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Measuring the Activities of Human Resources systems based IoT using Machine Learning Techniques

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ABSTRACT:

The electronic Human Recourses (eHR) management solutions are frequently employed in large organizations and sectors. For the company, such eHR is extremely competent, congruent, affordable, and committed. These days, eHR is greatly impacted by the Internet of Things (IoT), which provides eHR functions like standards, privacy, and security with a variety of facilities and supports. There are several uses for eHR and IoT together to execute plans, rules, and practices inside the company. The five essential components of an eHR are e-Selection, e-Recruitment, e-Performance, e-Compensation, and e-Learning. The suggested system in this study consists of two components. The first section covered a discussion and detailed explanation of the different eHR tasks using examples. The second section describes and provides examples of analytics of data using IoT for every eHR task. The four parts of the data analytics section are as follows: (a) preparing the data; (b) choosing features; (c) classifying the data; and (d) assessing performance. Four HR analytic datasets gathered at the Kaggle site were used to conduct extensive experimentation for each eHR activity. Ultimately, each dataset was used to perform performance with appropriate reasons for each eHR activity. CART outperformed kNN and SVM classifiers in terms of performance.

KEYWORDS

Electronic Human Resource (EHR); eHR Activities IoT; Machine learning (ML); deep learning (DL); AI

1. INTRODUCTION

Human Recourses (HR) department is responsible for maintaining the ideas and creativity of employees, which are what make the company successful. [1] The practices and disciplines that include and create various resources concerning employees for the organization are included in HRM. [2] HRM makes use of personnel management strategies to maintain workforce availability while boosting output and lowering service delivery expenses. People are valuable assets for a company, and the success of the company depends on having the proper people and having the correct skills and expertise. The company's HRM division is in charge of these procedures. [3] HRMS refers to the applications that combine the specialties, hypotheses, processes, and duties of HRM with the discipline of technology in order to manage daily human resource processes and increase system efficiency and effectiveness. This HR software provides the HR department with a range of tools to manage hiring and selection procedures, employee data management, salary administration, performance evaluation and reward administration, employee online learning opportunities, attendance tracking, employee meetings for benefits to the organization, and employee requirements to the organizations, among other things. In order to give HR specialists access to more crucial procedures and positions, the work [4] investigated the concept of an e-green field within the current HRIS.

As a result, the Human Resources department programming is carried out in a highly coordinated, flexible, and proactive manner to the point where the HR offices and the two representatives have a clear understanding of each other's needs, advantages, and association functions. HR systems are the middle of the road progressively work in the formative way of HRM, or at least, e-HR. HR stage when the workers were as yet viewed as an asset. The HR framework is a means of putting away and sharing data about the "Human Asset" in any association. Customarily, HRM was performed on papers and was done physically absent a lot of purpose of innovation. However, with the rising prevalence and use of programming and intranet in other practical regions in the associations, HR division likewise wanted to exploit different programming-based frameworks which before all else utilized extremely straightforward information putting away innovation to the more complicated and high level types of programming, for instance, undertaking asset arranging framework that coordinated every one of the utilitarian branches of an association.
Through use of the association's intranet, the parties involved may obtain the data needed for the HR. The method to doing HR then changed further with new innovation advancements, particularly in the area of online and digital advancement, and it is now known as eHR in its current structure. The eHR is a digital development that synchronizes all HR operations, transforming the role of HR directors and making them essential partners in the organizations. By utilizing the most advanced web technology, eHR increases the effectiveness and productivity of HRM, which is crucial and admirable for the organization. Each e-HR action has an advantage over the traditional method of carrying out these exercises, putting e-HR and its acceptance at the forefront of a quest to reap significant benefits in the current business environments. The current situation is one of limited ability, a scarcity of skilled workers, and challenges associations face in obtaining these workers. In addition to helping associations deal with these challenges, e-HR has altered the upper management's previous perception

of HRM, which was that it was merely a cost. This perspective has entirely transformed today with the use of online development in e-HR, and HR is seen as both a crucial ally and a place to speculate.

The eHR alleviates the representatives with their standard work and makes them allowed to deal with additional essential parts of their positions such frameworks show of the association that representatives are the resources for the organization. [5] The utilization of eHR with the exercises is popular in the different associations, however there are a few factors that might influence the exercises of e-HRM. [6] These variables are: (a) progression of data (ie, the utilization of eHR might build the progression of data about the entrance and assortment the employment opportunities data); (b) the utilization of eHR adjusts the social cooperation either in a positive or negative manner between the subordinates and the manager; (c) the eHR might go about as seen control by controlling the people opportunity; and (d) the utilization of eHR framework ought to be acknowledged by the businesses as their pessimistic mentality will make the eHR futile. The Web of Things (IoT) is a framework in light of a PC network where everything like gadgets (registering, mechanical, computerized), items, and individuals have relegated remarkable identifiers to move the information over the organization without being the connection between them. [7] IoT will help HR individuals to comprehend the significance of individual investigation, which comes from information over the organization. The IoT produces a surprising measure of information which might contain a special and uncommon example for information investigation of a person. [8] In this way, the IoT gives different future degrees and answers for the eHR model which is examined as follows:

- The IoT works with chiefs, representatives, and HR people to make them associated through a web-based cell phone, through which they can book gatherings, speak with any individuals, improve their thoughts for better adequacy, and experience the eHR model in the organization. [9]
- The IoT gadgets screen the various activities of the eHR model without utilizing various methodologies.
- The eHR has execution board activities, while IoT has very much empowered innovation that might add to the eHR model for estimating the presentation of workers and the administrators.
- IoT gives the backings of full digitalization techniques to the HR experts for better development of the association.

2. RELATED WORK

The study [10] talked about the organization's eligibility for the diffusion of innovation theory and the adoption of eHR packages. Ref. [11] created a methodology based on social participation that uses social media with accessibility and stratified characteristics to conduct a statistical evaluation of eHR practices. To disseminate, collect, and evaluate data for the e-HRM, an expert managerial decision-making platform has been implemented. [12] Authors in [13] have created a paradigm for both measurement and interpretation. While the interpretation model is based on measurement factors and complicated indicators, the model for measurement is constructed on e-concept, e-potential, e-knowledge, and e-utilization of business. These two models were created with the intention of enhancing the organization's e-business capabilities related to human resources. By adding some elements and going into great depth about communication systems with message and media characteristics, the work [14] increased the acceptability and efficacy of the eHR model. By combining HRM

and IT with four elements, the authors in [15] redesigned the eHR model: (a) content of e-HRM, where IT supports any HR strategy; (b) acceptance and appropriating of e-HRM; (c) producing the particular employees and managers; and (d) repercussions of e-HRM.

There are different exercises under e-HRM, which are named e-Enrollment, e-Choice, e-Execution The board, e-Pay, and e-Learning. Thus, e-enrollment, e-determination, e-execution of the board, and e-pay have been impacted by these factors. [6] The enlistment and choice are a significant piece of the eHR model, where the target of these exercises is to boost the quantity of solidarity of the representatives for accomplishing the objectives of the organization. [16] These exercises depict the short-postings, screening, obtaining, and choosing the workers for the association to top off the necessary empty position.

The enlistment cycle needs a few fundamental stages: (a) Reason for determination; (b) Plan the issue; (c) Executing the thoughts; (d) Testing and adjusting the thoughts; and (e) Ordering the quality and standard of eHR model. [17] In the e-HRM, e-Enlistment and e-Determination are vital components. [18] The enrollment part gives countless work candidates for the distributed employment opportunities regarding their abilities, information, execution, etc. The determination part gives the quality work candidates who are chosen for the comparing employment opportunities and expands the objectives of the association by estimating the exhibition and commitment of the chose work candidate.

