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CUSTOMER PURCHASING PATTERN
SEGMENTATION USING MACHINE LEARNING

Capstone Project-II ⁵ *Report submitted in*
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Submitted by

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IN

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

Under the Supervision of

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(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

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DEPARTMENT OF
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BONAFIDE CERTIFICATE

Certified that this project report “**CUSTOMER PURCHASING PATTERN SEGMENTATION USING MACHINE LEARNING**” is the bonafide work of “**YASHRAJ SINGH (18021011952), GUNJAN KUMAR (18021011974)**”, who carried out the project work under my supervision.

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APPROVAL SHEET

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PATTERN SEGMENTATION USING MACHINE LEARNING**

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CUSTOMER PURCHASING PATTERN SEGMENTATION USING MACHINE LEARNING

Statement of Project Report Preparation

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4. Specifications regarding thesis format have been closely followed.
5. The contents of the thesis have been organized based on the guidelines.
6. The report has been prepared without resorting to plagiarism.
7. All sources used have been cited appropriately.
8. The report has not been submitted elsewhere for a degree.

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ABSTRACT

Buying pattern of the consumer has been drastically changed in COVID-19. With the increased inconsistency in a change of the consumer, their buying pattern has also been changed. People's buying habits have changed as they learn to cope with the current reality of COVID-19. Online involvement in purchasing requests has increased, and Customer segment start having online shopping to their menu in response to changing customer preferences. With all the constant adjustments, the customer has a lot of unanswered questions. As a result, when Covid19 first came out, people were scared to leave their homes and they were afraid of Covid. They're also debating whether to go out and buy basic day to day products. Data mining method is being widely used for generating transactional data and gains its analytics for market forecasting. In this paper, we are using association rule mining and unsupervised clustering method for mining association rule between frequent item set.

Key words- Data Mining, Big Data, Machine Learning, AI

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List of abbreviations

1. AGMA American Gear Manufacturer's Association
2. CVT Continues variable transmission
3. GR Gear ratio
4. HP Horse power
5. TE Tractive effort
6. ATV All Terrain Vehicle
7. SAE Society of Automotive Engineers

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CHAPTER 1

INTRODUCTION

With rise demand in online transaction of Payment and open system-based ticketing system. The transaction produces huge amount of unstructured data which is used for completing the banking transaction successfully. Online analytical processing and transaction processing is method of Data Warehousing technology in which two different forms if temporal data are stored in data marts related to specific problem separately as per different designing and hierarchy concepts. These transaction produces the sequence of series in which frequently used transaction item are arranged. In course of Data mining, Association rule mining is used to investigating interrelationship between variable in large scalable data-based system. It is used to identify the frequently and maximum assignment of association between two entities strongly by using apriori algorithm. Market basket analysis is a well research area of mining customer purchasing habit by finding association between two items set in transaction data. Such investigation may help market analyst to market demand forecasting. The association works in a way if item 1 has brought maximum times, then how likely item 2 to be brought along with [1] [2]. Market decision making is one of the crucial processes of business decision support system. Thus, In this paper we are using supermarket data of covid -19 for analyzing the item association using data mining approach. The major contribution of this paper is that we have proposed a mining algorithm with less qualitative analysis like lesser time and space complexity. The paper organization is as [section 1 contains introduction](#), [Section 2 literature review](#), [Section 3 Algorithm analysis](#), [Section 4 proposed method and output](#).

CHAPTER 2

LITERATURE REVIEW

In Ref. [3], the author used a clustering-based data mining method for analyzing the trends of market during festivals with the high support and accuracy of 79%. The author in Ref. [4], have implemented supervised classification algorithm for surety prediction in college campus market. In Ref. [5], the authors propose a model based on the Deep learning algorithm for defining the involvement of customer in particular e-commerce website to draw the attention of click based web mining system. In Ref. [6], the author reviewed the performance of data mining algorithms on different datasets like labeled and unlabeled, tested upon different classifiers such as SVM and PCA. In Ref. [7], the authors have proposed a tool for school education for positive and negative emotion recognition with an accuracy rate of 70%. In Ref. [8], the author proposed a model to give recommendation on personalized movie interest. The author of Ref. [9] proposed MSDF based model to efficiency in classification algorithm for large scalable big data system in open-source root monitoring system with the precision of 78% and recall 91%. In Ref. [10], the authors proposed a model based on CBIR to address the different kinds of semantic gap inclusion with different RGB formats with different classification rate from 76-98% [3] [4].

