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Correlation Analysis for Identifying the Effective Factors in Predicting Industrial Electricity Energy Consumption

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***Abstract*— This paper plans to make a statistical analysis that focuses on forecasting electric power consumption of few industries from Ahmednagar city. The investigation regarding the energy consumption is mainly directed to three main categories like (i) Energy policy (ii) Production of Green and Non-Green products, and (iii) Production of FMCG and Non-FMCG products. In fact, the proposed methodology is carried out in three phases. The first phase initiates with preparing questionnaire that clearly addresses the effect of the aforementioned drives on various industries. The records mentioned in the questionnaire are closely related to the industries from Ahmednagar city. In the second phase, the prepared questionnaire is distributed to the industries of Ahmednagar city. The responses from the concerned industries related to power management are taken for analysis purpose. In this paper, the analysis is done based on higher-order statistical analysis that mainly focuses on correlation coefficients. Thereby, determining the correlation between different factors helps to arrive at a conclusion regarding the dependencies of various factors in the power consumption of industries in Ahmednagar city.**

Keywords*— Energy policy; Green and Non-Green products; FMCG and Non-FMCG products; Correlation analysis.

Nomenclature

Abbreviation	Description
EPS	Electric Power Systems
EE	Energy Efficiency
ANN	Artificial Neural Network
HEM	Home Energy Management
PSO	Particle Swarm Optimization
RMSE	Root Mean Square Error
FELM	Fuzzy ELM
SVM	Support Vector Machine

I. INTRODUCTION

Long-term electricity requirement forecasting is an important part for a good expansion and setting up of EPS [1] [2]. Actually, it holds a crucial and really significant role on the construction planning of novel generation services, on the improvement of a transmission lines expansion and also on country electric matrix [3] [4]. Based on the extent of the long-term predictions, it can demarcate decisions from administration [5] [6]. For example, predicting the electricity requirement for a particular dispensation region will definitely offer assistance for the electricity company to approximate the quantity of speculation required on personnel and equipment [7] [8]. Anyhow, to formulate superior and reliable electricity demand [9] [10], predictions is very important to obtain an indication of the entire forecasting schemes available, to have the entire knowledge regarding the long-term demand predicting schemes [11] [12] [13].

So as to develop the effectiveness of the supply systems and therefore to minimize the quantity of energy utilization, a significant step is to comprehend energy requirements at comparatively high spatial

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resolution. A precise forecast [14] [15] of energy demands could offer valuable information to formulate decisions on energy production and acquisition. In addition, a precise prediction [16] [17] would include a noteworthy impact on avoiding overloading and accordingly, permitting the world primary energy utilization is expected to raise yearly. Consequently, numerous computational works were going ahead on developing machine learning schemes to forecast the energy utilization of commercial and residential buildings by means of features like energy bills and weather.

Prediction of future energy needs [18] [19] for public policy producers is essential for infrastructure enlargement, economical planning and approximating of energy consumption. A widespread technique exploited by state policy formulators to plan future energy requirement is to carry out a simple linear search of chronological energy stipulation in opposition to time; anyhow, as it was revealed, this approaches would rigorously over-estimate prospect demands owing to the raise in EE and reducing energy intensity of the financial systems in the majority of states. Moreover, it fails to take into consideration the interdependence of energy requirement, population expansion, and fuel prices, financial activity and climate. Numerous manufacturing industries implement a variety of models for improved electric power forecasting and managements, anyhow, machine learning approaches comprises much-enhanced ability for prediction while distinguished with other models.

The major contributions are depicted below.

1. This paper intends to present a new scenario that concerns on forecasting electric power consumption of few industries from Ahmednagar city by higher order statistical functions.
2. Here, the analysis about the energy consumption is mainly directed to three major drivers like (i) Energy policy (ii) Production of Green and Non-Green products, and (iii) Production of FMCG and Non-FMCG products.
3. In the presented work flow, three phases are carried out, and in the first phase, a questionnaire is prepared that clearly addresses the effect of the aforementioned drives on diverse industries.
4. In the second phase, the prepared questionnaire is distributed to the industries of Ahmednagar city. In the questionnaire, all the questions are demanded to fill up by the industrial authorities, which are then taken for analysis purpose.
5. Finally, in this paper, the analysis is done based on higher order statistical analysis that mainly focuses on correlation coefficients that help to arrive at a conclusion regarding the dependencies of various factors.

The overall organization of the work is as follows: Section II portrays the literature work. Section III describes the proposed overall architecture of the proposed forecasting model. Section IV presents the perceptive of different industries on power consumption. Section V portrays the analytical results and section VI concludes the paper.

II. LITERATURE REVIEW

A. ***Related works***

In 2018, van *et al.* [1] have investigated the impact of aggregation of consumers and a rising contribution of PV Photo Voltaic power in the net load on PIs of probabilistic forecasting techniques that were deployed for allocation of grid consumers throughout spring and winter. In addition, the training window breadth was optimized and demonstrates that it generates reliable and sharp PIs with a set of training up to three weeks. At last, the increasing contribution of PV power was found to raise the reliability and sharpness of the proposed model.

In 2015, Kleshchyova and Nakhabov [2] have established an approach, where various applications of data analysis for predicting electric power utilization by NPPs - Nuclear Power Plants by means of accurate data were represented. Accordingly, assessment of these techniques among one another was performed in addition to those presently in application by NPPs was done. Consequently, a technique was presented for predicting NPP power utilization for treating the requirements of plants with considerably

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higher accurateness of prediction. At last, the diverse analysis was carried out to evaluate the effectiveness and efficiency of the introduced scheme.

In 2017, Collotta, and Giovanni [3] has presented an ANN as a sustainment for a HEM system depending on Bluetooth low energy, known as BluHEMS. The implemented technique was capable to predict the energy utilization circumstances, that is, to forecast the home energy needs at diverse periods of the day or on various days of the week. Moreover, this paper offered a comprehensive explanation of the ANN arrangement, a systematic examination on the embedding constraints for the derivation of best performance values, and simulative evaluations, attained through simulations.

In 2018, Xu *et al.* [4] have suggested a new PIs Prediction Intervals technique along with ESF-ELM- Error & Self-Feedback Extreme Learning Machine with PSO. In order to enhance the energy design and precision of ELM, the input weights were assigned by means of cosine similarity coefficients; however, it was not initialized arbitrarily. At last, PSO with a wide-ranging metrics was introduced to assess the probability and the mean width of PIs. In addition, the results demonstrate that the suggested model could produce high-quality PIs with better probability, slender width, and supremacy in reliability and adaptability that offers regulation for decision makers to increase profits and provide logical prospect plans.

In 2018, Angelos *et al.* [5] have scrutinized a power management method for over-voltage mitigation in active LV networks. The technique evaluates the utmost permitted quantity of infused power to the grid and consequently, it produces a power management agenda for the procurers depending on their SCR. Here, the adopted technique was scrutinized on an LV test system and was distinguished to other conventional schemes for voltage support. Here, the outcomes demonstrate that the appliance of the technique raises installation of SCR, treating at the similar time procurers in a better manner distinguished to traditional schemes.

In 2018, Samir *et al.* [6] have established an energy consumption baseline approach depending on a GBM. For evaluating the performance of this technique, a testing process introduced in recent times was exploited. Furthermore, the modeling training periods were altered and numerous forecasting accuracy measures were deployed to estimate the performance of the model. At last, the results demonstrate that by deploying the GBM model, the RMSE has been enhanced when compared with other traditional approaches.