In some further developed choice frameworks, after a few stages like quantitative examination, mental test, and space test, the up-and-comer faces a meeting with HR work force. This determination cycle is further developed through the e-choice exercises of the eHR model. [18] Here e-choice of the eHR model plays out every one of the undertakings electronically, for example, examination of occupations, screening of occupation candidates, assessment of online tests and appraisals, leading meetings, at long last taking the choices for assessing the candidates. In this article, we have expounded on the plan of eHR exercises and have played out the information investigation for every eHR action utilizing some datasets. The commitment of the proposed framework is as per the following:

- Here the execution of the proposed framework is separated into two sections. In the initial segment, the plan and clarification of every action have been performed separately, though in the subsequent part, the information examination has been performed for every eHR action.
- The proposed information examination errands have been separated into four parts, for example, (a) information preprocessing; (b) include determination; (c) information order; and (d) execution assessment.
- During information preprocessing, the utilized datasets have been very much changed into information frameworks and for these mathematical (whole number or genuine), all out, absent, not material (N/A), and invalid qualities are dealt with and maneuvered toward same different information type (ie, in numeric structure). Further to keep away from the various scales in mathematical qualities, the information standardization task has been performed. At long last, each line of the changed information frameworks has been addressed by an example, though every section addresses a component.
- During highlight choice, the first list of capabilities is partitioned into an objective component, while the excess sub-features as learning highlights which structure an element vector. Then the assortment

of these element vectors goes through to the component determination calculation to drive another element vectors where its most memorable component is more discriminant than second, second is more than third, etc. The objective component is considered as the class mark for which the issue space is characterized, and the determined element vectors are utilized to fabricate the expectation model for the ideal issue.

- In order to obtain the presenting of the eHR exercises throughout arranging, the goal part along with the chosen element vectors are passed through to a variety of classifiers, such as choice trees, k-closest neighbor (kNN), as well as support vector machines (SVM), while the execution that results from these classifiers has been discussed suitably.
- Using four HR experimental datasets (available on the Kaggle website), extensive trial and error were carried out for each eHR movement, and the presentation was flawlessly resolved. This work has been organized as follows. The design of the eHR activities is covered in Section 2. The data analysis for eHR processes is covered in Section 3. In Section 4, experimental results and a commentary are presented. This article is concluded at Section 5.

3. DESIGN OF EHR ACTIVITIES

The numerous IT-based HR functions, including electronic hiring, e-selection, e-performance management, online courses, and e-compensation, are covered under the eHR activities. [20] Figure 1 displays an eHR activity sample along with the hierarchical structure of eHR activities. These eHR activities have resulted in: (a) faster and more efficient improvement of service quality; (b) reduced bias and improved accuracy in employee performance measurement; (c) benefits for employees from standardized automation services using IT-based technology; and (d) online platforms available in eHR to perform activities related to hiring, selection, performance measurement, learning, and compensation for HR professionals. Thus, eHRM initiatives are essential in assisting HR professionals in expediting various organizational cycles. The following illustrates how each eHR movement is explained.

Fig 1: The hierarchical of eHR activities

3.1 The electronic Recruitment

Electronic Recruitment is the procedure of finding qualified applicants for available positions within a business by utilizing IT-based resources. [20] The hiring process has many advantages, including being cost-effective, considering remote candidates, producing dynamic content to attract more job seekers, requiring less work throughout the hiring process, and making job postings and open positions accessible to everyone. [21] Therefore, the eHR model performs a number of tasks during e-Recruitment, including scheduling, deciding on tactics, seeking, examination, evaluation and monitoring for the hiring process. Additionally, the eHR model of electronic recruiting and electronic selection operation is influenced by a number of internal and external factors. External elements involve competitors, labor laws, analysis, the level of unemployment, employment opportunities, and legal factors (21 recognition, promotion). Figure 2 illustrates the e-Recruitment activity's sub processes.

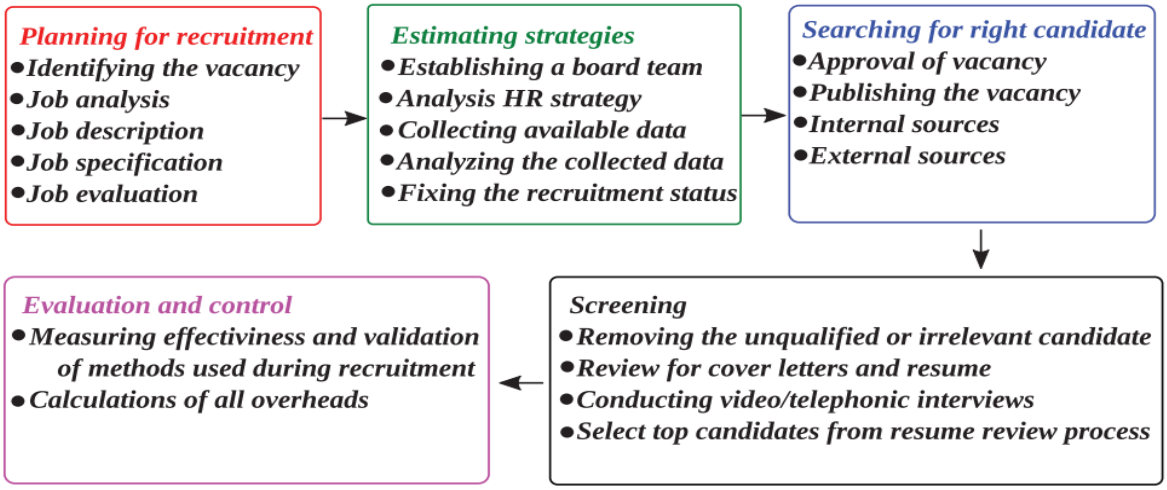


Fig 2: electronic Recruitment in EHR

3.2 The Electronic Selection

The process of choosing the best applicant for a position that needs to be filled in the company is called the electronic section. First come e-recruitment and then e-selection in the eHR paradigm. The main differences between electronic recruiting and electronic selection procedure are as follows: (a) recruitment creates the opportunity for candidates to apply for a position that is open, whereas electronic selection action in the eHR model is in charge of selecting the best candidate for the available job; and (b) recruiting process results in a positive strategy by providing as many opportunities for prospective employees to submit applications for a job, while selection process is a negative approach whose goal is to exclude the most applicants as possible. in order to select the best applicant for the open post. [22] E-selection has the positive aspects of saving time, being inexpensive, eliminating business, offering stringent verification, and separating distinct applicants. The end result of the e-selection procedure is the provision of a job to the selected applicant once he or she has been told regarding the organization's choice and their offers to that candidate for the empty position. **Figure 3** depicts the functioning flow of eHR activity from e-recruitment to e-selection.

