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# An Energy Efficient Framework for an Environmental Internet of Things Based Financial Management System with Big Data Management

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***Abstract*—** The "Internet of Things (IoT)" has been applied to everything from sustainable farming to constructing automobiles and homes to encouraging energy savings for ecological sustainability. IoT technology has recently had a favourable impact on practically all businesses, organizations, and the general public. IoT devices use cell phones and other renewable energies more frequently and use less power, enabling mobile and dispersed operations. As a result, it was claimed that IoT enhances a number of procedures. the standard of living in a variety of fields, such as health care, energy conservation, precision farming, internet-related businesses, etc.
Using the "Internet of Things" to improve energy infrastructure can lead to better financial planning using big data management and a sustained foundation for renewable energy. Numerous studies have revealed that the installation of IoT can be used to improve energy regulation for end customers, material extraction, and other concepts in the energy channel's value chain while preserving superior economics.

***Keywords*— *"Internet of Things", "Energy efficient framework", "Big data management", "Financial management system", "Regression analysis"***

## INTRODUCTION

The emergence of "internet of things" has enables in consistently evolving different areas covering communication, processing of activities, business relationship and others. The emergence of new application and ideas has resulted in transforming the life for a better future. The IoT has been applied from intelligent farming to manufacturing of cars and automobiles, creating smart homes and support in energy efficient usage for "sustainable development". In recent times the IoT technologies has impacted almost all industry, government and others in a positive manner (Curry et al., 2019). The IoT devices uses lower power consumption and are increasingly using batter and other sources of power to enable the operations through mobile and distributed applications.
An extensive application of modern technologies like the communication aspects like 5G network,

implementation of robotics and automation and IoT are inclined to enhance the industry 4.0. The IoT enable in interconnecting with the different devices, applications, data and processing allow the individuals and business to implement extensive communication so as to seamlessly perform the operations (Motlagh et al., 2020). Hence, it is stated that IoT can support in improving various process It has been stated by the researchers that the implementation of IoT can support in enhancing the various processes and more quantifiable through collection and processing the volume of information IoT can support in enhancing the overall quality of life in various areas covering "***medical services, energy management, smart farming, web related services etc***". which enables in enhancing the process automation, deliver better products and services, increase efficiency, support in protecting the environment in an efficient manner.

The total population of the world has reached nearly 7.8 billion by 2020 and is projected to increase by more than 1 billion in the next three years and also expected to reach to more than 9.5 billion in 2050. Hence the energy requirements tend to expand by more than 50% from the current levels (Alladi et al., 2019). It is identified that the demand energy has been increased by nearly 2% when compared between 2019 and 2020. This will result in increasing of CO2 emission in the atmosphere and spikes the global warming by nearly 1.2.C. If the same trend continues then the global warming will exceed and impact the lives of every individual in the planet. Hence, there is a growing environmental concern in protecting the environment, curtail global warming, improve air quality and enhance the lives of the current and future generation. (Sharma et al., 2018). Therefore, the application of smart technology is considered as an effective option which will support in increasing the efficiency of power generation, limit the usage of unwanted power, focus in limiting the depletion of resources, forecast the usage of the energy requirements and make progressive plans to meet them.

Based on the UN sustainable development goals (SDG), it is noted that the application of energy efficiency is considered to be the critical factor for achieving sustainable growth. The energy efficiency offers better economic benefits but lowering the reduction in the cost of fuels, support in better energy management and reduce emission which will benefit more financial aspects of the individuals, business and governments (Prauzek et al., 2018). It is noted that the IoT and big data analytics apply critical sensors, tools and technologies so as to sense and transfer of real time information, enable in meeting the requirements of the stakeholders, analyse the data to understand the pattern to support in quick decisions. The application of innovative technologies like "***IoT, Big data analytics, Machine learning and Deep learning***" support the energy industry to transform from the more centralised approach to the decentralised and efficient distribution aspects, also it supports the government, companies and individuals to create better environmental framework, also it helps in creating better collaboration of resources, distribution of wind and solar energy etc. Moreover, the IoT can support in integrating the supply chain and distribution network which will control the overall process, identify the areas of automation and improvements. The potential of IoT and Big data are involved in collecting and storing large volume of information from different sources, analyse them, critically understand the patterns so that meaningful data are generated for efficient decisionmaking.