CHAPTER 3

MATERIALS AND METHODS

3.1 Market based analysis

With the rise in the automation of this decision support system. Businesses and enterprises use business intelligence and determine these tools. On data analytics, data management, and decision support systems. for making business processes more efficient and reliable. and full of injuries. Data mining is one of the things widely used methods in commercial enterprises. Customer market basket analysis, segmentation, recommendation system, and market forecasting in businesses analysis of market baskets. It involves the method for finding the associations between customer purchasing patterns and the different items in a particular supermarket. and others. places for marketing. The examination of such patterns in the associations of the product, it relies upon gaining insight into the items that have been frequently purchased by the customer. For instance, if a customer buys a computer, how likely is it that the customer is also looking for the adoption of related products gadgets to that system. So, this way, the frequent associations are mined based on the transactional data. Market basket analysis is commonly used by market analysts to examine customers based on their purchasing habits and segment them based on the type of customer base they have. What kind of reference do you have for the specific product? Let us assume that the specific strategies in the market opportunities are dependent on transactional data, and threshold and frequency of the label [5] [6]

3.2 Association Rule Mining

Association rule mining can be defined as the set of items denoted by the I-1 to I_n and the set of deleted transactions. By the time one to two N has the binary attributes called items, and the set of transactions in the scalable database, each transaction has a unique transaction ID and item ID, which is a subset of the role in the implicit form that is generated, EX equals to Y. The set of items is gained as it is entertained. The right-hand signed arch, and the left-hand side generated rules as a result. Let us assume that we use a smaller database, and it contains the frequency of the items called milk, butter, bread, and biscuits. So, this molds the transaction of

the database, even having the codes in the present form of zeros and ones. An example rules in the supermarket Which could be the association between these two items having the transaction ID confidence, support, and the maximum threshold value.

3.3 Support, Confidence, and lift

Support: In association rule mining can be defined as. The number of proportion of the items in the transaction in which the particular set items contain the definite set of items within one set in the database and has a support maximum of 1. Rescue 5 and it occurs all the 20% of the entire transactions. The confidence based rule can be defined as. The confidence equal to support means the total support by the total confidence in the particular database, which means the 100% of the transaction. Consist of the particular rule. Which in having the maximum estimation of the probability of the occurrence in the arties in a rule in the transactions of this particular database lift in association rule mining can be defined as the total number of support by the total number of transaction one support plus total number of confidence of the item occurred in the conviction of the rule of the database. These three parameters are defined and have convictions of associations for having interpretation the association rule generation which is observed in the frequency of the database.

$$s = ta = tc \frac{1}{t}$$

3.4 Frequent pattern mining

Frequent pattern mining: Data mining can be defined as mining. The constrained, frequent items have the appropriate approximate set of items. In the itemset's frequent number and approximate frequent value, Which is produced by the main rule mean clustering. Suppose the set of associations in the come in clustering consists of the key entropy in the cluster groups, which includes Total rules. And abstracted in the particular database, the data dimensions can be described as the items and the attributes, such as dimension in the sense of the occurrence frequency of the items. At the maximum threshold value within the database [7].

3.5 Apriori Algorithm

The Apriori Algorithm is an algorithm that was proposed by R. Agarwal for association rule mining. From the Boolean association set of rules in the knowledge representation of the

artificial intelligence large scale database system, There are ¹⁷ a number of frequent algorithms that have been proposed. In light of the preceding, It associates the level of voice search and Linear search Method within the database: its form is found ¹³ by scanning the database, which consists of the count of each item. And investigating those items within the database that have the maximum support. The result is the maximum item set within the database. If repeated and until the maximum support is reached [8].

CHAPTER 4

Methodology

Separate titles for specifics may exist, resulting in inconsistencies and repetitions. Information change is a cycle technique similar to normalizations and classifications. Extra preprocessing steps are established by solidification, add to the outcomes of the mining process. Information reduction results in a simpler data collection image, which is vitally important. Despite its shorter duration, it provides a similar (or almost identical) level of perceptive efficacy. There are a plethora of information reduction strategies in use. This includes the following: Data Compilation (e.g., Creating an information shape), Determination of attribute subsets (By comparability, wiping out superfluous characteristics), Dimensionality Reduction (e.g., employing insignificant encoding schemes lengths of encoding or wavelets), Decreased Numerousness (e.g., "Supplement" subtleties by swapping, more modest ones), depictions such as clusters or parametric designs, Generalization (for example, data was limited). The proposed flowchart of algorithm is as follows [9] [10] :

Input: Transaction database D.
Minimum support threshold minsup.