Fig 3: the process from e-Recruitment to e-Selection activity

3.3 The Electronic Performance

The deliberate improvement of an association characterizes presentation management. This exhibition of the executives relates with the exhibition of every individual or group. The target of execution the board incorporates the improved outcome from the arranged objectives, ability necessity, and norms. It assumes a significant part to assess the exhibition of every worker and make a troublesome undertaking for them to get rouse for the organization. [23] The eHR utilizes different systemic programming apparatuses and bundles to make the e-execution the board exercises more helpful to ascertain the presentation or ability of the representatives. During this assessment, a few essential boundaries like abilities, potential, imagination, experience, steadiness, and obligations have been conducted. These boundaries have additionally been utilized for estimating work fulfillment and steady cutbacks from employment status of the representatives. The primary target of eHR based execution board is to establish a great climate and working society for the representatives where they are answerable for development of the association. To live up to the assumption for the representatives to their prerequisites is additionally one more point of the e-execution the board. The functioning guideline of e-execution the board is displayed in **Figure 4.**

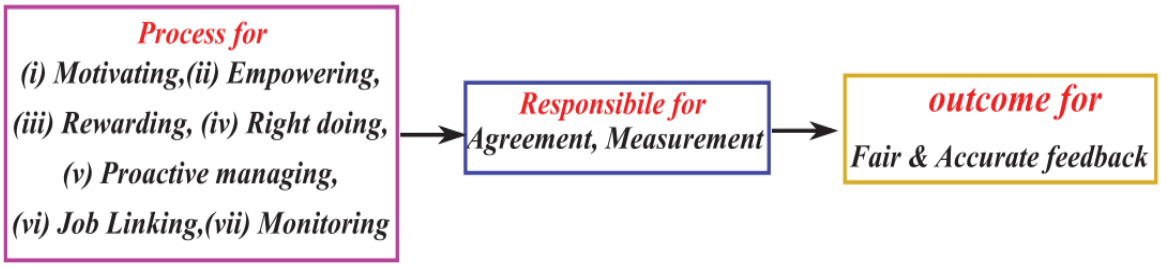


Fig 4: The e-performance management activity in the eHR model

Concerns about Input/ Output, Planning, Enhancement, Growth, Communication, collaborating stack-holders, and transparent sub processes are also addressed. Figure 5 depicts the cycle that the organization's e-performance management activity follows.

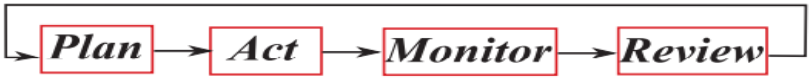


Fig 5: The e-performance in eHR

3.4 The Electronic Learning

Through the HR system, digital learning enables the organization's employees to adjust knowledge sharing to desired changes in the human brain. [24] Digital learning, computer-based learning, video classes, online domain knowledge, and other topics are covered in the e-learning. This task involves acquiring various hard and soft talents within the company. Whereas soft skills are concerned with the motivating, trust, and confidence tactics that people inside the firm convey, the hard skills are related to the administrative procedures, regulations, and techniques for processing data. Through the acquisition of new skills, individuals may improve their performance and seize chances inside the firm. The system is more flexible, time management is reduced, consistency is maintained, computer and internet-based knowledge abilities are enhanced, and the number of learners may be unlimited, and so on with e-learning. [25]

3.5 The Electronic Compensation

A good organization must have a pay plan. [26] The word "compensation" refers to a worker's gain or outcome for their labor. This remuneration can take the form of non-monetary benefits like travel, housing, stock resources, and so forth, or it can take the form of monetary benefits like bonuses, commission from sales, prizes for recognition, overtime pay, and profits from shares. This employee is bravery in receiving e-compensation for increasing organizational effectiveness. E-compensation management aims to achieve the following: (a) attract and retain talent; (b) retain motivated staff members; (c) pay fair compensation for a variety of jobs; (d) maintain compensation costs in line with organizational changes; (e) offer benefits to employees in the form of duty, loyalty, and appraisal; and (f) handle legal compliance. There are primarily two kinds of pay in the organization: direct compensation and indirect compensation. Direct remuneration focuses on motivating each employee toward their task through the provision of day care subsidies, personal development courses, productivity-based promotions, and workplace modifications. Figure 6 depicts the elements of an e-Compensation activity. The organization's performance and efficacy may be attributed to the design and concepts of each eHR activity that have been previously mentioned. Data resulting from these activities has also been tested using analytics methods and procedures. The part that follows goes over the data analytics methods.

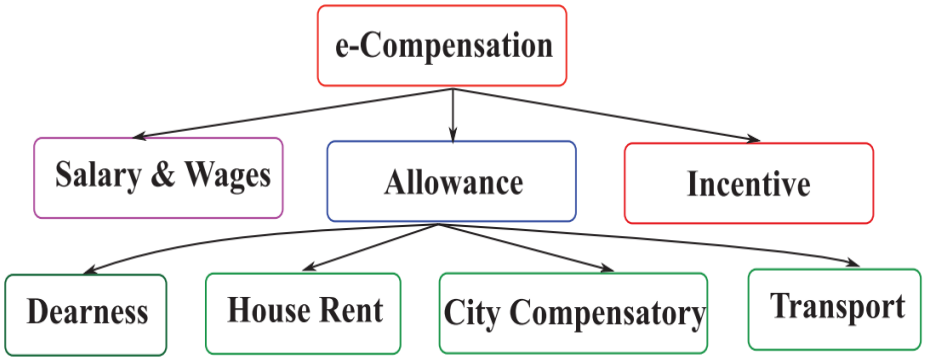


Fig. 6: The e-Compensation components in her

4. DATA ANALYTICS FOR EHR OPERATIONS

The purpose of data analytics for eHR operations is to determine how effective eHR is compared to traditional HRM. Additionally, understanding the many implementations of eHR activities in real-life scenarios and identifying some beneficial links between the various activities are the goals of this data study. [27] Now that these eHR operations have been analyzed, computer science, statistics, and mathematics have all contributed significantly to the resulting applications through the use of machine learning ML techniques. The study [28] has talked about many e-learning management approaches that a firm might use to help its workers grow. Data mining and data analytics have been combined by the authors in [29] to solve HR-related issues for the company. Business data nowadays is enormous in volume and increasingly difficult to interpret in order to provide accurate information. Therefore, ML methods are extensively employed in practice today for intelligently evaluating business data, and these approaches assist the IoT-based application to the eHR paradigm. Data science is the process of making meaning of data that might be more predictable, meet consumer needs, differentiate an organization's offering in the market, and increase revenues. [30] The diverse study domains of data science include physiology, computer science, mathematics, statistics, and philosophy. [31].The data science uses mathematics and statistics to enable analysis and prediction using the gathered data. The computer science fields of AI, ML, database management systems, database analysis, data warehousing, and data mining assist data science in understanding how to use the gathered and processed data to power various prediction models. Data from professionals in the fields of medicine, finance, business, and economics are used to assess how well the data science model performs when it comes to prediction models. [32]

Integration of data, cleaning the data, and data normalizing are all included in the data preprocessing step in data science. Gathering information from multiple sources and presenting it to the user in a cohesive manner is known as data integration. The process of data cleaning entails enhancing gathered data that has a number of issues, including garbage values, irrelevant, duplicated, incomplete, and inaccurate values. Creating more structured, standardized, and homogeneous data for use in data analysis is the goal of data cleaning. In order to improve the performance of data analysis and learning tasks, data normalization aims to convert the numerical values of the data into a similar range or scale. If the numerical values of the data come from multiple ranges, they are scaled within the same specified range. [33] Extensible machine learning is being used to extract data from big datasets. [34] Finding significant patterns in the data is the process at hand. Numerous research fields, including image processing, computer vision, recognition of patterns, processing of natural languages, business data analysis, data related to finance analysis, medical record analysis, and cognitive computing, have made extensive use of machine learning techniques. It gives the system the ability to learn without coding and to make decisions at a level that is comparable to that of a person. [35] The deductive and inferencing techniques needed to learn the system are provided by the learning tasks that are linked to machine learning. Learning strategies can be classified into four categories: reinforcement learning, semi-supervised learning, unsupervised learning, and supervised learning. [35] To obtain models, these learning techniques have been applied. Thus, supervised learning refers to learning models from labeled data, while unsupervised learning refers to learning models from unlabeled data. Classification and regression are examples of supervised machine learning

methods, while clustering, reduction of dimensionality, and likelihood density estimation are examples of unsupervised learning. [36]. Thus, records for eHR activities were examined utilizing machine learning algorithms and data science methodologies. Four steps make up this data analytic task: preparing the data (a), choosing features (b), classifying the data (c), and evaluating performance (d). Figure 7 displays the data flow diagram for the data analytics methodology used in eHR activities.