## REVIEW OF LITERATURE

The primary forces behind IoT are sensors used to send and collect data instantly. The usage of sensors boosts functionality and efficiency and is essential to the development of the "Internet of Things". For various applications, numerous types of sensors have been designed (Harris, and Joshua, 2018). The agriculture sector, environmental sensing, health and public security systems and products are a few examples of such uses. In reality, the energy industry makes extensive use of sensors for everything from power production to delivery and distribution. In order to reduce expenses and energy consumption, the energy sector needs sensors. The sensors support innovative techniques for controlling load profile, an advanced future control system, and real-time power conservation. The development of application areas to enhance load composition, consumer engagement, and the development of specialised facilities for improving the generation of renewable power are further goals of continued study and detecting device developments (Kaleva et al., 2018).

In the literature, researchers developed an energy system for LoRa-enabled structures in an effort to maximise energy consumption. The project will offer a platform with a number of systems, including electricity, power management, air conditioning, and other systems, to conduct out the building's thermal optimisation. The platform led to a 20% reduction in energy use. The authors used LoRa to create an intelligent machine learning-based control system for HVAC systems in commercial structures. When a

room is not vacant, the automated control system identifies it and turns off the HVAC, cutting energy use by up to 19.8%. Another study demonstrates the use of LoRa technology to establish an automated energy management network in government buildings. During the test, the developed platform saves energy from the lighting system by 40% (Atlam et al., 2018). Almost 80% of the nation's ultimate excess energy comes from fossil fuels, which are largely reliant on in the energy industry (Jain, Yadav & Shrivastava, 2019).
This section covers the role of the IoT in the "energy sector", including fuel collection, apparatus "operation and maintenance (O&M)", T&D, and end-user power. IoT has a significant impact on lowering CO2 emissions and energy waste. Energy usage can be tracked in real time by an IoT-based energy management system, which can also raise information on energy conservation throughout the entire supply chain. This section looks at the use of IoT in the stages of electricity generation initially (Jain, & Pandey, 2019). The early phases of IoT have assisted the energy sector in lowering the danger of power outages or interruptions in energy delivery by monitoring and components needed and operations. Reliability, productivity, environmental effect, and repair are the primary problems with ageing plants. Enormous energy loss and inefficiency can be caused by outdated electrical devices and poor mechanical problems. The equipment is frequently older than 40 years old, extremely expensive, and difficult to replace. IoT can assist in easing some of these management-related difficulties with power plants. IoT sensors enable Internet-connected equipment to identify any problems or unusual energy efficiency reductions, which is a concerning indication that maintenance is required. This lowers operating expenses by improving the company's capacity and dependability.

**METHODOLOGY**

The main objective of the study is to analyse the key determinants of implementing IoT and big data analytics in energy sector with a view to create a better framework for supporting environmental protection and also enable in creating better financial management. The researcher is confined to analyse the impact of the effective technologies in the energy sector, it is noted that when planning the IoT system the main aspect to be considered is the overall designing of the IoT system, and support in addressing the data storage, computation needs and enable in enhancing the computation needs in a sustainable manner. The IoT and Big data support in control the overall heating and maintaining of HVAC systems in the building, understand the patterns and control the light and cooling equipment for effective usage of the power, this supports in reducing the unwanted usage of electricity, reduce the cost of energy charges, support in better utilisation of alternative sources of power and increase profitability. The implementation of different IoT and Big data platforms support in using different form of sensors and actuators, address the data collection and transmission of information for better environmental protection (Sohraby et al., 2018).
The non-probability sampling method is used, mainly purposive sampling will be applied, which supports the authors to collate the data based on the individual judgement in selecting the respondents, the authors intend to gather the data from primary and secondary sources, in primary source the tool used in closed ended questions which uses Likert scale like "[1 – Strongly Disagree to 5 – Strongly Agree]". In case of secondary sources, the authors choose different online database and library covering EBSCO, ProQuest, Scopus indexed Journals etc. The researcher also uses IBM SPSS analysis tool for performing the analysis, critical analysis will be performed to address the hypothesis and detailed discussion will be presented in the next section.
Setting of hypotheses
There is no relationship between influence of IoT in protecting the environmental and ecological aspects and creating better energy efficient framework
There is no relationship between influence of IoT on forecasting the energy requirements based on the data patterns and creating better energy efficient framework
There is no relationship between influence of IoT towards support in realising the ESG goals and creating better energy efficient framework
There is no relationship between influence of IoT in addressing the goals of the financial management efficiently and creating better energy efficient framework.

**ANALYSIS AND DISCUSSSION**

This section involves in performing detailed analysis using the data collected by the researchers, nearly 169 responses were removed ad they are analysed using the "***IBMSPSS data analyses package***".

