisting of data, hardware, software, methods and algorithms, human resources and networks capable of input, management, analysis and display of "spatial information". GIS components include:

• Information - Displays the processed data.
Personnel - Dynamic thinking is the key to GIS power.
• System - Establishes the relationship between software, hardware and data.
• Spatial feature - is a spatial phenomenon.

The World Wide Web is a Web-based GIS, a type of GIS that enables the distribution, sharing, and exchange of data at any time, anywhere, and for any person through the World Wide Web. Therefore, on-line engineers, analyzing on-line data and advanced technology, receive signal error in ozone through remote reading sensor systems and manage thermal and cooling facilities through the World Wide Web. Energy consumption in utility systems (Figure 1-2). Energy management is the science of controlling and optimizing energy consumption through the integration of internet-connected sensor and drive systems and is used to optimize energy consumption. The IoT devices (switches, power media, television, etc.) are integrated and capable of communicating with the utility company to balance power generation effectively and energy consumption. They also give users the chance to remotely control their equipment. The equipment is centrally managed by an equal text interface while enabling advanced programming functions (such as turning on and off the remote heating appliances, controlling the stove, changing lighting conditions, etc). IoT devices can be used for surveillance and the mechanical, electrical and electronic systems used in a variety of buildings (eg public and private, industrial, industrial and residential) in home and building automation systems. There are three main areas covered in this area:

• Integrate the Internet with building energy management systems to create energy efficient and IoT-based "smart buildings".
• Possible ways of real-time monitoring to reduce energy consumption and monitor resident behavior.
• Integrate smart devices into the built environment and how to use them in future applications.

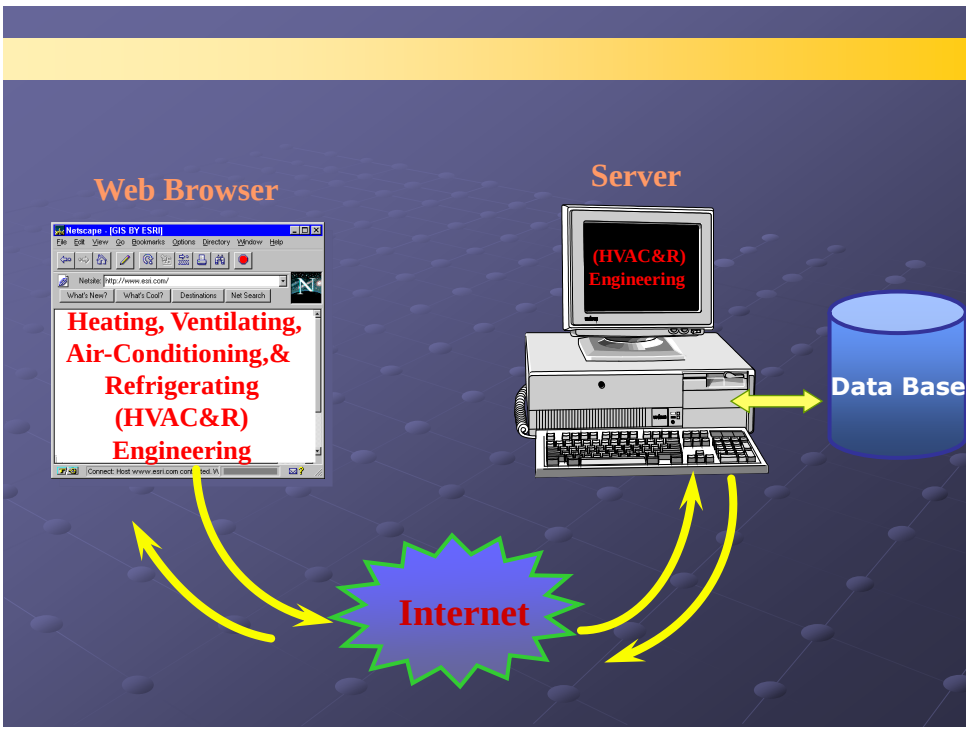

Fig. 1. Managing HVAC & R Facilities through the World Wide Web

Creating Extensions in HVAC & R Installation Software under ArcGIS9-ArcMap software enables troubleshooting and control and optimization of power consumption through the on-line control model and under the World Wide Web (Figure 2-1).