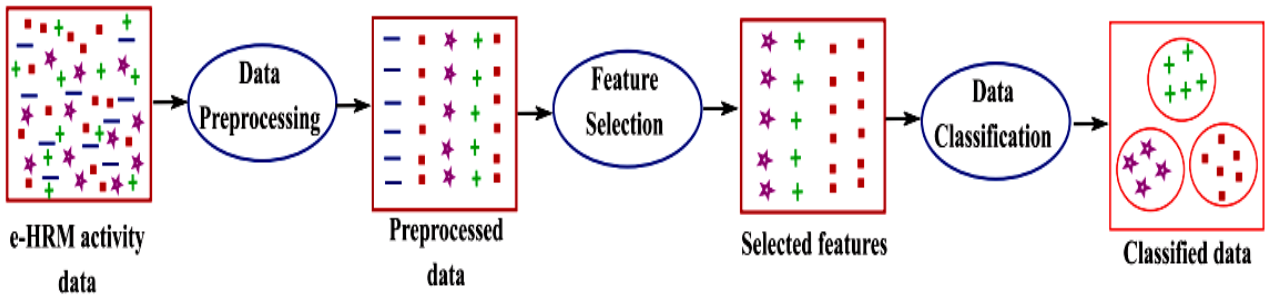


Fig. 7: The methodology of data analytics for eHR

4.1 Data preprocessing

To facilitate data analysis, the data are gathered from a variety of sources. These facts include human mistakes, different noises, inaccurate information, and mall function. [37] The data undergoes processing before being used to any analysis task in order to increase the generability of the data analytical framework and enhance the efficiency of the suggested system. One method for making data suitable for additional processing is data preparation. In this case, we treat every row in the provided data as an illustration and each of the columns as a feature. A value matrix D containing m row as well as n columns is assumed to exist.

There could be missing values, category values, or numerical values (real or integer) in the data matrix D. The category values are converted into numerical values during data analysis, and to do this, some integer values are substituted (for example, Marketing=200). If there are any remaining values in the attributes, the feature values' mean value fills in those missing values. Furthermore, a feature (column) will be eliminated from D if it has more missing data than others. Thus, after handling missing and category values, the value matrix is shortened to Dl*k. Data normalization, which is the second step in the preparation of the data, involves setting the unit standard deviation and zero mean for each sample in D.

4.2 The Selection of features

It's an unsupervised learning method that purges the data of less important or irrelevant information to increase its suitability for machine learning applications. 38 Among the many benefits of the method for choosing features are (a) a reduction in the overfitting issue, (b) an increase in accuracy, and (c) a reduction in the training time required to construct the model of classification for the issue at hand. To lessen the complexity of eHR derived feature data over analyzing purposes, we have used principal component analysis [39], one of the multiple feature selection techniques now in use. The benefits of methods for selecting features include: (a) extracting a small subset of discriminating attributes from the initial set of data and organizing those features based on some assessment criteria for distinctiveness; (b) improving classification model learning with reduced

computational cost and increased accuracy; and (c) deliberating the learning information among the models. [40] Figure 8 displays the proposed system's feature selection block diagram.

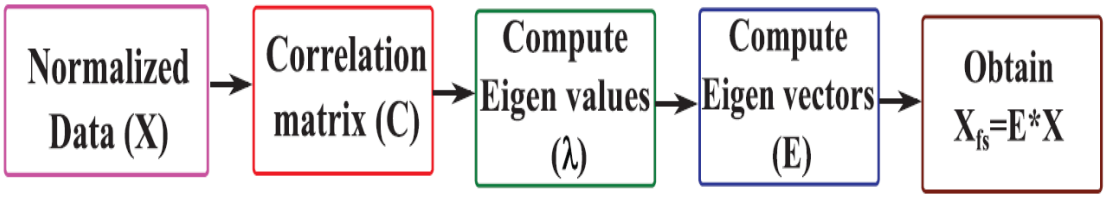


Fig. 8: The feature selection of the proposed system

4.3 Classification of data

The supervised learning methodology known as "data classification" [41] uses supervised learning to determine if a sample belongs to the designated class. The classification task yields a discrete, finite output that assigns a class to an input test sample. The three main elements of classification are the desired function, the learning algorithm, and the input. Binary and multiclass classification are the two categories of classification techniques.[41] Both of these methods have been used in this work to analyze data based on the label feature that was chosen from the HR data matrix. The classifiers are taught with learning features in relation to the label feature throughout the classification process. The classifiers that are being used are described as follows:

• **Decision Tree:** It is an algorithm for classification that uses recursive instance space partitioning as its foundation. [42] It consists of internal nodes that divide the space of the instance into subspaces according to the given attribute discrete functions, as well as root, terminal, and internal nodes. We have used the CART decision tree classifier, one of several available decision tree classifiers.

• **k-Nearest Neighbor:** kNN is a simple classifier in which the data set gets divided by the majority vote of its neighbors, and the desired function is approximated locally. [43] The lazy or instance-based learning classifier is the foundation of this classifier.

• **Support Vector Machine:** Yet another algorithm for data point classification is SVM. [44] It operates on the maximizing of margin principle, which involves minimizing the total number of weights and determining the distance between the hyper-planes to coincide with the support vector. The two linear and non-linear distinct cases are handled by the SVM. It is applied to multi-class and binary classification techniques.

4.4 Performance Evaluation

For the data classifying process, the learning features chosen and the matching target feature y are assigned at random to approximately half of the data for the set used for training and the other half for the testing set. The performance of the classifier is measured on the test set S2, after it has been learned on the training sample S1. This is where the performance's precision is calculated. There are M test samples in S2 that are run through classifiers and yield the expected labels. The anticipated and measured labels are then compared, and precision = (M / N) × 100 is the result of detecting N fits among M, which indicates the correctness of the proposed system.

5. RESULTS AND DISCUSSIONS

From the Kaggle website (https://www.kaggle.com/datasets?search=human+resource), we have used four HR analytic datasets. We have used four distinct HR datasets that the Kaggle site collected from various sources such as the HR datasets that are available for data analytics. We have experimented with these datasets to do data analytics for electronic recruiting, e-Selection, e-Performance administration, e-Compensation, and online courses of eHR activities. In order to make the datasets used for this work useable and correlated for the eHR activities, the datasets were preprocessed, and the suggested data analytics techniques were implemented. The suggested data analysis was carried out using a Windows 10 PC with 32GB of RAM and Python 3.2. The next part has covered the descriptions and testing of these resources for the suggested system.

Human resources datasets have been used in our experiments to display insightful analytic for operations of e-HR. Therefore, we used our initial HR analytics data [45] (The set1) for electronic recruiting, e-Performance, as well e-Compensation tasks in order to do data analytics. Table 1 provides a description of this database. It can be seen from this table that Dataset 1 has 4410 samples, each of which has 555 attributes; however, only 29 of these features ({A1, ..., A29}) are relevant to data analysis. The remaining elements have to do with time stamps pertaining to the employees' working hours. Only {A1, ... A29} features have been used in this work to analyze the electronic recruiting, e-Performance, as well as e-Compensation operations.