Table I. Table showing the demographic analysis

| Respondents Gender | Frequency | Percent |
|---|---|---|
| Male | 114 | 67.5 |
| Female | 55 | 32.5 |
| Respondents Age | Frequency | Percent |
| Less than 25 Years | 27 | 16 |
| 25 - 35 Years | 87 | 51.5 |
| 35 - 45 Years | 39 | 23.1 |
| Above 45 Years | 16 | 9.5 |
| Education | Frequency | Percent |
| Under Graduate | 50 | 29.6 |
| Post Graduate | 93 | 55 |
| Professional | 26 | 15.4 |
| Current work area | Frequency | Percent |
| Private enterprises | 51 | 30.2 |
| Government enterprises | 78 | 46.2 |
| Non-governmental organisation | 40 | 23.7 |
| Experience | Frequency | Percent |
| Less than 5 Years | 42 | 24.9 |
| 5 - 10 years | 48 | 28.4 |
| 10 - 15 years | 29 | 17.2 |
| 15 -20 years | 18 | 10.7 |
| More than 20 years | 32 | 18.9 |
| Total | 169 | 100 |

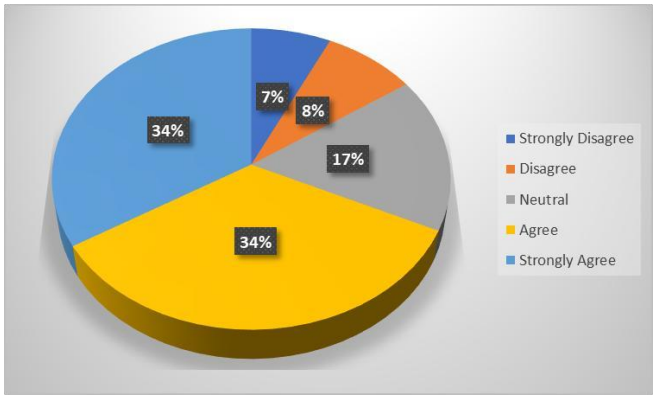
According to the data, 67.5% of the respondents were male and the balance were female. Additionally, 51.5% of the respondents were between the ages of 25 and 35, 23.1% were between the ages of 35 and 45, 16% were under 25, and the rest were above 45. Among the responders, 15.4% have completed professional coursework, 29.6% have undertaken undergrad coursework, and 55% have completed postgraduate coursework.

46.2% were working in government organisation, 30.2% were working in private enterprises, 46.2% Woking in government enterprises and remaining 23.7% were working in non-government enterprises. 2.4% of the responded possess experience between 5 – 10 years, 24.9% of the respondents possess experience of less than 5 years, 18.9% possess experience of more than 20 years, 17.2% posses experience f 10 – 15 years and remaining 10.7% possess experience between 15 – 20 years.

“Role of IoT in creating Energy Efficient framework”

Table II.Table showing the “role of IoT in creating energy efficient framework”

| ***IoT in Energy Framework*** | ***Frequency*** | ***Percent*** |
|---|---|---|
| Strongly Disagree | 10 | 5.9 |
| Disagree | 15 | 8.9 |
| Neutral | 29 | 17.2 |
| Agree | 62 | 36.7 |
| Strongly Agree | 53 | 31.4 |
| Total | 169 | 100 |




According to the above table, 36.7% of respondents agreed with the statement that IoT has a stronger effect on energy-efficient frameworks, and 31.4% of respondents were agreed with it. Additionally, 17.2% of respondents said they were neutral toward the declaration, 8.9% of respondents disagreed with the statement, and 5.9% of respondents strongly disagreed with it.

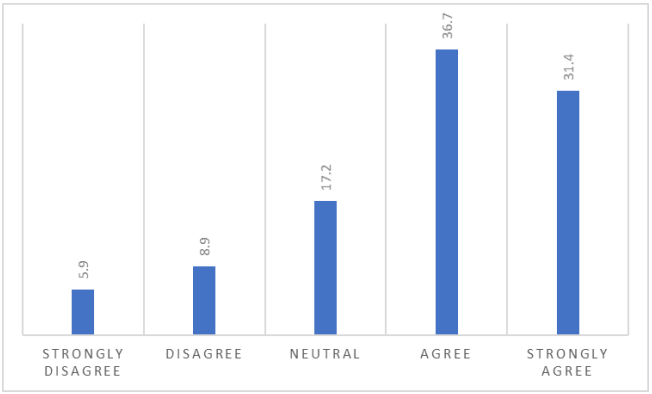



**Fig 1: Chart stating the Role of IoT in creating EnergyEfficient framework**

"Impact of Business data analytics on financial management"