On-line control model to optimize energy consumption while providing the information needed to determine energy intensity: (EUI) Energy use intensity under Web-based GIS can include other features including better visualization of system components; ease of change, ability to filter data for the design (Table 1) provides maintenance, energy management and commissioning of the building and thus compares the intensity of the building's energy consumption while optimizing its energy consumption (Figure 3). The on-line control model for HVAC & R heating, cooling and air conditioning using its and technique information reading techniques and remote control instruments in GIS base for lighting, cooling, heating system, protection system. This operation is at its simplest possible by remote control over a very long distance through the telephone line, mobile phone and internet, tablet and computer. In addition, smart building makes the home modern and comfortable. Constructs will also help save energy if properly designed and used with standard equipment Rejected. With the Industrial Internet of Things in a smart home all the following smart and automatic installations are performed:

• Ability to define intelligent scenarios.
• Load management and energy consumption of buildings.
• Ability to control and execute commands remotely via phone, internet.
• Control of HVAC & R heating, cooling and air conditioning systems

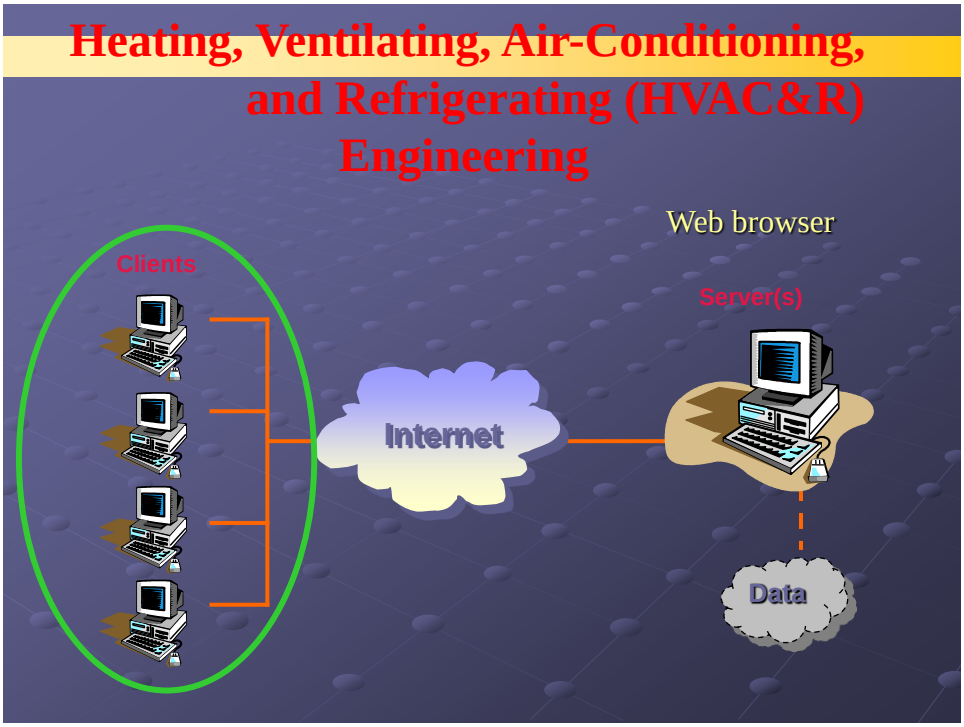

Fig. 2. Troubleshooting Troubleshooting Facilities under the Web Web-Based GIS

Industrial Internet of Things (hereinafter IIOT) is one of the most important and widely used areas of IoT deployment in the HVAC & R HVAC system. The IOT Industrial Objects Internet means using the technology in industrial fields and using it as a smart industrial network. Using IIOT in industrial units, all objects can be connected on-line, creating an integrated network for information exchange, control and monitoring. This technology is one of the five major technologies that will greatly affect the future of industrial automation in all industries as well as in HVAC & R air conditioning, refrigeration and air conditioning systems. The technology will be developed to the extent that it is projected by year 5, and with the entry of large and active industrial automation companies, the market value of the technology will reach more than $ 2 billion [11-13].
In this study, factors such as thermal resistance of walls (Table 1), temperature factor, energy consumption unit were investigated. Taking into account consumption data, temperature and power consumption factors on energy consumption intensity (EUI) factors such as:

Input; Outputs; Efficacy was evaluated by regression model. Factors such as total heat power, occupancy rate, unit income level and unit energy income can increase energy consumption and temperature factor can lead to energy consumption decrease (1-2). In addition, mathematical analysis of the regression model can provide a model for managing energy consumption and saving energy consumption through multi-factor analysis method:
Data Envelopment Analysis (DEA) (Table 1).

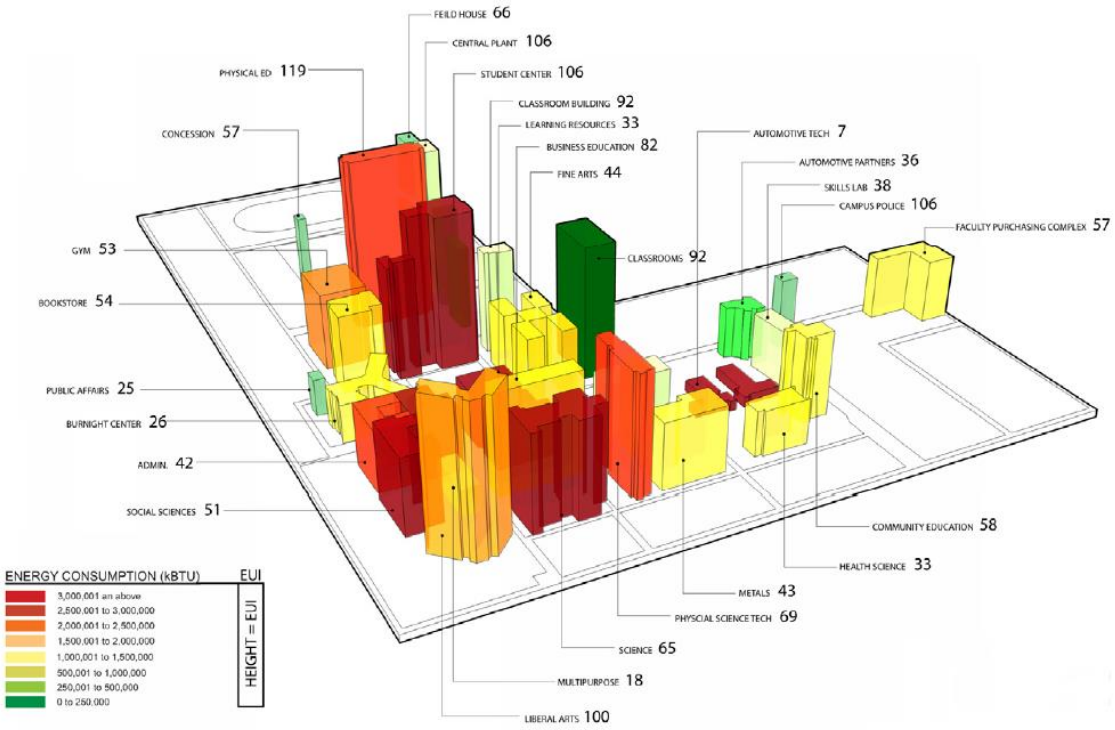

Fig. 3. Comparison of the results of the energy use intensity (EUI) computational model

TABLE 1. MINIMUM HEAT RESISTANCE OF NON-LIGHT TRANSIENT WALL R (M2.K / W)