In order to demonstrate distinction and uniqueness for each feature, Figure 9 displays the distribution of the {A1,...,A29} characteristics as a histogram. Each figure in this example displays the reduced values in the desired range ([−2 2] or [−5 5] or [−10 10]), and the column corresponding to that scaled value displays the counts for that feature in the data. These aspects are now being used to demonstrate the investigations regarding different operations through data analysis tasks utilizing data science and machine learning approaches. The "A6=Attrition" is the label feature (i.e., the goal feature for which data analysis will be done) for the e-Recruitment activity, while the remaining characteristics {A2,...,A5,A7,...,A29} are the learning features (i.e., the features which are utilized to learn the model to conduct data analysis). The HR department can make decisions about hiring new staff members based on attrition. In a similar vein for e-Performance, we designated {A2,A4,…,A29} for learning features and “A3=Job Satisfaction” as the objective feature. The best indicator of a relationship between e-Performance activities and job happiness is job satisfaction because low performance is a direct outcome of unhappy workers, which has an impact on the organization's overall performance. [46]
"A2=Environment Satisfaction" is the objective feature for e-Compensation, and the following features, {A3,...,A29}, are the learning features. A positive work environment is essential for retaining employees, and as a result, e-Compensation and the work environment go hand in hand. [47] Here, we create a model for employee attrition vs non-attrition using the most effective features from {A2, ..., A5, A7,..., A29} in order to associate the electronic recruiting activity with the "A6=Attrition" feature. By utilizing the best attributes from {A2, A4, …, A29} to create a model that predicts outcomes for 4-class problems, the task's e-Performance has been connected with "A3=Job Satisfaction." By creating a model for 4-class problems, the characteristic "A2=Environment Satisfaction" has been linked to e-Compensation activity. For this analysis, we have used the

attributes section and data classification task (which was addressed at Section 3). Here, the purposes of these associations are for performing the mentioned operations in the company according to the eHR centered on the corresponding target features.

TABLE 1: Description of HR analytics *DataSet*1

Number of Samples	Number of features	Name of features	Purpose
4410	**555**	A1=Employee-ID, A2=Environment -Satisfaction, A3=Job-Satisfaction A4=Work-Life-Balance, A5=Age, A6=Attrition, A7=Business-Travel A8=Department, A9=Distance-From-Home, A10=Education A11=Education-Field, A12=Employee-Count, A13=Gender A14=Job-Level, A15=Job-Role, A16=Marital-Status, A17=Monthly-Income A18=Num-Companies-Worked, A19=Over18, A20=Percent-Salary-Hike, A21=Standard-Hours, A22=Stock-Option-Level, A23=Total-Working-Years, A24=Training-Times-Last-Year, A25=Years-At-Company, A26=Years-Since-Last-Promotion A27=Years=With-Current-Manager, A28=Job-Involvement, A29=Performance-Rating	**e-Recruitment** **e-Performance** **e-Compensation**

In order to acquire more selective features for electronic recruiting, e-Performance, as well as e-Compensation operations, we used the methods outlined in Algorithm 1 for feature selection. The features that were chosen for these activities are displayed in **Table 2** in a decreasing order of distinctiveness.

Such training-testing sets of features are subjected to CART, KNN, as well as SVM classifiers for data classification tasks. The classifiers that individually produce the predictive model have been trained using the training dataset. In order to determine the effectiveness of classification for the purpose of testing datasets, each model has then been applied separately. The categorization performance for eHR activities using DataSet1 is displayed in Figure 10. **Figure 10** shows that only five features are needed to achieve improved performance for the operations. Each activity has superior performance for the CART classifier.

TABLE 2: DataSet1feature selection Analysis

Experiment	Class label (*y*)	Decreasing order of Learning feature	Purpose
Attrition	**A6**	A:10, A:14, A:9, A:19, A:2, A:24, A:28, A16, A15, A7, A:4, A:3, A:17, A:11, A8, A:13, A:22, A:18, A:26, A:5, A:27, A:23, A:29, A:20, A:25, A:21, A:12	**e-Recruitment**
Job satisfaction	**A3**	A:10, A:14, A:9, A:19, A:24, A:2, A:28, A:16, A:15, A:7, A:4, A:17, A:11, A:6, A:8, A:13, A:22, A:18, A:26, A:5, A:27, A:23, A:29, A20, A25, A12, A21	**e-Performance**
Environment satisfaction	**A2**	A:10, A:14, A:9, A:19, A:24, A:16, A:28, A:15, A:7, A:17, A:4, A:11, A:3, A:8, A:6, A:13, A:22, A:18, A:26, A:5, A:27, A:23, A:29, A:20, A:25, A:12, A:21	**e-Compensation**