Output: frequent item set b in D.

Begin
 $L_1 = \text{find_frequent_1-itemsets}(D)$;
For ($k = 2$; $L_{k-1} \neq \emptyset$; $k++$) {
 $C_k = \text{apriori_gen}(L_{k-1}, \text{minsup})$; //New candidate
For every transaction $t \in D$ {
Candidates included in $C_t = \text{subset}(C_k, t)$; //t
For each candidate $c \in C_t$
 $C.\text{count}++$;
} }
 $L_k = \{c \in C_k \mid c.\text{count} > \text{minsup}\}$
}
Return $L = \cup_k L_k$
End

The proposed flowchart is shown in figure 1

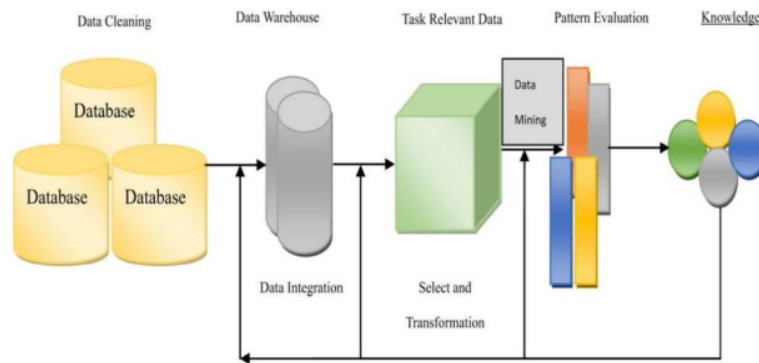


Figure 1: Process flow of proposed algorithm

The most popular method of selecting a model that better organizes the dataset is model selection or computation determination. Given information, model determination is the task of selecting a measurable model among a group of competitors [11]. A pre-it is a collection of information that exists in the simplest of instances. In any event, the task might also include the design of trials in order to ensure that the data acquired is relevant to the issue of model determination. The calculation is completely responsible for model creation. There are also a few computations that do not construct a model and rely on the dataset for the most part. After reviewing everything, we decided on a model that provides the highest level of precision. Nave was one of the classifiers utilized. The affiliation rule is linked to the statement of "what" with "what." This topic might be taken as an explanation of how customers complete trade development at a store [12] [13]. As a consequence of this

assertion, there is a strong relationship between examining client trade data informational gathering and determining the inclination for a purchased item with what object, and so, alliance rule is widely advocated as market receptacle investigation. Two criteria can be used to calculate the relevance of a well-known standard: explicit support and conviction. The phrase "backing" is a concept that refers to the process of obtaining (as in "supporting worth") [14] [15] [16]

Confidence If c percent of the exchanges in a contain a, then the criterion t a holds with confidence c. The person who decides that a c is more prominent than a client-determined level of confidence is said to have the least level of certainty: Support If s percent of transactions in a contain X Y, the standard t c holds with assistance s. The person who decides that a s is more important than a client-determined help is said to have the least help

[11].

$$s = \sum ta + tc \frac{1}{\sum t} \quad (4)$$

$$support = \frac{\text{the number of transaction on a}}{\text{total transaction}} \quad (5)$$

Where; S is support; $ta + tc \frac{1}{(\sum t)}$ is the amount of operation that contains antecedent and consequent; and is the number of transaction.

$$Confidence = \frac{\text{number of transactio on Aand b}}{\text{total number of transaction a conytains}} \quad (6)$$

Where; C is the confidence; is the numeral of operation that contains antecedent and subsequent; and is the number of operation that restrain antecedent [8].

calculation of affiliation rule mining. For Apriori calculation we really want something sets to remove an example of most regular thing sets. Successive Item set: A thing set whose help is more noteworthy than or equivalent to a min_sup limit. Incessant thing sets can assist with supporting showcasing choices and give an extremely valuable design. In affiliation rule mining task from a bunch of exchanges T , the objective of affiliation rule mining is to find all rules having [17].

Support $\geq min_sup$ limit and

Confidence $\geq min_conf$ limit

In figure 2 we show histogram of frequent items



Figure 2: Frequent item set.