In 2018, Han *et al.* [7] have implemented a novel methodology on energy management and optimization design depending on the FELM procedure. In addition, the FELM includes enhanced forecasting performance and training speediness. At last, the implemented technique was exploited to optimize and manage the energy position of ethylene industry in China under multifaceted petrochemical manufacturing industries. Finally, the investigational results demonstrate that the adopted technique was effectual and appropriate in the energy-saving prospective that was indicated at a higher range.

In 2018, Wang *et al.* [8] have introduced a novel methodology, which intends to deploy an AMVO - Adaptive Multi-Verse Optimizer for optimizing the constraints of the SVM. Moreover, the results point out that the hybrid AMVO-SVM model includes superior accuracy when distinguished with other models. At last, the hybrid AMVO-SVM technique was evaluated in terms of its prediction capability under five set-ups. In the reference set-up, China's prime energy consumption would attain 4839.3 Mtce in 2020 and 5656.2 Mtce in 2030.

B. ***Review***

Table 1 shows the methods, features, and challenges of conventional techniques based on the electric power consumption management. At first, the Gaussian process was introduced in [1], which offers the enhanced sharpness and it offers better reliability. However, it needs more contemplation using NN. SVM algorithm was exploited in [2] that estimate the increased accuracy and it also minimizes economical expenses, but it requires consideration on delivery and management. In addition, NN approach was deployed in [3] that provide increased performance of network and improved end to end delay. Anyhow,

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there was no consideration on hybrid optimization scheme for precise results. Likewise, PSO scheme was exploited in [4], which offers Better reliability and it also offers logical future plans. However, it needs contemplation on exploiting the energy sources. Also, SCBPM was employed in [5], which offers better treatment of prosumers and better novel power profiles; however it needs awareness on consumption of storage devices. GBM algorithm was exploited in [6] that offers high flexibility and it also provides enhanced prediction accuracy, anyhow, it requires more contemplation on GBM to be deployed in other energy efficiency issues. FELM was implemented in [7], which offers an effective model and it can be deployed under complex conditions, but this approach needs contemplation on time density. At last, the SVM framework was suggested in [8] that provides more precision outcomes and improved economic growth. However, it has to be focused on different scenarios; these limitations have to be considered for improving the performance of electric power consumption management effectively in the current research wor

TABLE I. FEATURES AND CHALLENGES STATE-OF-THE-ART ELECTRIC POWER CONSUMPTION MODELS

Author [citation]	**Adopted methodology**	**Features**	**Challenges**
van *et al.* [1]	Gaussian process	❖ Enhanced sharpness ❖ Better reliability.	❖ Needs more contemplation using NN.
Kleshchyova and Nakhabov [2]	SVM	❖ Increased accuracy ❖ Minimizes economical expenses.	❖ Requires consideration on delivery and management.
Collotta, and Giovanni [3]	NN	❖ Better performance of the network. ❖ A better end to end delay.	❖ No consideration on hybrid optimization scheme for precise results.
Xu *et al.* [4]	PSO	❖ Better reliability ❖ Offers logical future plans ❖	❖ Needs contemplation on exploiting the energy sources.
Angelos *et al.* [5]	SCBPM	❖ Better treatment of prosumers ❖ Novel power profiles.	❖ Needs awareness on consumption of storage devices.
Samir *et al.* [6]	GBM	❖ Enhanced prediction accuracy.	❖ Requires contemplation on GBM to be deployed in other

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		❖ Minimizes the frequency of charging.	energy efficiency issues.
Han *et al.* [7]	FELM	❖ Effective model ❖ Can be deployed under complex conditions.	❖ Needs contemplation on time density.
Wang *et al.* [8]	SVM	❖ Better precision. ❖ Improved economic growth.	❖ Has to be focused on different scenarios.

III. OVERALL ARCHITECTURE OF PROPOSED FORECASTING MODEL

A. *Prepared Questionnaire*

Here, in the presented work, the investigation regarding the energy consumption is mainly directed to three main categories or drives like (i) Energy policy (ii) Production of Green and Non-Green products, and (iii) Production of FMCG and Non-FMCG products. Here 65 questionnaires are prepared and the responses are obtained from the industries. The energy policy comprises of 18 questions, the production of green and non-green products includes 29 questions and the production of FMCG and Non-FMCG products includes 18 questions. The diagrammatic representation of the modelled questionnaire is revealed by Fig. 1. Accordingly, the prepared questionnaires for the three categories are given by Table II,TABLE III and Table IV

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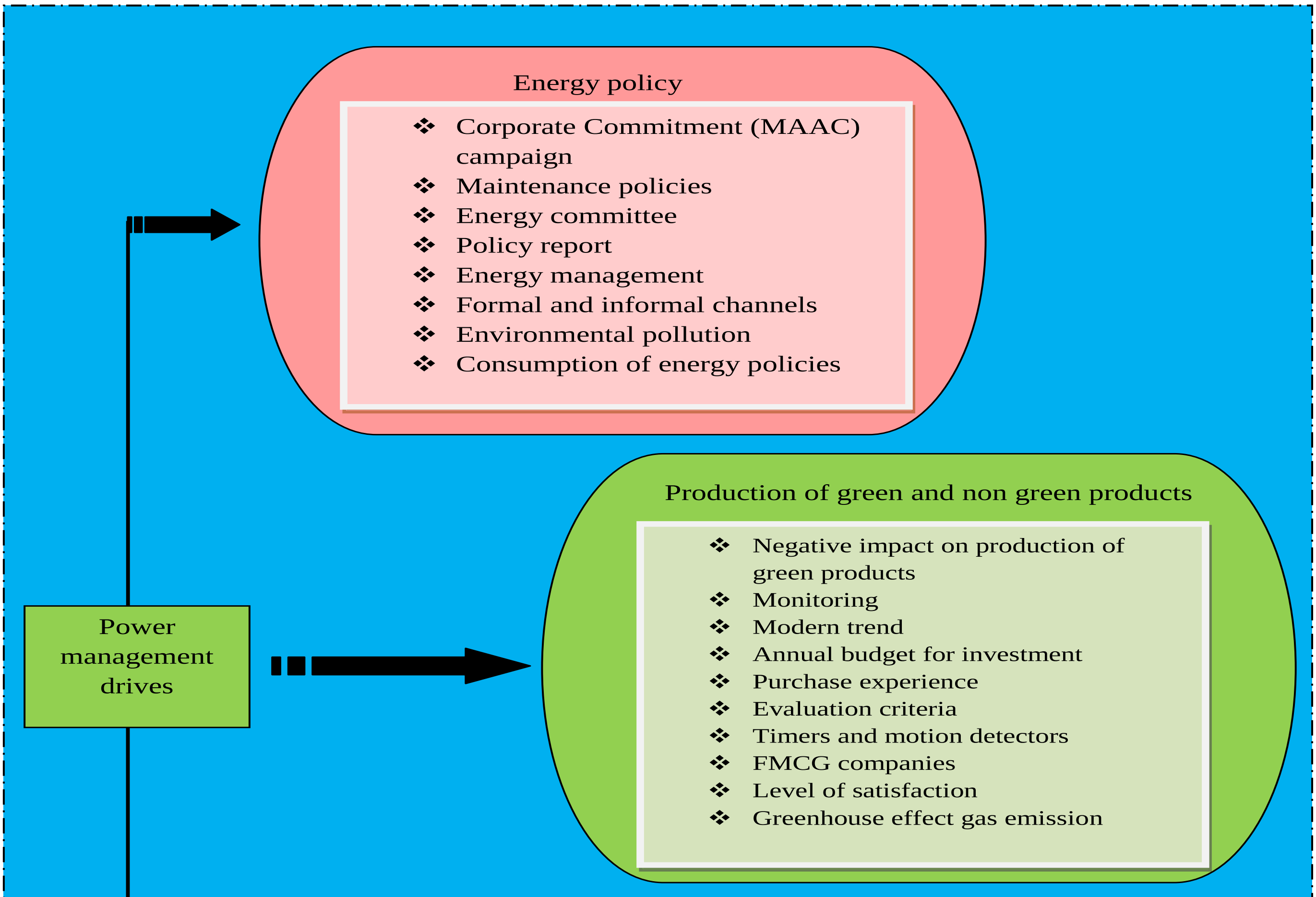