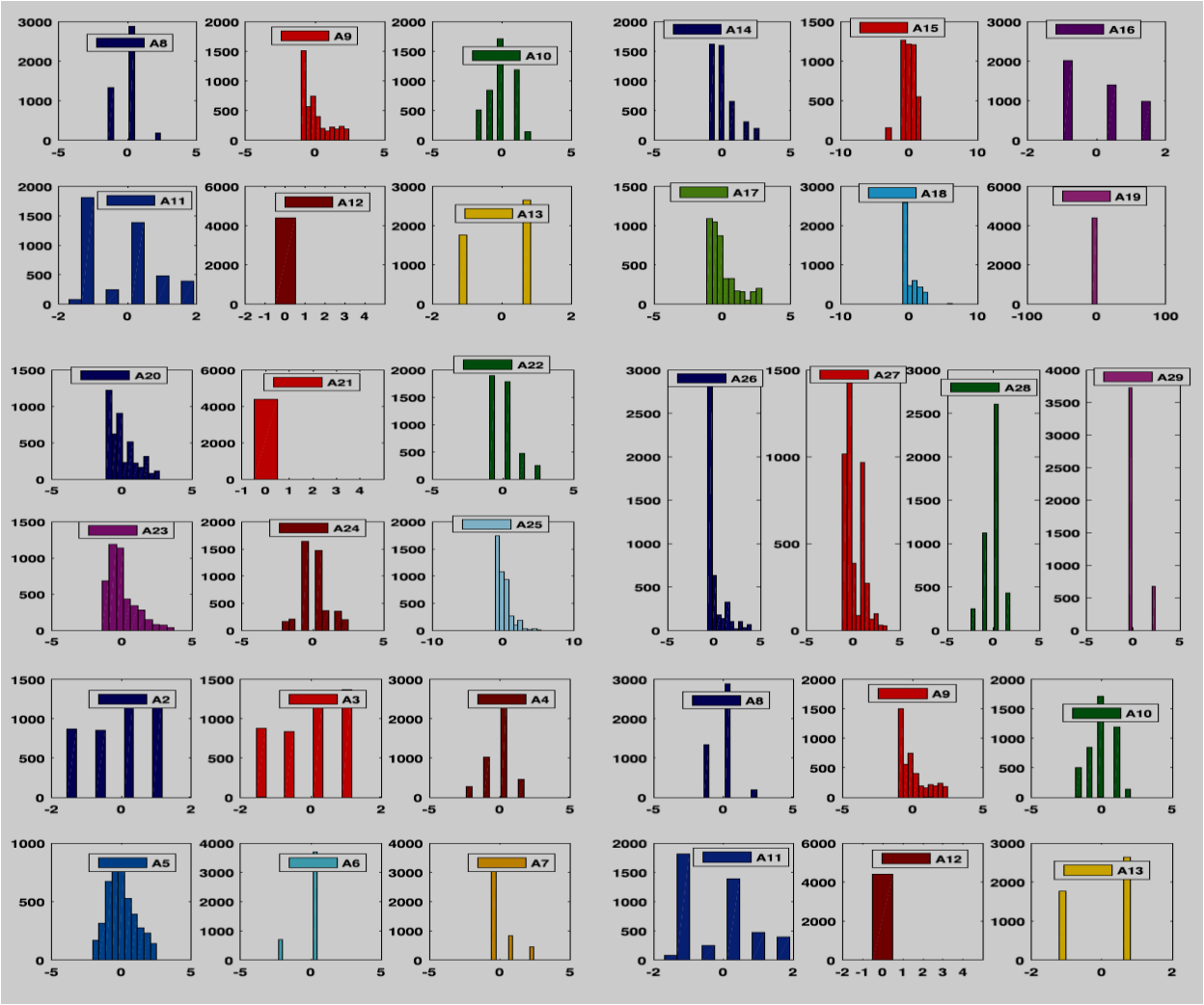


Fig 9: DataSet1's features distribution

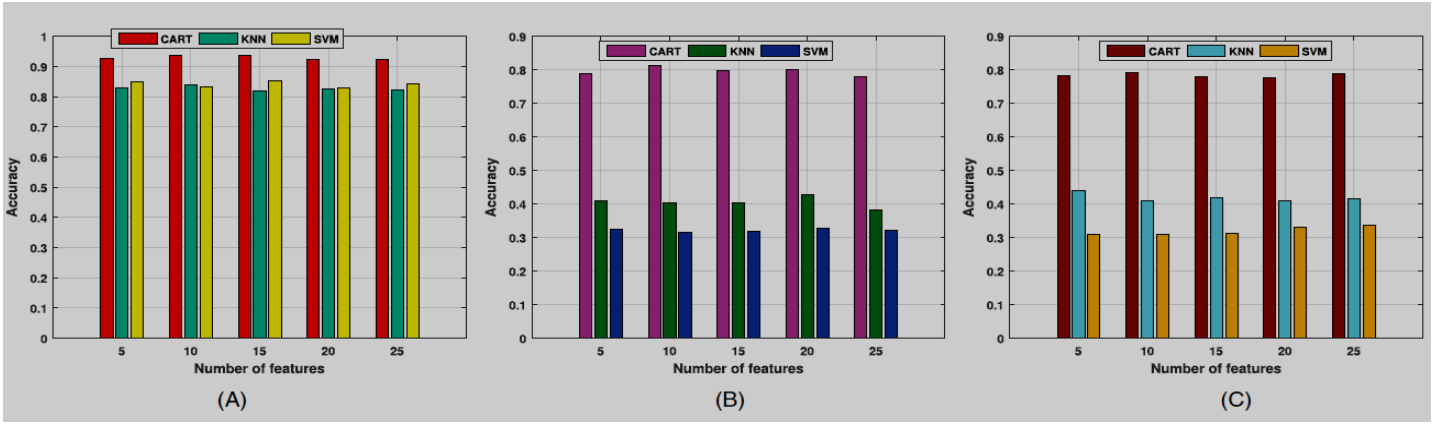


Fig. 10: Classification task performance using *DataSet*1

To analyze data for e-Performance activities, we have also used an enhanced HR database [48] (set2). This dataset is being used because it is much larger than DataSet1 and has a sample with more features for testing. In this case, the DataSet2 has 14999 samples with 62 characteristics apiece. Table 3 displays the features included in DataSet2. Figure 11A-E displays the data distribution for these attributes as histograms. Here, in every figure, the column displays the counts for the appropriate scaled value with regard to the corresponding feature in the dataset, and the row displays the adjusted values in the desired range ([−2 2] or [−5 5] or [−10 10]).

TABLE 3: Description of HR analytics *DataSet2*

Number of Samples	Number of features	Features	Purpose
14999	62	B-1=em-ID, B-2=em-Name, B3=Department, B4=GEO, B5=em-Role, B6=Rising-Star, B7=Will-Relocate B8=Critical, B9=Trending-Perf, B10=Talent-Level, B11=Validated-Talent-Level, B12=Percent-Remote, B13=EMP-Sat-On-Prem-1, B14=EMP-Sat-On-Prem-2, B15=EMP-Sat-On-Prem3, B16=EMP-Sat-On-Prem-4, B17=EMPSatOnPrem5, B18=EMPSatRemote1, B-19=EMP-Sat-Remote2, B-20=EMP-Sat-Remote3, B-21=EMP-Sat-Remote4, B-22=EMPSat-Remote-5, B-23=EMP-Engagement1, B24=EMP-Engagement2, B25=EMP-Engagement3, B-26=EMP-Engagement-4, B27=EMP-Engagement5, B28=last-evaluation, B-29=number-project, B30=average-monthly-hours, B31=time-spend-company, B-32=Work-accident, B33=left-Company, B34=CSR-Factor, B35=promotion-last-5-years, B36=sales, B37=employee-salary, B-38=employee-Gender, B-39=LinkedIn-Hits, B40=EmpWork-Status-2, B-41=Emp-Work-Status3 B42=Emp-Work-Status4, B43=Emp-Work-Status5, B-44=Emp-Identity, B45=Emp-Role, B46=Emp-Position, B47=Emp-Title, B-48=Women-Leave, B49=Men-Leave, B50=Emp-Competitive-1, B-51=Emp-Competitive-2, B52=Emp-Competitive-3, B53=Emp-Competitive-4, B-54=Emp-Competitive-5, B55=Emp-Collaborative-1, B56=Emp-Collaborative-2, B57=Emp-Collaborative-3, B58=Emp-Collaborative4, B59=Emp-Collaborative-5, B60=Sensor-Step-Count, B61=Sensor-Heartbeat(Average/Min), B62=Sensor-Proximity(1-highest/10-lowest)	e-Performance

After using the feature selection method, the chosen features are displayed (Table 4) in order of decreasing by distinctiveness. The set for testing is used to determine the performance of each classifier independently, while this conditioning set gets used to train the CART, kNN, along with SVM classifying algorithms separately. The classifying efficiency (in %) is displayed in Figure 11F. Using only 35 features, CART outperformed kNN and SVM classifiers in terms of performance.