Out[41]:

	consequent	antecedent	support	confidence	lift
4	root vegetables	yogurt, tropical fruit	228	0.463636	2.230611
5	sausage	shopping bags, rolls/buns	59	0.393162	2.201037
8	tropical fruit	yogurt, root vegetables	92	0.429907	2.156588
1	citrus fruit	whole milk, other vegetables, tropical fruit	66	0.333333	2.125637
10	yogurt	whole milk, tropical fruit	199	0.484211	1.891061
2	other vegetables	yogurt, whole milk, tropical fruit	228	0.643836	1.826724
6	shopping bags	soda, sausage	50	0.304878	1.782992
0	bottled water	yogurt, soda	59	0.333333	1.707635
9	whole milk	yogurt, tropical fruit	228	0.754098	1.703222
3	rolls/buns	yogurt, tropical fruit	97	0.522222	1.679095
7	soda	yogurt, sausage	95	0.390625	1.398139

Figure 3: Screenshot Of Output Showing Support, Confidence And antecedent

In figure 3 we have shown output of python showing transactional data output of supermarket, 4, 5, 6 the result of customer segment as per their income and purchasing habit shown using clustering. Figure 3 shown confusion matrix of classified accurate data [18].

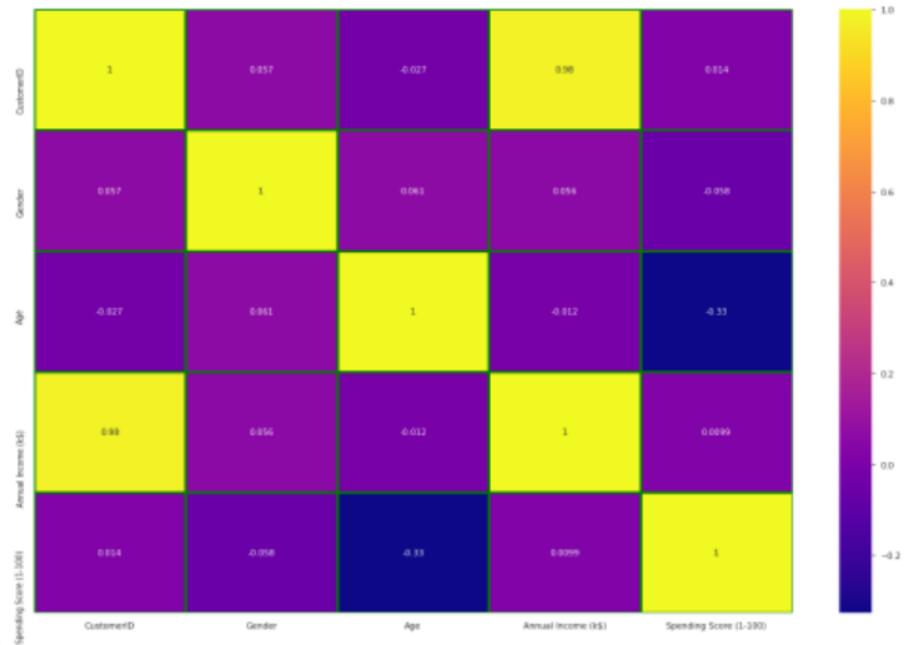


Figure 4: confusion matrix

Figure 5, gives cluster in data point

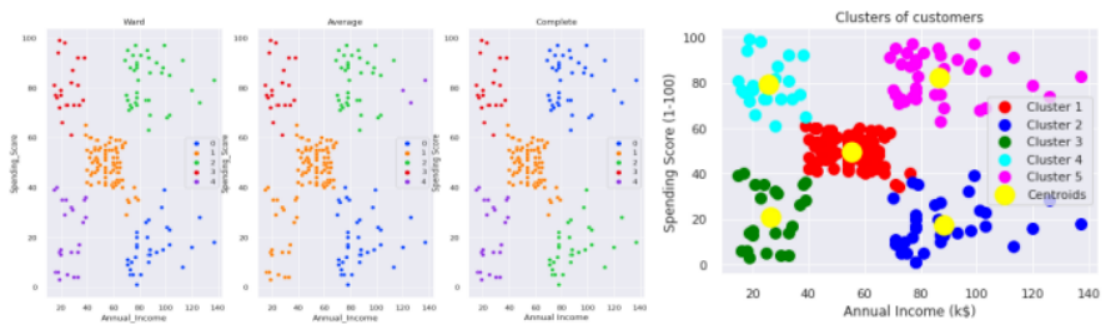


Figure 5: Types of purchasing habit of customer as per their income

CHAPTER 6

CONCLUSION

Throughout the study, we used association rule mining to do market basket analysis and determine which customers frequently purchased a specific set of products. Data mining for association rules has a wide variety of applications in e-commerce. One of the most common uses is in CRM systems, where a company may design marketing efforts to have the greatest impact based on previous data. This information was gathered. It is possible to expand the use of association rules mining to detect fraud. There are various uses for associating a rule once the transaction is completed.