Table III. Table showing the impact of business data analytics on financial management

| ***BDA in Financial Management*** | ***Frequency*** | ***Percent*** |
|---|---|---|
| Strongly Disagree | 12 | 7.1 |
| Disagree | 14 | 8.3 |
| Neutral | 28 | 16.6 |
| Agree | 58 | 34.3 |
| Strongly Agree | 57 | 33.7 |
| Total | 169 | 100 |

From the table above, it can be stated that 34.3% of the respondents have agreed to the statement that the role of business data analytics is immensely supporting in achieving the goals of financial management, the evolving technologies of IoT and BDA are focusing in deploying the resources effectively, analyse them so as to apprehend the data and

*A. Regression analysis*

The next part of analysis is confined in understanding the linear relationship between the independent variables which are considered in the study: Environmental and ecological aspects; Forecasting the energy requirements; Realising the ESG goals and goals of the financial management.

Table IV.Regression coefficients

| ***Regression*** | ***B*** | ***SE*** | ***Beta*** | ***t stat*** | ***P Value*** |
|---|---|---|---|---|---|
| (Constant) | 0.14 | 0.187 | | 0.74 | 0.46 |
| Environmental and ecological aspects | 0.36 | 0.104 | 0.344 | 3.417 | 0.001 |
| Forecasting the energy requirements | 0.35 | 0.102 | 0.365 | 3.452 | 0.001 |
| Realising the ESG goals | 0.01 | 0.088 | -0.002 | -0.024 | 0.981 |
| Goals of the financial management | 0.19 | 0.097 | 0.183 | 1.971 | 0.05 |
| R Square | 0.73 | | | | |
| F | 112.00 | | | | |
| Sig Value | 0.00 | | | | |

The regression equation can be stated as

Y (Energy efficient framework) = 0.14 + 0.36 x Environmental and ecological aspects + 0.35 x Forecasting the energy requirements + 0.01 x Realising the ESG goals +
0.19 x Goals of the financial management.

realise the specific goals. Furthermore, 33.7% f the

*B. Testing the hypothesis*

A t test is considered as one of the key statistical tests which is used to measure the nature of significant association between two variables. The researchers have set the hypothesis to measure if there is any relationship between thetwo variables through comparison of the means.

Hypothesis 1

Null: There is no relationship between influence of IoT inprotecting the environmental and ecological aspects and creating better energy efficient framework

Alternate: There is a relationship between influence of IoT in protecting the environmental and ecological aspects and creating better energy efficient framework

TABLE V. T test between relationship between influence of IoT in protecting the environmental and ecological aspects and creating better energy efficient framework

| ***T test*** | ***t*** | ***df*** | ***Sig. (2-tailed)*** | ***Mean Difference*** | ***SE Diff*** | ***95% Confidence Interval of the Difference*** | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Energy efficient framework | 1.547 | 20 | 0.138 | -0.417 | 0.269 | -0.979 | 0.145 |
| Equal variances not assumed | 1.516 | 4.353 | 0.199 | -0.417 | 0.275 | -1.156 | 0.323 |
| Levene's Test | | | | | | | |
| F | 10.50 | | | | | | |
| P Value | 0.02 | | | | | | |

**CONCLUSION**

The introduction of the Internet of Things has made it possible to continuously improve a number of sectors, including corporate partnerships, business operations, and communication. New technologies such as apps and concepts have altered life for the better. The Internet of Things (IoT) has been applied to everything from smart agriculture to building automobiles and homes to encouraging energy efficiency for sustainable development. To find and transmit information in real time, satisfy stakeholder expectations, and analyse data

to comprehend the model to be supported, IoT and big data analytics are crucial sensors, tools, and technologies that should be taken into consideration. The use of innovative technologies such as IoT, big data analysis, machine learning and deep learning will help the energy industry move from a more centralized approach to decentralized distribution and effectively help authorities, companies and people to improve the environment. helps to better collaborate with resources, distribute wind and solar energy, etc. In addition, IoT can help integrate the supply chain and distribution network, which will guide the whole process and identify areas for automation and development. The capabilities of IoT and Big Data consist of collecting and storing large amounts of information from various sources, analyzing it and critically understanding patterns to create important data for effective decision making.

IoT and Big Data support global thermal control and maintenance of buildings' HVAC systems, know the models and control lighting and cooling equipment for energy efficiency. resources and increase profitability. The implementation of various IoT and Big Data platforms supports the use of different types of sensors and actuators, handles data collection and information transfer to better protect the environment.

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