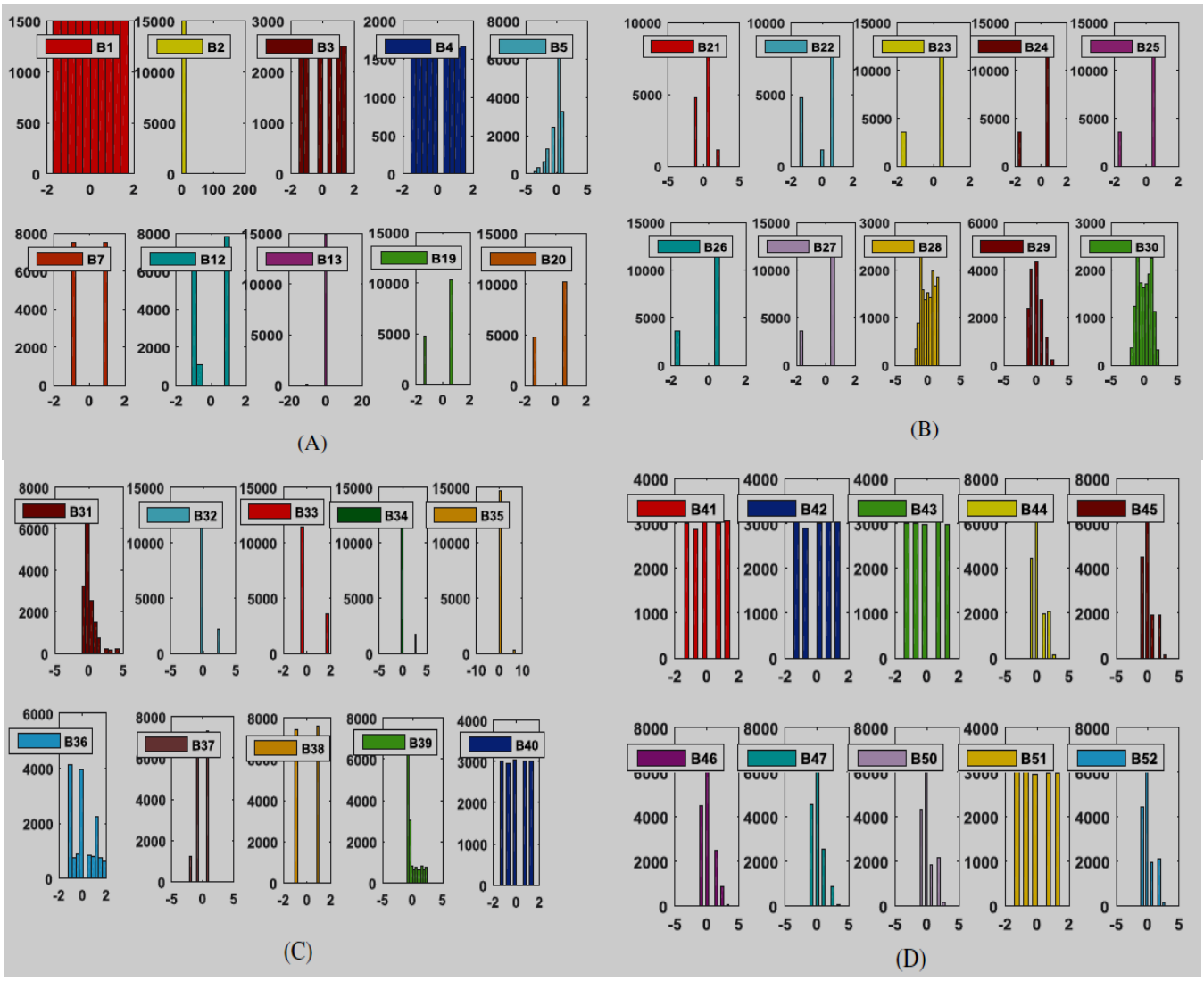
TABLE 4: DataSet2 feature selection Analysis

Label Feature (*y*)	Learning feature (Decreasing order of distinctiveness)	Purpose
B-7	B-3, B-59, B57, B-54, B-53, B-51, B-2, B-40, B-4, B-36, B-32, B-58, B-43, B-41, B-5, B-42, B-38, B-55, B-56, B-31, B-52, B-50, B-47, B-61, B-46, B-62, B-37, B-13,B-29, B-30, B-39, B-45, B-35, B-60, B-44, B-22, B-1, B-28, B-34, B-20, B-19, B-21, B-24, B-26, B-25, B-27, B-33, B-23, B-12	**e-Performance**

We used the HR-TRAIN-IN [49] (set3) dataset to conduct data analysis for the e-learning activity; Table 5 provides a summary of this dataset. This table demonstrates that there are 1158 instances in the dataset, with 12 features per sample. Additionally, data cleaning and normalization procedures have been used to this dataset.

TABLE 5: *DataSet*3 Description for HR analytics

Number of Samples	Number of features	Name of features	Purpose
1158	12	C-1=Years, C-2=company, C-3=Departments, C-4=Position, C-5=Position-count, C-6=Planned-Position-Count, C-7=Expense-Total, C-8=Course-Cost, C-9=Course-Days, C-10=Termination, C-11=Internal-Hires, C-12=External-Hires	e-Learning



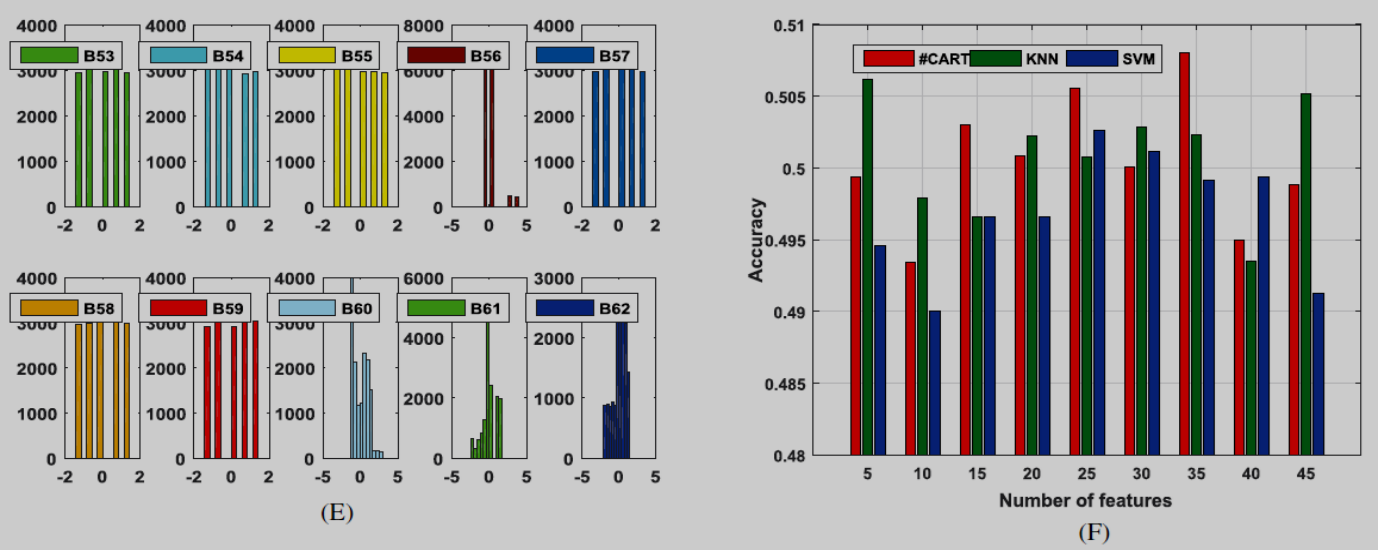


Fig 11: *DataSet*2 features Distribution (A)-(E) and classification performance using *DataSet*2 (F) e-Performance activity

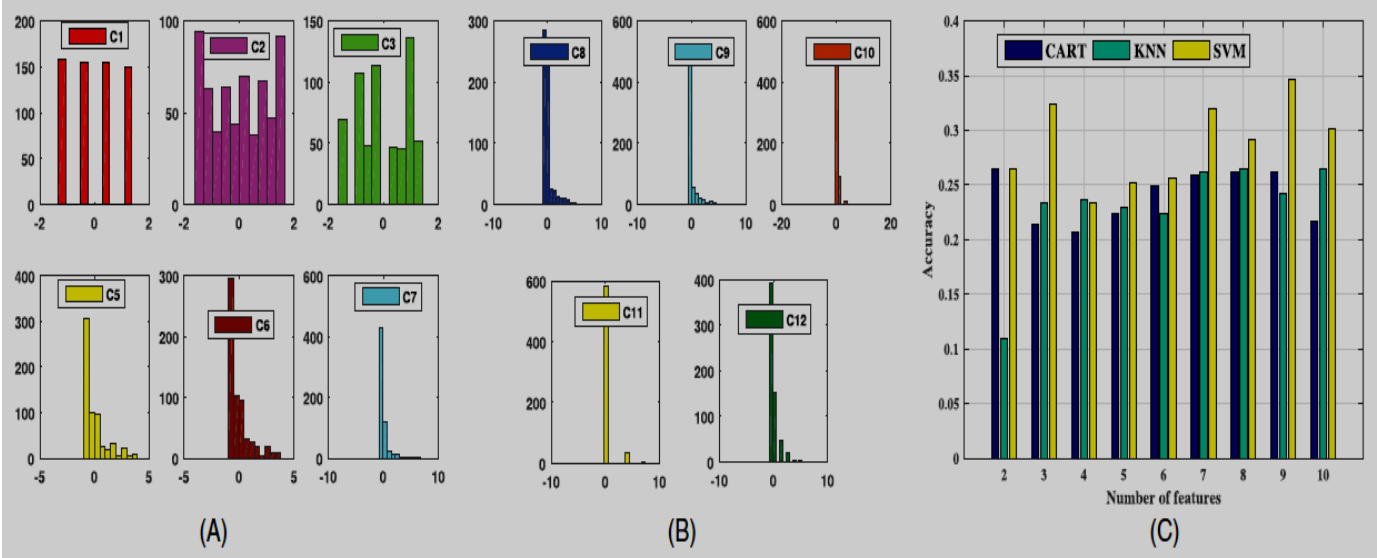


Fig. 12: *DataSet*3 features Distribution (A-B) and classification performance utilizing *DataSet*3 (C) e-Learning activity