CHAPTER 7

FUTURE SCOPE AND LIMITATION

As per the current scope of this study association rule mining is not so robust because of having its only one factor of statistics. Big data is very complex in nature and mining abstracted data format from data warehouse requires algorithm to be optimized in terms of analyzing the dimension and minimizing global optimum. So , more robust algorithm can be developed with swarm intelligence for data cluster optimization.

CHAPTER 8

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CHAPTER 9

APPENDIX

Optimizing parameters for waste heat conversion in Thermo electric generator

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Abstract.

Waste heat energy from car exhaust may be converted into useful power using thermoelectric modules, which are used in thermoelectric generators. This energy can then be recovered and used in other applications. An problem of reduced power production due to the uneven distribution of temperature gradients on the heat exchanger's surface is typical in real-world operation. Individual modules and a bench were used in this case study to examine how thermal imbalance affects output electrical power. During the individual module measurement, the temperature difference and the clamping pressure are also evaluated for any fluctuations. Experiments at the system level clearly show that when the temperature conditions are mismatched and the working temperature is confined, the thermoelectric generator power output is reduced. Solution: The modules may be thermally insulated.

Keywords: Waste heat Energy, Thermo electric Generator, Heat exchanger

2 **1. Introduction**

A thermoelectric generator (TEG) is a device that, as a result of the Seebeck effect, turns heat energy directly into electrical energy and vice versa and is used to generate electricity.

When it comes to waste heat recovery, it has shown excellent promise as well as tremendous potential over the last several decades. Because TEGs do not include any mechanical components, they have the ability to function for an extended period of time without making any noise. This is only one of the various benefits of working with them. They are also environmentally friendly, and their correct operation does not need any continuing maintenance efforts. Because it only uses 30 percent of the entire heat created by the gasoline necessary to power the car it drives, it is believed that the internal combustion engine (ICE) is responsible for a substantial share of the fuel crisis and environmental degradation. During the course of this process, it is anticipated that 40 percent of the heat is lost by waste gas exhaust, with another 30 percent of the heat lost through the cooling water. TEG is said to be able to reduce ICE and alternator loads when utilised as a heat source. This, it is claimed, results in reduced fuel consumption as well as fewer emissions of harmful pollutants into the environment. A number of automobile manufacturers, most notably General Motors in the United States and BMW in Germany, have successfully developed TEGs for the purpose of recovering waste heat from exhaust emissions. It was because of the ability of the Be₂Ti₃-based bulk thermoelectric material to withstand the rigours of the complicated automotive environment, as well as the fact that it is commercially available, that the great majority of car manufacturers chose this material to be used in their vehicles. When it came to the thermoelectric materials, on the other hand, they had a detrimental influence on efficiency of the TEG system, which resulted in a system Overall, the efficiency, is below 5 per cent.

2. Experimental Set-Up

In order to increase the thermal conductivity of the system, a TEM is formed of a large number of thermo elements that are electrically connected in series with one another as well as thermally coupled in parallel with one another. TEMs are now being employed because of their capacity to operate at greater voltages than were previously possible. TEMs may convert thermal energy to electrical energy (thermoelectricity) in the presence of a temperature difference by using the Seebeck effect to transfer thermal energy to electrical energy, a process known as thermoelectricity.