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Fig. 1. Representation of the designed questionnaire

Fig. 2. Representation of the designed questionnaire

TABLE II. DESIGNED QUESTIONNAIRE IN TERMS OF ENERGY POLICY ANALYZATION

A1.	Whether the industry has an energy policy
A2	Are the objectives of energy integrated into new build/refurbishment specifications?
A3	Is the industry a signatory to the Making a Corporate Commitment (MAAC) campaign?
A4	Are the objectives of energy integrated into maintenance policies?
A5	Are the objectives of energy integrated into purchasing policies?
A6	Whether there should be a need for a managing head to maintain the energy policies?
A7	How many staffs have responsibility for energy management policies?
A8	Approximately what percentage of time is devoted for managing the energy policies?
A9	Does the industry have an energy committee?
A10	Have energy audits been conducted in major policies?
A11	Is an annual energy policy report produced?
A12	Has the industry's energy policy had a significant impact on energy management?
A13	When the information of industry's energy management is generally recorded?
A14	Does your company agreed to develop more developed policies on energy management?
A15	Whether the formal and informal channels of communication has to be regularly exploited by the energy policy manager
A16	Whether the energy policies should be cost-effective and environmental pollution free?
A17	Can informal contacts used to promote energy efficiency?
A18	Is the consumption of energy policies compared with other sector benchmarks?

TABLE III. DESIGNED QUESTIONNAIRE IN TERMS OF PRODUCTION OF GREEN AND NON-GREEN PRODUCTS

B1	Whether the Energy policy, action plan and regular review on green product production, have commitment as part of energy management?
B2	What is the range of difficulty in attaining information regarding the energy consumption of green/non green products
B3	Is there any necessity to replace the existing policies or equipment that have a negative impact on

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	production of green products?
B4	Does the production of green products based on energy management monitored periodically?
B5	Whether the green produced as per the modern trend more focusing on energy management?
B6	Is there an annual budget for investment on production of green and non green products?
B7	If yes, how much is it for green products?
B8	If yes, how much is it for non-green products?
B9	How product and service items are satisfied based on value in accordance with energy management?
B10	How the product and service items are satisfied based on Purchase experience in accordance with energy management?
B11	How the product and service items are satisfied based on Usage experience in accordance with energy management?
B12	How the product and service items are satisfied after purchase service in accordance with energy management?
B13	Do you think that Green Marketing activities are good at addressing energy management?
B14	Specify the importance level of the production of green products that should be encouraged by marketers focusing on energy management?
B15	Which of following words would you use to describe energy-aware green product manufacturing?
B16	Do you think that by implementing green marketing strategy the companies are able to gain competitive advantage over others in terms of energy consumption?
B17	Does your company have energy-efficient production system for green products?
B18	Which product is preferred more with respect to energy policies?
B19	Is there any setup evaluation criteria for each green product based on the concept of energy management?
B20	Does industry use timers & motion detectors to optimize energy use for production of green products
B21	Which green products utilize more energy?
B22	Specify the importance level of the energy management practices that should be encouraged by Green product marketers
B23	Do you think FMCG companies which can establish themselves with green image along with energy efficiency will have distinctive advantage in the market place?
B24	How will you describe your level of satisfaction regarding green and non green products based on energy management?
B25	Is there any requirement to educate the people about the environment free green and non green products through some public forums?
B26	Does the products minimize energy consumption at all stages of the product life cycle, including manufacturing, sales, distribution, use, and disposal.
B27	Whether the low energy consumption power design reduces greenhouse effect gas emission?
B28	Whether information given on the energy usage of green product/non-green product is trustworthy?
B29	Whether there are any technologies or practices to enhance energy management while producing green products?

TABLE IV. DESIGNED QUESTIONNAIRE IN TERMS OF PRODUCTION OF FMCG AND NON-FMCG PRODUCTS

C1	Many FMCG clients are targeting energy as a priority in keeping costs down?
C2	Whether the marketing practitioners of FMCG sector utilize energy management strategies to minimize environmental pollution nowadays?
C3	Does the FMCG manufacturing require more contemplation on consumer attitudes and values towards energy policies?

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C4	Whether the production of global and local FMCG brands consumes more energy?
C5	FMCG products usage and the opportunities for improving its energy efficiency depend on which of the below factors?
C6	What is the contribution of industrial energy waste for FMCG production when compared with overall energy consumption?
C7	Whether younger people utilize recommendations from their peers regarding energy management on FMCG and Non-FMCG products and services in order to make rational purchase decisions?
C8	Would you like to switch your FMCG brand preference if you get some developed energy management scheme with another brand?
C9	Select the reason for making a purchase on FMCG and Non-FMCG products?
C10	Are there any worthwhile commission schemes and rewards for better management of energy concerned FMCG products?
C11	Is there any necessity to involve media to distribute knowledge regarding the energy policies in buying FMCG products?
C12	Whether the energy policy has been extended beyond the traditional issues of availability and price to include environmental quality and industrial competitiveness in FMCG products?
C13	Whether steps are taken to investigate the energy management within the FMCG and non-FMCG markets to ensure satisfaction and loyalty?
C14	Whether the customers evaluate the energy policies on the regular FMCG store when they tend to evaluate typical physical quality factors?
C15	Is there any significant efforts taken to minimize energy consumption during the production of FMCG products?
C16	Is there any integral energy management and efficiency solutions, tailored to the specific needs of the FMCG industry through its many technical and managerial solutions?
C17	Whether the negative customer reviews related to the FMCG products regarding the energy consumption have been rectified?
C18	Do the FMCG companies are looking to invest in energy efficient plants to benefit society and lower costs in the long term?

*B. **Data Collection Procedure***

This research work plans to develop the model that is focussed on predicting electric power consumption of few industries from Ahmednagar city. The investigation regarding the energy consumption will be mainly directed to three main categories or drives like (i) Energy policy (ii) Production of Green and Non-Green products, and (iii) Production of FMCG and Non-FMCG products. For managing power consumption, every industry performs a clear cut policy that can be analyzed

through this research work, as it plays an important role. Here, initially, a questionnaire is prepared that clearly addresses the effect of aforementioned drives on various industries. The records mentioned in the questionnaire are closely related to the industries in few industries from Ahmednagar city. Accordingly, the prepared questionnaire is distributed to fifteen industries of Ahmednagar city. In the questionnaire, all the questions are made mandatory. Subsequently, the industrial authorities are demanded to fill up the precise information as much as possible. Further, the 15 responses from the concerned industries related to power management are taken for analysis purpose.