Group	Group	Group	Building group in terms of energy savings	
1.5	2.1	2.8	Style	Wall
1	1.4	1.9	Heavy	
0.8	1.1	1.5	Adjacent to uncontrolled space	
2.7	3.7	5	Style	ceiling
2.2	3	4	Heavy	
1.7	2.3	3.1	Adjacent to uncontrolled space	
1.6	2.2	3	Style	Floor
1.3	1.8	2.4	Heavy	
1	1.3	1.8	Adjacent to uncontrolled space	
2	2.7	3.7	Peripheral insulation	Floor foam
0.9	1.3	1.7	Insulation all below the surface	

$U = \Sigma / 1R$ (1), (1)

U (W / m2.K) - Heat Transfer Coefficient
R (m2.K / W) - Total heat resistance

$P = U.A.T$ (W / K), (2)

P - Total thermal power
U (W / m2.K) - Heat Transfer Coefficient
A (m2) -Area
T (K) - Temperature
P (W) - Total thermal power

Data Envelopment Analysis Method (DEA)

A Multi-Factor Productivity Analysis method for evaluating the relative efficiency of an instance building by decision makers named Decision Making Units (DMUs). DMU decision units contain a homogeneous set of equipment in which objects are evaluated for performance (1). The purpose of this study is to obtain a building energy efficiency score (Table 2) under the name of a DMU. Regression analysis is a statistical technique for examining and modeling the relationship between variables.

This research is a quasi-experimental study and the researcher intends to use Energy Use Intensity (EUI) in GIS space in Rasht city. The research is conducted by field method using regression analysis. In addition to using regression analysis or analysis of variance, ANOVA and T-test are defined for the research model. The parameters of the regression model are:

-Input EUI (kWh / m2)

-Outputs Percentage of dissatisfied (PPD) DEA Score -Efficiency

The curve of the estimated method, which is the regression test, was thus identified using these data. The model was calibrated using a set of data without changing the parameter values. The research tools used are: Meters for Metering Gas Meters - Meters for Metering Electricity - Timers for Time Logs - CO2 Measuring Instruments. The statistical population of this study consisted of 12 apartments in Rasht city. Research hypotheses are:

Hypothesis One: There is a significant relationship between Input (independent variable) and Outputs (dependent variable):

Output = f (Input)
(Dependent variable):
Outputs Percentage of dissatisfied (PPD)
(Independent variable):
Input Energy Use Intensity (EUI)

Hypothesis Two: There is a significant relationship between DEA and Input (independent variables) and Outputs (dependent variable):

Outputs = f (DEA Efficiency, Input)
(Dependent variable):
Outputs Percentage of dissatisfied (PPD)
(Independent Variables):
(DEA) Data Envelopment Analysis
Input Energy Use Intensity (EUI)

3. RESULTS

In this research, the implementation of GIS and GIS Ready implementation of HVAC & R system maps was performed as follows:

TABLE 2. RESULTS OF THE COMPUTATIONAL MODEL OF ENERGY USE INTENSITY (EUI) IN THE PRESENT STUDY

No.	DEA Efficiency Score	Outputs CO2 [ppm]	Outputs Percentage of dissatisfied (PPD) [%]	Outputs Occupancy Density [Person/m2] [%]	Working time [Hours]	Input Energy Use Intensity (EUI) [kWh/m2]	Building Code
1	0.77	799	17.1	0.2	9	78	101
2	1	866	17.5	0.21	11	80	102
3	0.87	777	33.2	0.2	8	80	103
4	0.43	901	34.1	0.24	7	80.8	104
5	0.73	821	20.8	0.18	9	79	105
6	0.88	920	35	0.2	8	81	106
7	0.71	790	19.9	0.19	7	80.4	107
	82%	43%	77%	42%	39%	1.20%	Difference (%)

• Exchange graphical information from CAD space to GIS space
• Fixes errors in CAD space.
• Convert graphics data from DWG format to SHP.
• Completing the descriptive and spatial information layers and fixing the errors in the GIS space (descriptive and spatial).
• Eliminate tolls that are in the wrong place.
• Create primary and external keys for the toll table.
• Creating appropriate tolerances and exchanging effects from spaghetti to topology.
• Preparation of conceptual model (Table 3-4) for modeling network in GIS space.
• Create the right database.
• Ability to track and execute HVAC & R system analyzes.
• Speed up the handling of HVAC & R system accidents.
• Systematically store and use HVAC & R system information using GIS.
• Economical savings due to the rapid flow of information in thermal and refrigeration facilities management.
• Create maps and reporting on all of the above.
• Regression analysis of facility systems.