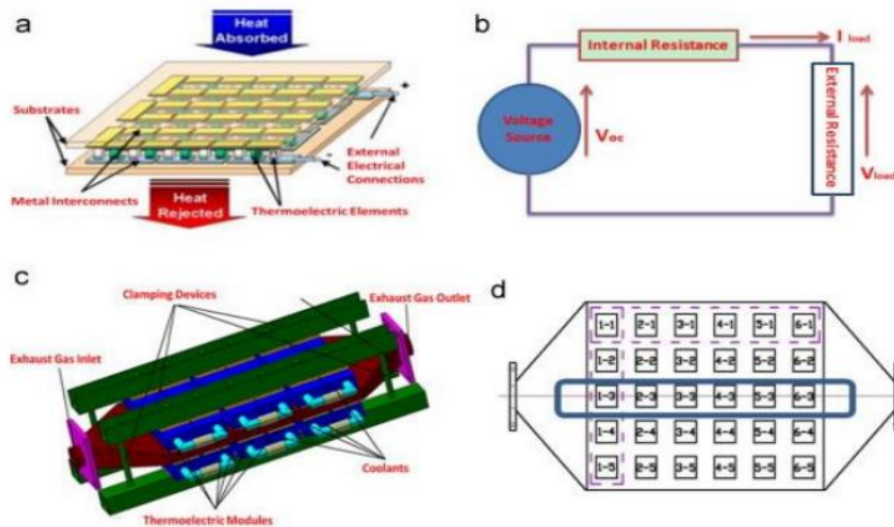


Figure-1 -Schematic diagram for utilization of waste

Bench tests for the TEM and TEG systems have been developed, one for each.

According to the figure, the same test setup is utilized to examine the performance of one TEM at various temperatures. TEM test setup at various temperatures is shown in Figure 2. Wuhan University of Technology's Institute of New Materials has donated a transmission electron microscope (TEM) (50*50 mm) for use with the system, which is sandwiched between two cold blocks on top and a hot block below. An oil tank fitted with a thermostatic oil bath (between 10 degrees Celsius and 120 degrees Celsius) may be used in place of the high-temperature heater, which is driven by DC power. To apply pressure to the TEM, an adjustable load cell must be used, and an electronic load is needed to monitor the TEM's output power and voltage.

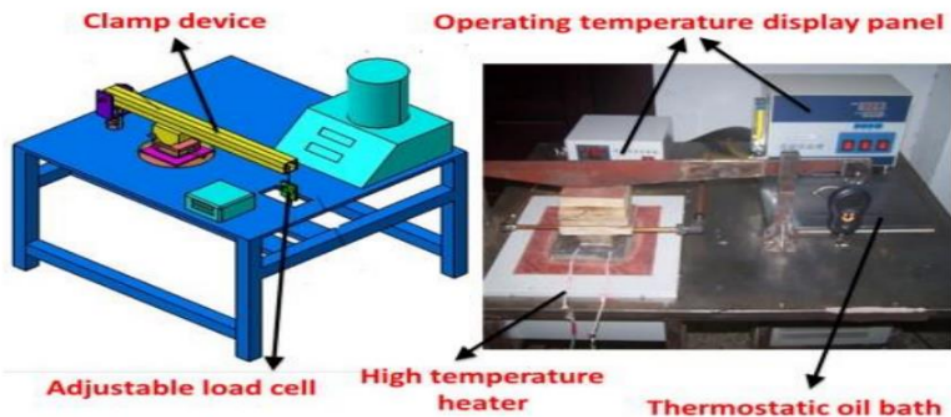


Figure- 2 Set -Up for experiment

3. Result and Discussion-

TEM (thermal emission spectroscopy) testing Performance analysis and assessment of the system must be completed before any system performance testing can be performed, and this should be done by examining each individual TEM. Figure 2 depicts the experimental setup in schematic form. Maximum operating temperatures should not exceed 350 degrees Celsius owing to the restricted working temperature (less than 360 degrees Celsius). The TEM is subjected to a variety of clamp loads throughout the testing procedure in order to improve electrical performance. Electrical qualities that were correct may be achieved by altering electrical loads at various levels while preserving a temperature difference, according to the manufacturer. Measurement of the open circuit voltage V_{oc} as well as the short circuit current I_{sc} are both required to estimate the internal resistance of an electronic device. A point on the circuit diagram indicates that the electrical load matches the internal resistance R_L when that condition is met. Temperature differences of 260 degrees Celsius between the two surfaces of the TEM resulted in straight lines for output power versus current measurements, as shown in Fig. 3