IV. PERCEPTIVE OF DIFFERENT INDUSTRIES ON POWER CONSUMPTION

A. *Energy Policy*

The responses obtained from the various industries regarding the energy policies of power management drives are given by Table V. From the obtained responses, the industry that encompasses the energy policy is about 80% and the industries that do not encompass the energy policy are found to be 20%. Here, in almost 80% of the industries, the energy was integrated into new build/refurbishment specifications, whereas in 20% of the industries, the energy was not integrated into new build/refurbishment specifications. In addition, about 60% of the industries act as a signatory to the Making a Corporate Commitment (MAAC) campaign, while 33.3% of the industries often acts as a signatory to the MAAC campaign. However, 6.7% of the industries do not act as a signatory to the MAAC campaign. In around 73.3% of the industries, the objectives of energy are integrated into maintenance policies, whereas in 26.7% of the industries, the objectives of energy are not integrated into maintenance policies. Moreover, from the response, in 85.7% of the industries, the objectives of energy are integrated into purchasing policies, while in 14.3%, the objectives of energy are not integrated into purchasing policies. 33.3% of the industries strongly agree that a managing head is necessary to maintain the energy policies and 46.7% of the industries just agree that a managing head is necessary to maintain the energy policies. 6.7% of the industries remain neutral, while 6.7% of the industries disagree and strongly disagree in portraying the need for a managing head to maintain the energy policies. In 53.3% of the industries, only 10 to 50 staffs were given the responsibility for energy management policies; whereas, in 33.3% of the industries, 50 to 75 staffs were given the responsibility for energy management policies and 75 to 100 staffs contribute only 13.3% in including the responsibility for energy management policies. In addition, 66.7% of the time is devoted to managing the energy policies in certain firms, while an average of 20% time is dedicated by certain industries for managing the energy policies. Only 13.3% of the firms offer a minimum percentage of time for managing the energy policies. Further, 80% of the industries include an energy committee, while 20% of the industries do not encompass an energy committee. In 53.3% of the industries, the energy audits have been conducted in major policies, whereas in 33.3% of the industries, the energy audits were not often conducted in major policies and in 13.3% of the industries, the energy audits were not conducted in major policies. Consequently, in 66.7% of the industries, the annual energy policy report was produced and in 26.7% of the industries, the annual energy policy report was not produced at regular intervals, while in 6.7% % of the industries, the annual energy policy report was not at all produced.66.7% of the industry's energy policy had a significant impact on energy management, whereas 33.3% of the industry's energy policy do not have a significant impact on energy management. From the response, about 26.7% of the information of industry's energy management is generally recorded annually, monthly and daily, while 20% of the information of industry's energy management is generally recorded weekly. Moreover, around 53.3% of the companies strongly agreed to develop more developed policies on energy management, whereas, 20% of the firms have agreed and remain neutral to develop more developed policies on energy management. Only 6.7% of the firms do not agreed to develop more developed policies on energy management. Further, 53.3% of the companies strongly agreed that the formal and informal channels of communication has to be regularly exploited by the energy policy manager, while 20% and 13.3% of the firms have agreed and remain neutral regarding the formal and informal channels of communication that has to be regularly exploited by the energy policy manager. Here, 6.7% of the firms do not agree that the formal and informal channels

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of communication have to be regularly exploited by the energy policy manager. 53.3% of the industries strongly agree that the energy policies should be cost-effective and environmental pollution free, while, 26.7% of the industries agree that the energy policies should be cost effective and environmental pollution free. However, 6.7% of the firms have disagreed and remained neutral in suggesting about cost effective and environmental pollution-free energy policies. Furthermore, around 33.3% of the companies agreed and remain neutral in deploying informal contacts to promote energy efficiency, whereas, 13.3% of the firms have strongly agreed and 13.3% of the industries have disagreed to deploy informal contacts to promote energy efficiency. Only 6.7% of the firms do not agreed to deploy informal contacts to promote energy efficiency. The consumption of energy policies is compared with other sector benchmarks in 46.7% of the firms while 33.3% of the firms compare the energy policies with other sector benchmarks at certain intervals. Here 20% of the firms do not compare the energy policies with other sector benchmarks.

TABLE V. ANALYSIS ON ENERGY POLICIES BASED ON TABLE I
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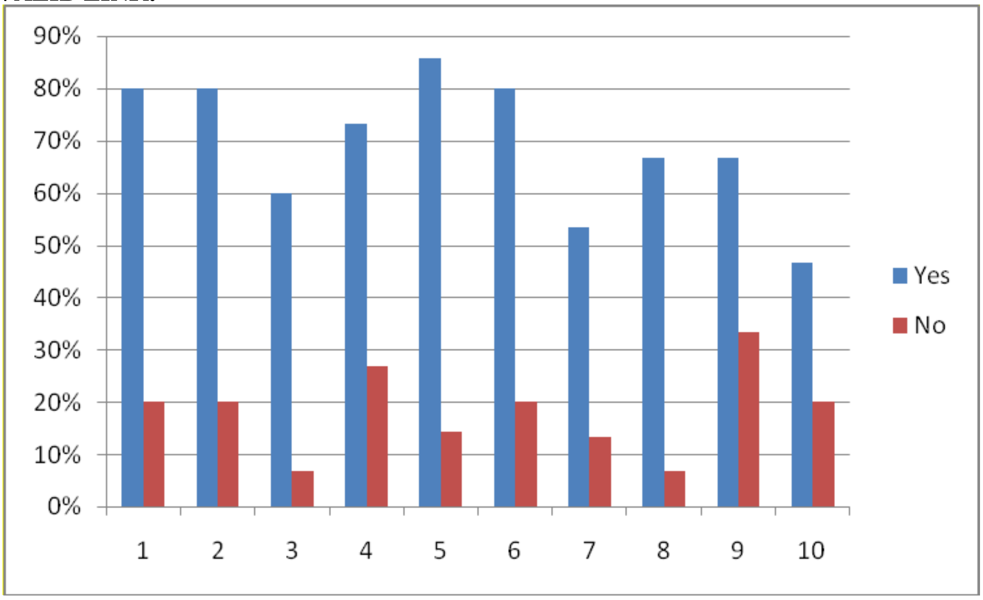

FIGURE 2 ANALYSIS ON ENERGY POLICIES

B. *Production of Green and Non-green Products*

Table VI shows the responses obtained from the various industries regarding the production of green and non-green products. From the response, it is observed that about 66.7% of the firms have commitment as part of energy management in the Energy policy, action plan and regular review on green product production, while 26.7% are often committed. The range of difficulty in attaining information regarding the energy consumption of green/non green products is maximal in 40% of the firms and minimum in 40% of the firms and only 20% of the firms have found an average range of difficulty in attaining information regarding the energy consumption of green/non green products. In addition, 40% of the industries strongly agree to replace the existing policies or equipments that have the negative impact on production of green products, whereas 13.3% strongly disagree with this fact. The production of green products based on energy management was monitored periodically in 53.3% of the industries and13.3% of the industries do not periodically monitor the production of green products. The green products produced as per the modern trend was more focused on energy management by 60% of the industries and