Regression is needed for estimation and forecasting in almost every field including engineering, physics, economics, management, biological sciences, biology and social sciences. Regression analysis is one of the most widely used statistical techniques. The use of one variable to perform the prediction for another variable is called regression. Regression using one known and predicted variable predicts the values of another unspecified variable. The rate of change of one variable by the effect of another variable is also called the regression coefficient, which is the amount of change that occurs in the dependent variable by the unit of change in the independent variable. The regression is calculated as one variable and two variables. the door One-variable regression has one independent variable and one function variable, but two-variable regression has one function variable and two independent variables. To begin with, there must be a linear relationship that forms the scatter plot of the original idea. The regression line reflects the trajectory of the total distribution of points in the nominal coordinate system, which can indicate the severity and weakness and the type of correlation between the variables. The regression equation should be used to draw the regression line. In this research, the modeling results (Figure 4-5) are based on the rapid flow of location-based information for the HVAC & R system:

• Designing and implementing an energy module to reduce energy consumption, improve the energy rating of the building and improve the quality of comfort for residents.
• Design and implementation of HVAC module based on simulation of dynamic thermal behavior of building, solar behavior, simulation of central and local control system of mechanical installations.

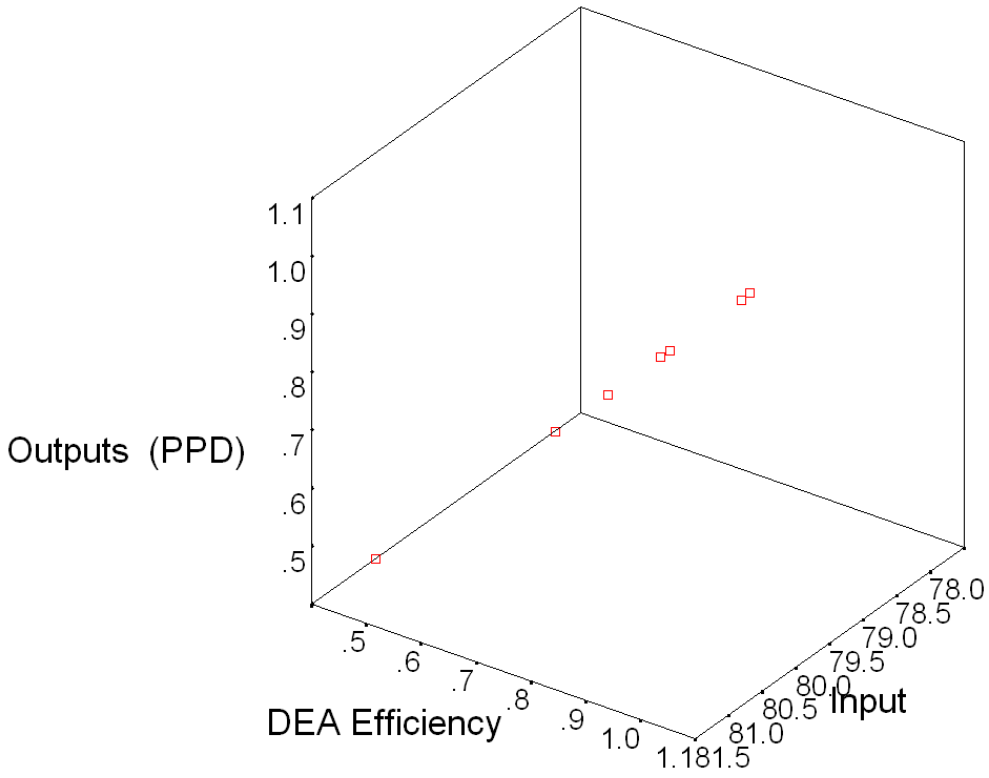

Fig. 4. Energy Intensity (EUI) based on the regression model of the present study