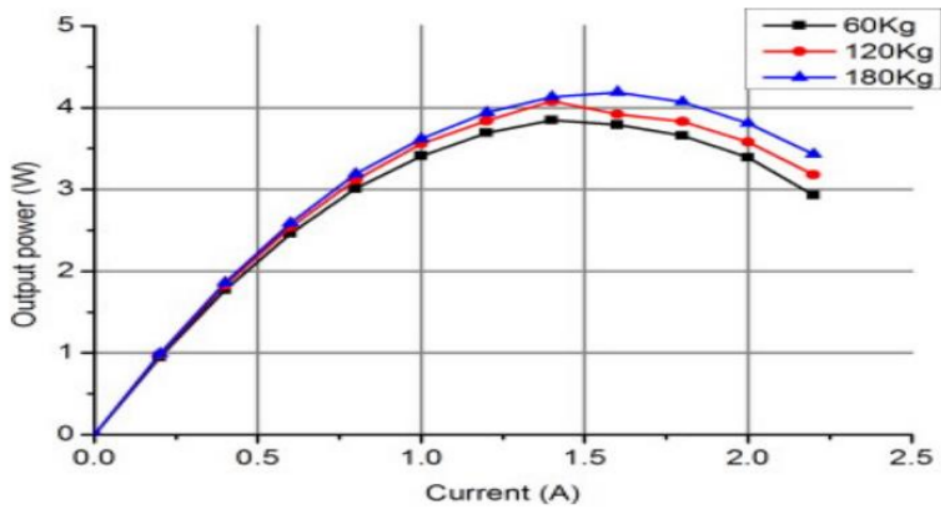


Figure 3- Variation of Power with Current

Fig. 3 shows that as the current changes, electrical power changes with a mono-peak curve, reaching its maximum of 4.19 W at 1.6 A (Fig. 4). Peltier effect may be avoided by changing the TEM output power when the current flow in the system is less than 1.6 A. This results in a lower thermal conductivity and lower output power. This results in a decrease in total energy flow through the TEM as opposed to when running at full power, which is beneficial to the heat exchanger design since it leads to a gain in overall thermal efficiency. TEM thermal conductivity rises when the current is more than 1.6 A. This means that the amount of thermal energy that travels through the TEM is greater than it would be in a maximum power state. Because of this, the apparatus' thermal efficiency is reduced. During the course of a vehicle's operation, temperature disparities do not stay constant; rather, they vary. In certain temperature mismatch cases, it is hard to estimate the maximum power since the temperature difference is not continuous. The pressure load in the experiment was 180 kg, a 3D map of the TEM's peak output power achieved under different temperature changes (0.72 Mpa).

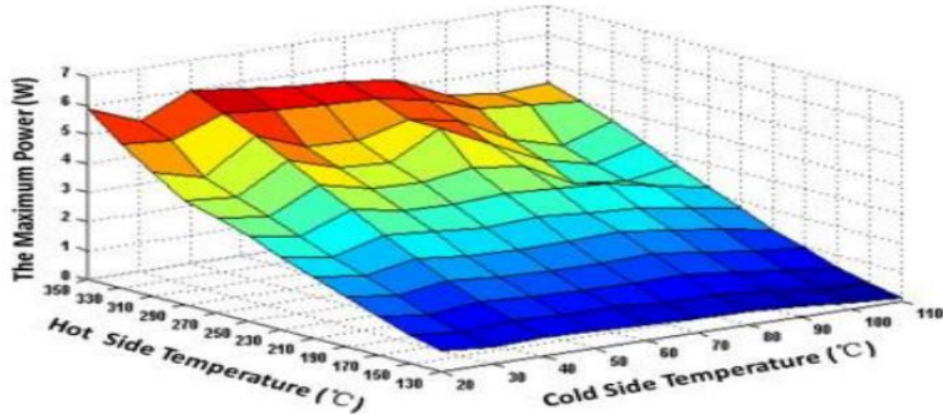


Figure 3- Performance Evaluation of the system

Fig. 3 depicts a schematic representation of an experimental test bench for system performance assessment. A test bench for system performance monitoring is shown in this picture as an interior configuration, which represents an experimental test bench for the system. According to the picture below, the TEG system is shown in Figure 1 being connected to a central section of the engine's exhaust pipe. It is necessary to connect six temperature measuring devices (TEMs) in series along the central axis in order to account for shrinkage of the temperature distribution along exhaust direction and symmetry of the distribution perpendicular to flow direction. The TEMs are numbered 1-3, 2-3, 3-3, 4-3, 5-3, and 6-3. (Fig. 1d). Whenever mechanical pressure loads are applied, a preset value of 180 kilograms per square metre is applied to the modules. Through the placement of two thermocouples on its intake and output parts, it is intended to deflect excess waste heat away from the TEM, preventing damage. For added safety, the intake and output of this system have a bypass gas circuit fitted to prevent damage. To keep the TEM safe, a gas bypass circuit is used.