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6.7% do not. Further, in 46.7% of the firms, there is an annual budget for investment on production of green and non green products, whereas there is no annual budget for investment on production of green and non green products in 20% of the industries. The annual budget for investment on green products is very high and almost high in 40% of the industries, while in13.3% of the firms, in low. On considering non green products, 20% of the firms offer low and very high annual budget for investment on non green products, while 33.3% of the industries offer high annual budget. The product and service items are very unsatisfied based on the value in accordance with energy management in 6.7% of the firms, while the product and service items are very satisfied based on value in accordance with energy management in 26.7% of the firms. The product and service items are satisfied based on purchase experience and usage experience in accordance with energy management is very satisfied in 33.3% 20% respectively. The green marketing activities are good at addressing energy management in 78.6% of the firms while in 21.4% of the industries; the green marketing activities are not good at addressing energy management. The importance level of the production of green products that should be encouraged by marketers focusing on energy management is important in 26.7% of the firms. The energy-aware green product manufacturing is great in 33.3% of the firms. On implementing green marketing strategy, 46.7% of the companies are fine to gain competitive advantage over others in terms of energy consumption, while, 20% of the companies are bad in gaining competitive advantage over others in terms of energy consumption. Accordingly, 80% of the industries include energy-efficient production system for green products while 20% of the industries do not include. In 73.3% of the firms, green product is preferred more with respect to energy policies whereas, in 26.7% of the firms, non-green product is preferred. 53.3% of the industries use timers and motion detectors to optimize energy use for the production of green products, however, 33.3% of the industries sometimes prefer to use timers and motion detectors to optimize energy use for the production of green products. Green products like solar speakers and green GPS units utilize more energy of 40% and dryer balls utilize more energy of 20%. The energy management practices are Very important (i.e. 46.7%) be encouraged by Green product marketers as per the responses, while it is average in 33.3% of the firms. 40% of the firms strongly agree that FMCG companies can establish themselves with green image along with energy efficiency have distinctive advantage in the market place, while 20% of the firms neutral in this case and 6.7% of the firms do not accept this case. The level of satisfaction regarding green and non green products based on energy management is very much satisfied with 6.7% of the firms while 46.7% of the companies remain neutral. 33.3% of the firms strongly agree and the same percentage of the firms remain neutral regarding the requirement to educate the people about the environment free green and non green products through some public forums whereas 6.7% of the firms disagree with this. 80% of the firms accept that the products minimize energy consumption at all stages of the product life cycle, including manufacturing, sales, distribution, use, and disposal, while 20% do not. The low energy consumption power design reduces greenhouse effect gas emission in 78.6% of the firms while 21.4% do not agree with this fact. The information given on the energy usage of green product/non-green product is trustworthy in 60% of the firms and in 26.7%, the information given on the energy usage of green product/non-green product is not much trustworthy. In addition, 60% of the firms include technologies or practices to enhance energy management while producing green products, while 13.3% do not.

ANALYSIS ON THE PRODUCTION OF GREEN AND NON-GREEN PRODUCTS BASED ON TABLE III**ERROR! NOT A VALID LINK.**

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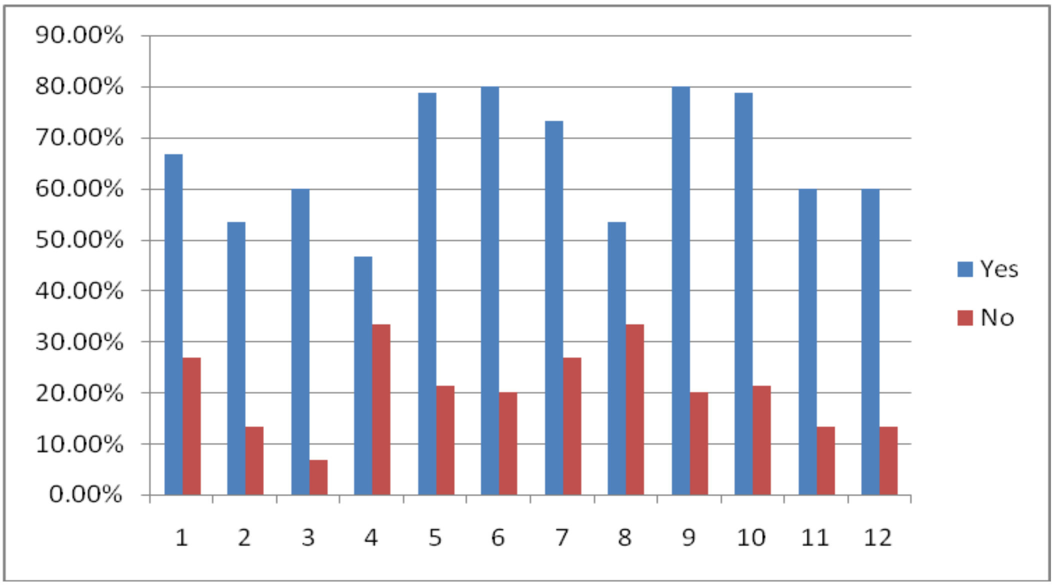

FIGURE 3 ANALYSIS ON THE PRODUCTION OF GREEN AND NON-GREEN PRODUCTS

C. Production of FMCG & Non-FMCG Products

Here, 26.7% of the industries strongly agree while a similar percentage of the industries disagree that FMCG clients are targeting energy as a priority in keeping costs down. In 33.3% of the firms, the marketing practitioners of FMCG sector strongly agree and equally disagree to utilize energy management strategies to minimize environmental pollution. In 60% of the firms, the FMCG manufacturing requires more contemplation on consumer attitudes and values towards energy policies whereas, in 26.7% of the firms, the FMCG manufacturing does not require more contemplation on consumer attitudes. The production of global and local FMCG brands consumes more energy in 40% of the firms while 33.3% of the firms so not often consume more energy. FMCG products usage and the opportunities for improving its energy efficiency depend on technical factors and economic factors in 33.3% of the firms, while 13.3% and 20% of the firms depend on political and institutional factors. The contribution of industrial energy waste is very high in 33.3% of firms for FMCG production when compared with overall energy consumption while in 26.7% and 20% of firms; it is high and very low. The younger people in 66.7% of the firms utilize the recommendations from their peers regarding the energy management on FMCG and Non-FMCG products while 26.7%, the younger people do not utilize the recommendations from their peers. Further, 60% of the industries like to switch their FMCG brand preference if they get some developed energy management scheme with another brand whereas, 20% of the firms do not like to switch their FMCG brand preference. The reason for making a purchase on FMCG and Non-FMCG products is 33.3% due to variety, 13.3% due to low power consumption and service and 6.7% due to ambience and proximity. The worthwhile commission schemes and rewards are always available for better management of energy concerned FMCG products in 46.7% of the firms, while 20% of the firms sometimes avail and 20% of the industries do not avail it at all. 33.3% of the companies always require or sometimes require involving media to distribute knowledge regarding the energy policies in buying FMCG products. The energy policy has been extended beyond the traditional issues of availability and price in FMCG products in 66.7% of the industries, while in 26.7%, it has not been extended. Steps are taken to investigate the energy management within the FMCG and non-FMCG markets to ensure satisfaction and loyalty in 71.4% of the firms while in 28.6% of the industries, steps were not taken regarding this. 46.7% of the industries agree that the customers evaluate the energy policies on the regular FMCG stores while 26.7% of the firms strongly agree with this fact. In 40% of the firms, significant efforts were taken to minimize the energy consumption during the production of FMCG products; on the other hand, in 26.7% of the firms, no significant efforts were taken to minimize the energy consumption during the production of FMCG products. Moreover, 40% of the industries include integral energy management and efficiency solutions, whereas 46.7% sometimes include integral energy management and efficiency solution. The negative customer reviews related to the FMCG products regarding the energy consumption have been rectified in 53.3% of the firms, while in 6.7%, it was not rectified. 46.7% of the industries strongly agree to invest in energy efficient plants to benefit the society and lower costs in the long term and 33.3% agree with this fact. Table VII shows the responses obtained from the various industries regarding the production of FMCG and non-FMCG products.