TABLE 6: *DataSet*4 Description

Number of Samples	Number of features	Name of features	Purpose
66	14	D-1=IDs, D-2=Job-Family, D-3=Job-Family-Description, D-4=Job-Class, D-5=Job-Class-Description, D-6=Pay-Grade, D-7=Education-Level, D-8=Experiences, D-9=Org-Impact, D-10=Problem-Solving, D-11=Supervisions, D-12=Contact-Level, D-13=Financial-Budget, D-14=PGs	e-Selection

TABLE 7: *DataSet*4 feature selection Analysis

Label Feature (*y*)	Learning feature (Decreasing order of distinctiveness)	Purpose
D6	**D-8, D-14, D-11, D-10, D-7, D-13, D-9, D-12, D-3, D-2, D-5**	**e-Selection**

The testing set is used to obtain the performance that each classifier produces after it has been tested on the set used for training. Figure 12C shows that even though just nine parameters were utilized for the e-learning challenge, the SVM learner performed better. To identify what positions belong to a particular department inside the company, jobs must be classified. This is why positions where personnel requirements are crucial have been classified using e-Selection. For the e-Selection exercise, we thus employed the staffing data in Ref [50] (Set4). This dataset is summarized in Table 6. The Set 4 has 66 samples, each of which has 14 properties, as Table 6 demonstrates. The histogram for each characteristic from Set4 is shown in Figure 13A-C. The feature selection technique was then used to extract the best characteristics, as shown in Table 7. The classifiers are then trained on the testing set to determine each classifier's accuracy independently, as shown in Figure 13D. This performance suggests that the CART algorithm performed exceptionally well even with just six features.

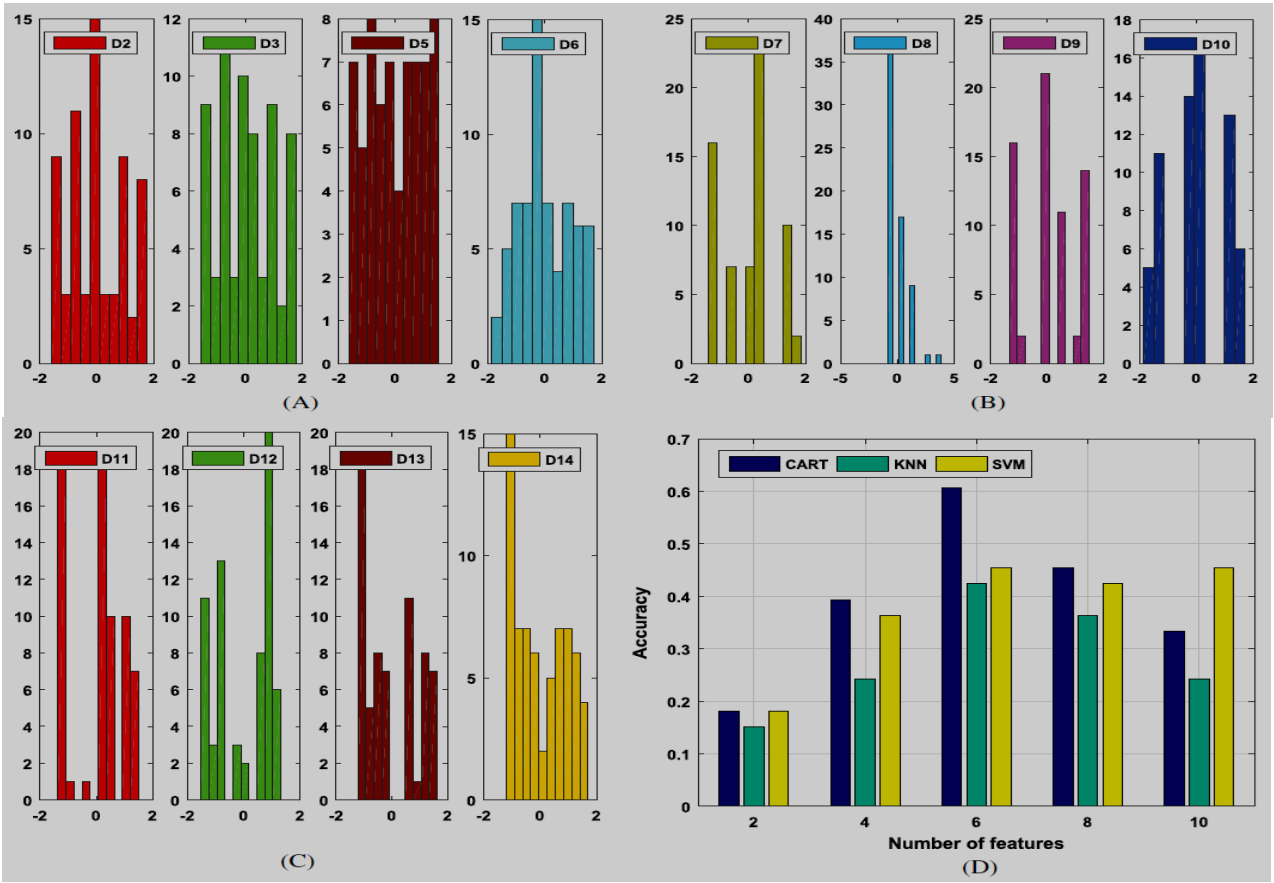


Fig. 13: *DataSet*4 features distribution (A-C) and classification performance employing *DataSet*4 (D) e-Selection activity

CONCLUSIONS

Here, a unique design and analytical methods for eHR tasks via Internet of Things applications are suggested. The information system for human resources serves as the foundation for the eHR model, yet the HR analytical data that is now available is vast and unclear. In order to address this, a few IoT-based applications have been used to give the source data context and have been linked to different eHR initiatives. The suggested system has been split into two sections in this work: The first part of the article delves into the design and theories of eHR activities. The second part uses IoT-based algorithms to analyze the HR data related to each activity. Four steps make up the HR data analytics process: feature selection, performance evaluation, data classification, and data preprocessing. Effective data science and ML approaches have been embraced and deployed for these components. The suggested data analytics have been tested using four difficult datasets that were taken from the website of Kaggle. The utilization of these datasets effectively describes the functionality and efficacy of eHR activity. Each dataset has then been handled and modified for the intended use of eHR activity. Ultimately, each dataset that has been given in a well-structured manner matches to the performance that has been assessed. The CART outperformed kNN and SVM classifiers in terms of performance. In the future, to assess the efficacy and usability of the HR model, we will utilize and research several newly developed data analysis techniques on a few difficult datasets and the answers to questionnaires.

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