The TEG coolant unit is connected to the engine cooling system on the cold side, which decreases the amount of space needed and lowers the total cost of the system. As a consequence, the temperature on the cold side may be kept at or below 90 degrees Fahrenheit. During operation, the engine creates a temperature differential, which causes a direct voltage to accumulate across the temperature electrode grid. It is possible to create a temperature difference while the engine is functioning (TEG). Figure 6 shows the intake and exhaust temperatures of the engine during a highway driving cycle at a speed of 2500-3400

rpm, which is based on the highway driving cycle (see text for more information). When the engine speed rises, the output power of the TEG system grows as a direct function of the temperature differential between the TEM's surfaces, as indicated by the growing temperature differential in Figure 1. As soon as the hot side of the TEM reaches 350 degrees Celsius, the bypass gas circuit is activated to prevent the TEM from being damaged by the heat. When the engine is forced to surpass this limit, even at higher engine speeds, the maximum output power is lowered as a result of the reduction in maximum output speed.

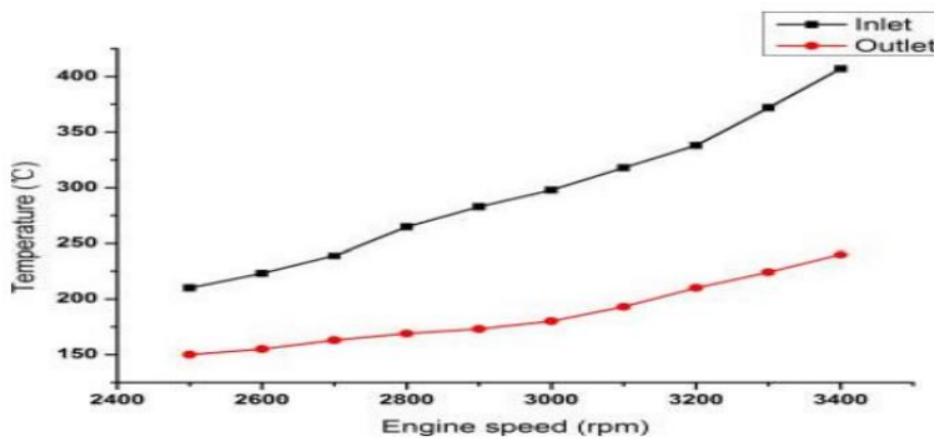


Figure-4- Variation of engine speed with Temperature

As an array, the six TEMs are electrically coupled in series, and TEMs 1–3 operate at their maximum high temperature limits at 3200 rpm. It is possible to determine a total maximum electric output power of 15.86 kW by adding the observed electrical characteristics of each of six TEMs (as shown in Fig. 7), and then multiplying the results by these values (as indicated in the table). As a group, the six modules produce 14.12 W with a current of 1.25 A, which is 11% less power than the TEMs could produce when evaluated individually. This is because they are connected in series and examined as a unit. At currents less than half of their optimal working values, they are reaching higher levels of thermal efficiency while incurring less of the parasitic Peltier effect. Raising heat conductivity while simultaneously increasing the parasitic Peltier effect results in a less efficient operating point. When this happens, the temperature differential between e modules becomes smaller, which exacerbates the problem of temperature mismatches between the two modules. In addition to the series link itself, the series link's cabling and connectors would contribute to the loss of power. Excess waste heat

may be divided for module protection by the bypass gas circuit when the input temperature exceeds 350 °C. This results in the maximum output power staying at 14.12 W.

4. Conclusion

Under mismatch conditions, such as low working temperature or uneven temperature distribution across modules connected in series, the electrical performance of the TEM and TEG systems is further investigated. It has been developed and implemented an individual module testing system as well as a test bench, in order to investigate and analyse the impacts of thermal imbalance on electrical power production. The results of the experiments are provided in order to provide insight into the influence of mismatch circumstances, such as mechanical stress and temperature, on electrical performance during operation of the equipment. By applying the required mechanical pressure to the module, it is possible to increase the electrical performance of the apparatus. The findings of the experiments demonstrate that the modules linked in series suffer a considerable power loss of 11 percent less than the theoretical maximum power as a consequence of the temperature mismatch between the modules. When thermal insulation is applied to the modules, temperature distribution anomalies may result in power losses of up to 2.3 percent under the same operating conditions. In this configuration, the TEG's power output increases to 17.3 W at 3400 rpm, a 22.5 percent improvement above the TEG's power output when not insulated from engine heat. Using an innovative and effective technique to manage the inconsistent electrical properties of modules, it is possible to increase the performance of the TEG system when the engine is working at a higher than typical speed.

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