ANALYSIS ON PRODUCTION OF FMCG AND NON-FMCG PRODUCTS BASED ON TABLE IV

Q	Analytical questions	Yes	No	Sometimes
C3	Contemplation on consumer attitudes and values	60%	13.30%	26.70%
C4	Energy consumption on the production of global &local FMCG brands	40%	26.70%	33.30%
C7	Recommendations from peers	66.70%	6.70%	26.70%
C10	worthwhile commission schemes& rewards for better management	46.70%	20%	33.30%
C12	Energy policy extended beyond the traditional issues	66.70%	6.70%	26.70%
C13	Investigation on energy management	71.40%	28.60%	
C15	Minimization on energy consumption	40%	26.70%	33.30%
C16	Integral energy management	40%	13.30%	46.70%
C17	Negative customer reviews	53.30%	6.70%	40%

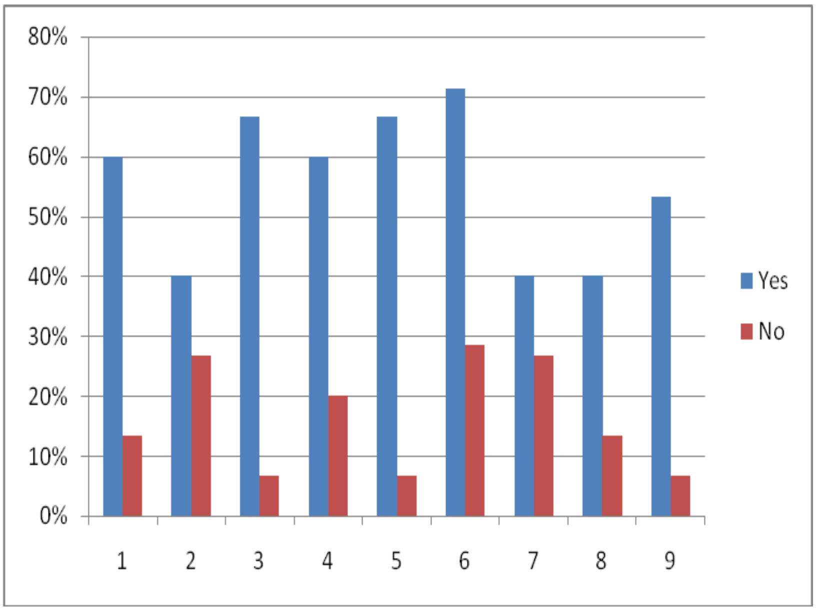

Figure 4 Analysis on production of FMCG and non-FMCG Products

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V. Analytical Results on Forecasting Industrial Power Consumption

A. Simulation Procedure

The developed analysis was implemented in MATLAB 2018a after loading the attained raw data from the industries. The analytical results were focussed on two three drives like Energy policy, Production of Green and Non-Green products, and Production of FMCG and Non-FMCG products and each drive includes 18, 29 and 18 questions respectively. Here, correlation analysis was done for all the questions on three drives and the question, which was more correlated (more rank) was attained. Let A and B are two matrix, the correlation coefficient formula used for the computation of the

concerned matrix is given by Eq. (1), in which σ_A and μ_A denotes standard deviation and mean of A. σ_B and μ_B denotes standard deviation and mean of B.

$$\rho(A,B)=\frac{1}{N-1}\sum_{i=1}^{N}\left(\frac{A_i-\mu_A}{\sigma_A}\right)\left(\frac{B_i-\mu_B}{\sigma_B}\right) \qquad (1)$$

B. Correlation Analysis on Energy Policy

This section describes the correlation analysis on energy policy for the considered 18 questions as given by Table VIII. Since eighteen questions are analyzed, 18×18 matrix is formed as a result of correlation analysis, in which the highest correlation rank is occupied by the question, “1. Whether the industry has an energy policy?”

TABLE VI. Representation of 18×18 matrix formed as a result of Correlation Analysis on Energy Policy

1	0.5833	0.5026	0.4523	0.7845	-0.0297	0.0468	-0.0928	1	0.4766	0.6065	0.3536	0.3778	0.7825	0.8357	0.4708	0.6202	0.0754
0.5833	1	0.5026	0.8292	0.2942	-0.0297	0.5151	-0.0928	0.5833	0.11	0.2274	0	0.2325	0.4423	0.4313	0.3323	0.3101	-0.3015
0.5026	0.5026	1	0.3355	0.3238	-0.3025	0.1412	0.1867	0.5026	0.3317	0.4409	0.2031	-0.1961	0.3078	0.3329	0.0278	-0.0223	0.1191
0.4523	0.8292	0.3355	1	0.207	-0.0358	0.5507	0.028	0.4523	0.2985	0.1029	-0.1066	0.0175	0.5847	0.2764	0.192	0.3272	-0.0795
0.7845	0.2942	0.3238	0.207	1	-0.1978	-0.3306	0.0182	0.7845	0.302	0.6244	0.5547	0.1824	0.6805	0.8142	0.5322	0.4865	0.2809
-0.03	-0.0297	-0.3025	-0.0358	-0.1978	1	0.1167	-0.3691	-0.0297	-0.3133	-0.108	-0.4196	-0.0241	0.0727	-0.0928	0.1052	0.0184	0.0089
0.0468	0.5151	0.1412	0.5507	-0.3306	0.1167	1	-0.4174	0.0468	-0.1236	-0.3621	-0.596	0.147	0.0765	-0.1818	-0.2179	-0.0871	-0.6142
-0.093	-0.0928	0.1867	0.028	0.0182	-0.3691	-0.4174	1	-0.0928	0.5514	-0.0211	0.5252	-0.1025	0.1327	0.2603	-0.0051	0.0288	0.098
1	0.5833	0.5026	0.4523	0.7845	-0.0297	0.0468	-0.0928	1	0.4766	0.6065	0.3536	0.3778	0.7825	0.8357	0.4708	0.6202	0.0754
0.4766	0.11	0.3317	0.2985	0.302	-0.3133	-0.1236	0.5514	0.4766	1	0.2335	0.6222	-0.0384	0.5538	0.5218	0.0365	0.3411	0.1326
0.6065	0.2274	0.4409	0.1029	0.6244	-0.108	-0.3621	-0.0211	0.6065	0.2335	1	0.4825	-0.1454	0.3714	0.466	0.3275	0.141	0.36
0.3536	0	0.2031	-0.1066	0.5547	-0.4196	-0.596	0.5252	0.3536	0.6222	0.4825	1	-0.0411	0.2887	0.61	0.3133	0.2193	0.1066
0.3778	0.2325	-0.1961	0.0175	0.1824	-0.0241	0.147	-0.1025	0.3778	-0.0384	-0.1454	-0.0411	1	0.2017	0.398	0.4314	0.6128	-0.4644
0.7825	0.4423	0.3078	0.5847	0.6805	0.0727	0.0765	0.1327	0.7825	0.5538	0.3714	0.2887	0.2017	1	0.7594	0.3731	0.633	0.1231
0.8357	0.4313	0.3329	0.2764	0.8142	-0.0928	-0.1818	0.2603	0.8357	0.5218	0.466	0.61	0.398	0.7594	1	0.442	0.535	-0.0691

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0.4708	0.3323	0.0278	0.192	0.5322	0.1052	-0.2179	-0.0051	0.4708	0.0365	0.3275	0.3133	0.4314	0.3731	0.442	1	0.4809	0.0459
0.6202	0.3101	-0.0223	0.3272	0.4865	0.0184	-0.0871	0.0288	0.6202	0.3411	0.141	0.2193	0.6128	0.633	0.535	0.4809	1	0.0935
0.0754	-0.3015	0.1191	-0.0795	0.2809	0.0089	-0.6142	0.098	0.0754	0.1326	0.36	0.1066	-0.4644	0.1231	-0.0691	0.0459	0.0935	1

C. *Correlation Analysis on Production of Green and Non-Green products*

Table IX portrays the correlation analysis on production of green and non-green products for the considered 29 questions. Since twenty nine questions are analyzed, 29 ×29 matrix is formed as a result of correlation analysis, in which the highest correlation rank is occupied by the question, "29. How the product and service items are satisfied based on Usage experience in accordance with energy management?"