TABLE 3. REGRESSION MODEL IN THE PRESENT STUDY CURVE FIT

Mth	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
LIN	.016	5	.08	.785	2.5086	-.0218		
LOG	.016	5	.08	.788	8.2502	-1.7076		
INV	.015	5	.08	.791	-.9070	133.945		
QUA	.017	5	.08	.783	1.6549	-.0001	-.0001	
CUB	.105	4	.23	.801	-240.06	4.5557		-.0002
COM	.038	5	.20	.677	40.1875	.9514		
POW	.037	5	.19	.680	2.3E+07	-3.9311		
S	.036	5	.19	.682	-4.1690	.0499		
GRO	.038	5	.20	.677	3.6936	-.0499		
EXP	.038	5	.20	.677	40.1875	-.0499		
LGS	.038	5	.20	.677	.0249	1.0511		

TABLE 4. EQUATIONS USING THE OBTAINED REGRESSION MODELS FOR THE PRESENT RESEARCH REGRESSION MODEL

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	a_0	a_1	a_2	a_3
Linear, (3) $\mathbf{y = a_0 + a_1}x$	.016	.08	5	5	.785	2.5086	-.0218		
Logarithmic, (4) $\log y = \log(a) - (b)\log x$	.016	.08	5	5	.788	8.2502	-1.7076		
Inverse, (5) $\mathbf{y} = f^{-1}(\mathbf{y})$	.015	.08	5	5	.791	-.9070	133.945		
Quadratic, (6) $\mathbf{y = a_0 + a_1 x + a_2 x^2}$	.017	.08	5	5	.783	1.6549	-.0001	-.0001	
Cubic, (7) $\mathbf{y = a_0 + a_1 x + a_2 x^2 + a_3}x^3$	.105	.23	4	4	.801	-240.06	4.5557		-.0002
Compound, (8) $\mathbf{A = Ce^{kt}}$	.038	.20	5	5	.677	40.1875	.9514		
Power, (9) $\mathbf{y = cx^p}$	.037	.19	5	5	.680	2.3E+07	-3.9311		
S, (10) $\mathbf{y} = f_0(\mathbf{T, X, U})$	.036	.19	5	5	.682	-4.1690	.0499		
Growth, (11) $\mathbf{(dA/dT) = KA}$	.038	.20	5	5	.677	3.6936	-.0499		
Exponential, (12) $\mathbf{e}^x = \lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$	.038	.20	5	5	.677	40.1875	-.0499		
Logistic, (13) $\mathbf{f}(x) = \frac{L}{1+e^{-k(x-x_0)}}$	.038	.20	5	5	.677	.0249	1.0511		