TABLE VII. REPRESENTATION OF 29×29 MATRIX FORMED AS A RESULT OF CORRELATION ANALYSIS ON PRODUCTION OF GREEN AND NON-GREEN PRODUCTS

1	0.3	0.4	0	0.6	0.4	-0	0.2	0.2	0.2	0.3	0.2	0.8	0	-0	0.5	0.4	0.6	0.6	0.1	-0	-0	0.6	0.5	0.4	0.8	0	0.2	0.2
0.3	1	0.2	0	0.4	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.4	-0	-0	0.2	0	0.2	0.2	0.4	-1	-1	0.5	0.3	0.5	0.4	0.4	0.6	0.8
0.4	0.2	1	0	0.2	0	-0	0.6	0.6	0.6	0.6	0.7	0.4	-0	-0	0.4	0.8	0.6	0.6	0.1	-0	-0	0.6	0.7	0.6	0.4	0	0.1	0.1
0.4	0.3	0.4	1	0.3	0.5	0	0.3	0.5	0.5	0.6	0.5	0.1	0.1	0.2	0.5	0.1	0	0	0	0	0	0.2	0.5	0.7	0.1	0.1	0.3	0.4
0.6	0.4	0.2	0	1	0.4	-0	0.1	0.3	0.3	0.4	0.3	0.5	0	0.1	0.2	0.1	0.3	0.3	0.2	-0	-0	0.3	0.2	0.3	0.5	0.1	0.6	0.3
0.4	0.3	0	1	0.4	1	0.3	0	-0	0	0	-0	0.3	0	0	0.2	-0	0.1	0.1	-0	-0	-0	0.1	0.3	0.2	0.3	0.1	0.4	0.5
-0	0.3	-0	0	-0	0.3	1	-0	0	0	0	0.1	0.1	0.3	0.4	0	-0	-0	-0	0.1	0.1	0.1	-0	-0	-0	0.1	0	0.2	0.6
0.2	0.5	0.6	0	0.1	0	-0	1	0.5	0.6	0.5	0.5	0.1	-0	-1	0	0.3	0.4	0.4	0.2	-0	-0	0.5	0.5	0.3	0.1	-0	-0	0.4
0.2	0.5	0.6	1	0.3	-0	0	0.5	1	1	1	1	0.4	-0	0	0.5	0.5	0.4	0.4	0.6	-0	-0	0.7	0.7	0.8	0.4	0.2	0.4	0.5
0.2	0.5	0.6	1	0.3	0	0	0.6	1	1	1	0.9	0.4	-0	0	0.5	0.5	0.4	0.4	0.6	-0	-0	0.7	0.7	0.8	0.4	0.2	0.4	0.5
0.3	0.5	0.6	1	0.4	0	0	0.5	1	1	1	1	0.4	-0	0	0.4	0.5	0.4	0.4	0.6	-0	-0	0.7	0.7	0.8	0.4	0.2	0.4	0.5
0.2	0.5	0.7	1	0.3	-0	0.1	0.5	1	0.9	1	1	0.4	-0	0	0.4	0.5	0.4	0.4	0.6	-0	-0	0.7	0.6	0.8	0.4	0.2	0.4	0.5
0.8	0.4	0.4	0	0.5	0.3	0.1	0.1	0.4	0.4	0.4	0.4	1	0	0	0.5	0.6	0.8	0.8	0.3	-0	-0	0.8	0.5	0.4	1	0.2	0.4	0.4
0	-0	-0	0	0	0	0.3	-0	-0	-0	-0	-0	0	1	0.5	0.3	-0	-0	-0	-1	0.2	0.2	-0	-1	-0	0	-0	0	0
-0	-0	-0	0	0.1	0	0.4	-1	0	0	0	0	0	0.5	1	0.4	-0	-0	-0	-0	0.2	0.2	-0	-0	0	0	0.3	0.4	0.1
0.5	0.2	0.4	1	0.2	0.2	0	0	0.5	0.5	0.4	0.4	0.5	0.3	0.4	1	0.4	0.3	0.3	-0	0	0	0.4	0.4	0.6	0.5	0.1	0.3	0.2
0.4	0	0.8	0	0.1	-0	-0	0.3	0.5	0.5	0.5	0.5	0.6	-0	-0	0.4	1	0.8	0.8	0.3	-0	-0	0.6	0.6	0.4	0.6	0.2	0.2	0
0.6	0.2	0.6	0	0.3	0.1	-0	0.4	0.4	0.4	0.4	0.4	0.8	-0	-0	0.3	0.8	1	1	0.3	-0	-0	0.7	0.5	0.2	0.8	0.1	0.2	0.2
0.6	0.2	0.6	0	0.3	0.1	-0	0.4	0.4	0.4	0.4	0.4	0.8	-0	-0	0.3	0.8	1	1	0.3	-0	-0	0.7	0.5	0.2	0.8	0.1	0.2	0.2
0.1	0.4	0.1	0	0.2	-0	0.1	0.2	0.6	0.6	0.6	0.6	0.3	-1	-0	-0	0.3	0.3	0.3	1	-0	-0	0.5	0.3	0.2	0.3	0.5	0.4	0.4
-0	0.4	0.1	0	0.1	-0	0.2	0.3	0.3	0.3	0.3	0.4	-0	-0	0.2	-0	-0	-0	-0	0.3	-0	-0	-0	0	0.2	-0	0.2	0.3	0.3
-0	-1	-0	0	-0	-0	0.1	-0	-0	-0	-0	-0	-0	0.2	0.2	0	-0	-0	-0	-0	1	1	-1	-0	-0	-0	-0	-0	-0
0.6	0.5	0.6	0	0.3	0.1	-0	0.5	0.7	0.7	0.7	0.7	0.8	-0	-0	0.4	0.6	0.7	0.7	0.5	-1	-1	1	0.9	0.7	0.8	0.2	0.2	0.3
0.5	0.3	0.7	1	0.2	0.3	-0	0.5	0.7	0.7	0.7	0.6	0.5	-1	-0	0.4	0.6	0.5	0.5	0.3	-0	-0	0.9	1	0.8	0.5	0.2	0.2	0.2
0.4	0.5	0.6	1	0.3	0.2	-0	0.3	0.8	0.8	0.8	0.8	0.4	-0	0	0.6	0.4	0.2	0.2	0.2	-0	-0	0.7	0.8	1	0.4	0.3	0.4	0.4

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0.8	0.4	0.4	0	0.5	0.3	0.1	0.1	0.4	0.4	0.4	0.4	1	0	0	0.5	0.6	0.8	0.8	0.3	-0	-0	0.8	0.5	0.4	1	0.2	0.4	0.4
0	0.4	0	0	0.1	0.1	0	-0	0.2	0.2	0.2	0.2	0.2	-0	0.3	0.1	0.2	0.1	0.1	0.5	-0	-0	0.2	0.2	0.3	0.2	1	0.8	0.2
0.2	0.6	0.1	0	0.6	0.4	0.2	-0	0.4	0.4	0.4	0.4	0.4	0	0.4	0.3	0.2	0.2	0.2	0.4	-0	-0	0.2	0.2	0.4	0.4	0.8	1	0.6
0.2	0.8	0.1	0	0.3	0.5	0.6	0.4	0.5	0.5	0.5	0.5	0.4	0	0.1	0.2	0	0.2	0.2	0.4	-0	-0	0.3	0.2	0.4	0.4	0.2	0.6	1

D. `Correlation Analysis on Production of FMCG and Non- FMCG products

Table X describes the correlation analysis on production of FMCG and Non- FMCG products for the analyzed 18 questions. As eighteen questions are analyzed, 18 ×18 matrices is formed from the correlation analysis, in which the highest correlation rank is occupied by the question, "56. Are there any worthwhile commission schemes and rewards for better management of energy concerned FMCG products?"

TABLE VIII. REPRESENTATION OF 18×18 MATRIX FORMED AS A RESULT OF CORRELATION ANALYSIS ON PRODUCTION OF FMCG AND NON- FMCG PRODUCTS

1	0.4478	0.7075	0.3062	-0.015	-0.308	0.525	0.2883	0.618	0.562	0.5788	0.105	0.6606	0.3945	0.5763	0.563	0.2571	0.547
0.4478	1	0.2542	-0.026	-0.142	-0.347	0.172	0.1302	0.4795	0.588	0.618	0.172	0.307	0.696	0.4733	0.4827	0.2507	0.599
0.7075	0.2542	1	0.4192	-0.025	-0.128	0.785	0.4794	0.6196	0.425	0.6737	0.436	0.4047	0.1025	0.3294	0.6883	0.187	0.3032
0.3062	-0.026	0.4192	1	-0.142	-0.677	0.231	0.449	0.2185	0.074	0.3136	0.053	-0.13	-0.042	0.4512	0.342	0.3972	0.1235
-0.015	-0.142	-0.025	-0.142	1	0.3689	0.207	0.1465	0.4438	0.364	-0.155	0.355	0.2159	-0.191	0.0102	-0.22	0.0181	0.2573
-0.308	-0.347	-0.128	-0.677	0.3689	1	0.101	-0.028	-0.02	-0.24	-0.335	0.101	-0.05	-0.223	-0.482	-0.335	-0.511	-0.395
0.5245	0.1723	0.7849	0.2309	0.2073	0.1011	1	0.7202	0.7797	0.428	0.5423	0.655	0.4457	-0.122	0.2309	0.6042	0.412	0.2997
0.2883	0.1302	0.4794	0.449	0.1465	-0.028	0.72	1	0.66	0.263	0.4392	0.531	0.1131	-0.067	0.3514	0.3051	0.6271	0.2635
0.618	0.4795	0.6196	0.2185	0.4438	-0.02	0.78	0.66	1	0.705	0.633	0.601	0.6297	0.2317	0.4492	0.4357	0.431	0.6854
0.562	0.5875	0.4248	0.0735	0.3641	-0.24	0.428	0.2631	0.7049	1	0.4413	0.68	0.4342	0.3701	0.333	0.2903	0.3627	0.7444
0.5788	0.618	0.6737	0.3136	-0.155	-0.335	0.542	0.4392	0.633	0.441	1	0.257	0.5581	0.6372	0.2401	0.5901	0.2973	0.6449
0.1049	0.1723	0.4361	0.0533	0.3553	0.1011	0.655	0.5307	0.6005	0.68	0.2569	1	0.1029	-0.122	0.0533	0.2776	0.412	0.2997
0.6606	0.307	0.4047	-0.13	0.2159	-0.05	0.446	0.1131	0.6297	0.434	0.5581	0.103	1	0.3223	0.2237	0.2814	0.2416	0.7151
0.3945	0.696	0.1025	-0.042	-0.191	-0.223	-0.122	-0.067	0.2317	0.37	0.6372	-0.122	0.3223	1	0.1461	0.2111	-0.075	0.5071
0.5763	0.4733	0.3294	0.4512	0.0102	-0.482	0.231	0.3514	0.4492	0.333	0.2401	0.053	0.2237	0.1461	1	0.5943	0.5604	0.3087
0.563	0.4827	0.6883	0.342	-0.22	-0.335	0.604	0.3051	0.4357	0.29	0.5901	0.278	0.2814	0.2111	0.5943	1	0.3852	0.1703
0.2571	0.2507	0.187	0.3972	0.0181	-0.511	0.412	0.6271	0.431	0.363	0.2973	0.412	0.2416	-0.075	0.5604	0.3852	1	0.4957
0.547	0.599	0.3032	0.1235	0.2573	-0.395	0.3	0.2635	0.6854	0.744	0.6449	0.3	0.7151	0.5071	0.3087	0.1703	0.4957	1

E. Overall Correlation Analysis

Table XI demonstrates the overall correlation analysis of the three considered topics, namely, energy policy, production of green and non-green products, production of FMCG and Non- FMCG products. Here, the overall correlation analysis is attained based on the most correlated three ranks namely, **A1:**"Whether the industry has an energy policy?", **B11:**"How the product and service items are satisfied based on Usage experience in accordance with energy management?" **C10:** "Are there any worthwhile commission schemes and rewards for better management of energy concerned FMCG products?" As three questions are taken into account, a 3 ×3 matrix is formed from the correlation analysis. From the overall analysis, the best correlation is finally attained by the question, "1. Whether the industry has an energy policy?" Correlation coefficient (a value between -1 and +1) tells you how strongly two variables are related to each other. A value +1 indicates a perfect positive correlation.

TABLE IX. REPRESENTATION OF 3×3 CORRELATION MATRIX FORMED AS A RESULT OF OVERALL CORRELATION ANALYSIS

	Q-A1	Q- B11	Q- C10
Q-A1	1	0.5385	0.5714
Q- B11	0.5385	1	0.31
Q- C10	0.5714	0.31	1

Which says,

- Question **A1** and Question **B11** are positively correlated and correlation coefficient is **0.5385**.
- Question **A1**and Question **C10** are positively correlated and correlation coefficient is **0.5714**.
- Question **B11** and Question **C10** are positively correlated and correlation coefficient is **0.31**.

VI. CONCLUSION

This paper gives the numbers of uncertainty factors from three phase questionnaire fill up by the industrial authorities which were then taken for analysis that primarily focuses on correlation coefficients. The study concludes dependencies of diverse factors related to the mainly three highest correlation rank questions from each phase of questionnaire.

Question A1: "Whether the industry has an energy policy?"

Question B11:"How the product and service items are satisfied based on Usage experience in accordance with energy management?"

Question C10: "Are there any worthwhile commission schemes and rewards for better management of energy concerned FMCG products?"

The study further investigates the individual characteristic of each question which will help in predicting industrial energy consumption to increase the prediction accuracy. It can reduce the gap between power demand by industries and power supply by power management which may increase the percentage of project success.

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