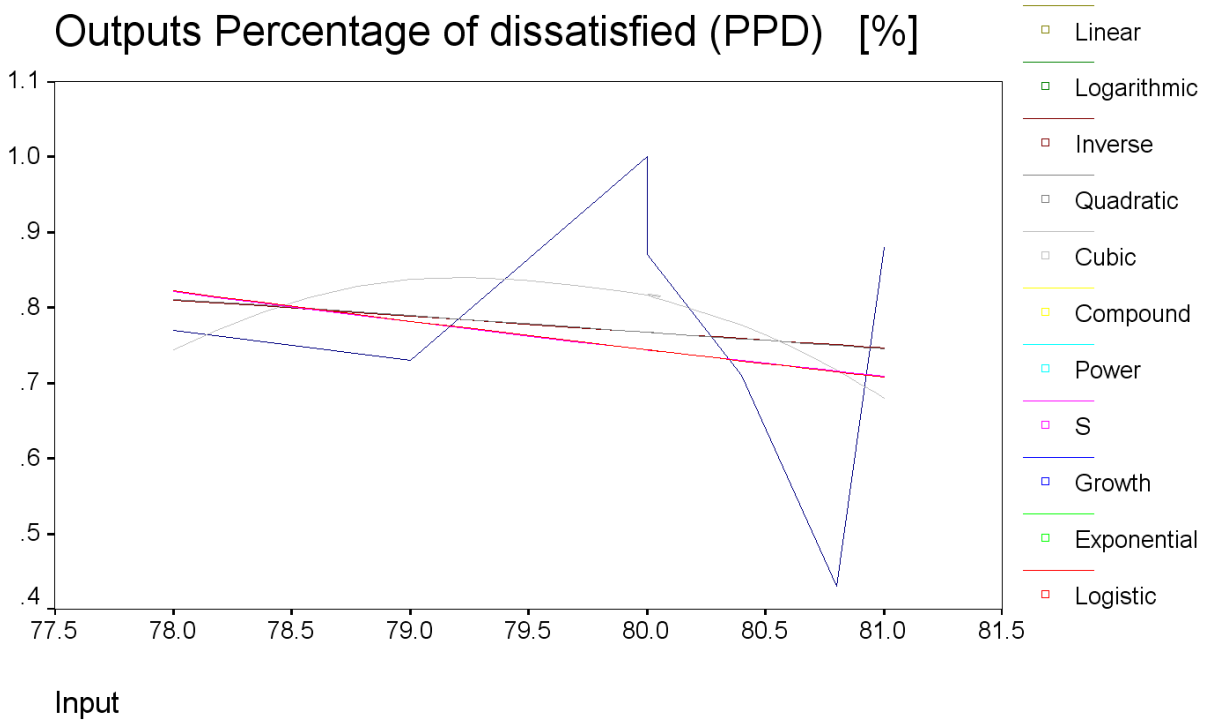

Fig. 5. Disadvantage Percentage (PPD) based on the regression model of the present study

4. FINAL CONCLUSION

Currently, the building industry accounts for the largest amount of energy consumption, and heating and cooling systems are the largest energy consumers in the building. Therefore, there is a need to improve energy efficiency or optimize energy consumption. In the present study, the role of remote sensing of HVAC & R facilities and energy audit of buildings was investigated. In this regard, consumption patterns in energy were determined. The research method in this research is documentary-analytical and the type of research is based on the presented analytical-practical solutions. Based on the findings and results of the research, the use of remote sensing technology and the necessity of applying GIS in the management of various industries such as thermal, refrigeration and air conditioning industry for energy audit and optimization of energy consumption pattern were emphasized. Therefore, the achievements of utilizing the remote sensing of HVAC & R facilities and the energy audit of buildings in the present research for the facility industry are as follows:

1-Scientific management by analyzing the received data on a variety of hydraulic and thermodynamic parameters by remote reading in the facility systems and creating the following capabilities:

• Hydraulic analysis
• Simulation properties and specifications
• Graphic properties
• Hardware requirements
• Software requirements
• Software capabilities
• Required data
• Cost

2- By identify any qualitative and quantitative changes in the facility set up in least possible time it is possisle to analyze the related data at the system outlet.

3- Develop the ability to cope with a variety of hydraulic and thermodynamic instability factors at the facility.

4- By Managing of HVAC & R ON-LINE Thermal, Refrigeration and Air Conditioning facilities while utilizing remote read and fast flow information technology in accordance with GIS.

5-Scientific leadership and upgrading of HVAC & R installation systems' technical and health safety coefficient and the following capabilities:

• Eliminate unwanted usage.
• Fixing and controlling HVAC & R thermal, refrigeration and air conditioning facilities at different times of the day.
• Reduce depreciation and increase efficiency of HVAC & R thermal, refrigeration and air conditioning installations.
• Alert alarms for periodic equipment reviews.
• Control the number of HVAC & R thermal, refrigeration and air conditioning equipment such as in-service burners tailored to the building's thermal load demand and so on.

• Deactivate HVAC & R thermal, refrigeration, and air conditioning installations in office buildings in accordance with work schedules or in accordance with outdoor temperatures.
• Ability to remotely control and monitor the status of HVAC & R thermal, refrigerating and air conditioning installations.
• Alarm system and alarm and event logging.
• Accurate statistical reporting of the performance of various components of the HVAC & R building's thermal, refrigeration and air conditioning installations.
• Cleverly prioritize emergency and peak consumption.

THANKS

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