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A Review on Machine Learning driven Frameworks for Employee Behaviour Prediction and Proactive Organizational Risk Management in Human Resource Management

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Abstract- In today's era, many multinational companies (MNCs) operate worldwide. In these organizations, human resource management and senior managers face several challenges, such as employees leaving their jobs suddenly, low performance, stress and burnout, and skill gaps. This paper reviews the use of machine learning, artificial intelligence (AI), and sentiment analysis to address these problems effectively. These tools help predict which employees may leave their jobs, who may underperform, potential future workforce risks, and other related issues. The system works by collecting employee data, cleaning and preparing the data, predicting risks, and assisting human resource management in taking early action. This approach provides several benefits, such as reducing employee turnover, saving company costs, and improving employee satisfaction. The paper reviews machine learning based frameworks that identifies human resource problems at an early stage to avoid such issues. It aims to transform human resource management from a reactive approach to a proactive one and improve decision-making for betterment.

Keywords: Artificial Intelligence, Human Resource Management, Machine Learning.

I. INTRODUCTION

In the current business environment, employees' mental and physical health is very important, for which there is a need for HR. Human resources is a department within an organisation responsible for managing the entire employee lifecycle, from recruitment and onboarding to training, compensation, benefits, and performance management. As organizations rely on machines and data for results and decisions, which help them to make an intelligent workforce, a strategic environment with accuracy and precision is created [1].

This technology helps HR to understand employee behaviour, performance, and threats to an organisation. Some occupations like mining, construction, and manufacturing expose employees to various hazardous diseases, which can cause multiple disorders like respiratory disorder, stress illness, musculoskeletal injuries, and noise-induced hearing loss [2]. While other sectors like technical and healthcare, etc., have adopted Enterprise Resource Planning (ERP), mining is still lagging behind in systems to improve resource efficiency, streamline workflows, data accuracy, and decision making [3]. Companies use various strategic instruments like HR management, the Internet of Things (IoT), technological advancement, and time management skills [4].

To use the machines, data mining is really important. It extracts pattern, knowledge and large data using Statistics, machine learning and database systems. With the help of machine learning, it plays a very important role by learning from data to build models that creates understanding [5]. The average cost per-hire is estimated to be $4000 and turnover is very costly for HR management which is why modes like Random Forest Explainable AI (XAZ) used for predictive accuracy over 90% [6]. The Knowledge-based view (KBV) sees companies as a system as a fundamental source that develops, integrates and shares knowledge together, while recognising that

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knowledge can be managed but not controlled and can still be affected by psychological reasons [7].

HSBC's national security group in HRM discussed employee turnover using machine learning, challenges in hybrid workplace and competition in the global world but to use such machines, strong data, infrastructure and skilled staff is required [8]. This paper discusses how machine learning frameworks can help predicting behaviour. It will also analyse how technology can help to achieve proactive organizational risk management in human resource management.

II. LITERATURE REVIEW

Dreichuk et al.[9] claimed that human resources analytics has changed into an essential, data based approach that improves workforce management from simple descriptive methods like layoffs and attendance to using it to forecast workforce trends, improve employee management and design initiative based approaches. Furthermore, technological advancements like AI, big data and business intelligence platforms have improved the precision and availability of HR analytics which can help organizations to identify patterns, predict employee behaviour and automate various HR processes such as recruitment and performance analysis. These features support better decision making and benchmarking against industries.

Miglani et al. [10] proposed that data pretreatment techniques boost prediction reliability by 25% even when integrated AI models use multi-source inputs including social media feedback, performance evaluations, and live data streams. The model uses NLP for sentiment analysis on employee surveys and feedback, as well as Deep Learning for predictive analytics about staff retention and turnover patterns. A branch of computer science and artificial intelligence (AI) called natural language processing (NLP) is concerned with how computers and human language interact. It makes it feasible for robots to understand, interpret, and create meaningful and useful human language. These technologies help to make HR resources efficient.

Shikonde et al.[11] explained major factors affecting HR are organisational factors and individual factors. Organizational factors consist of security policies, training programs, access controls measures, incident responses monitoring systems, encryption and governance framework. Meanwhile individual factors consist of employee dissatisfaction, financial challenges, personal advantage, greediness along with job satisfaction, awareness level, and compliance attitude. Both of them can lead to threat life data theft system sabotage, financial fraud and & reputational damage.

Niu et al.[12] talked about artificial intelligence like radial basis function (RBF) is designed for pattern recognition, classification and function approximation. The basic structure of RBF consists of an input layer, a hidden layer with an RBF neuron and an output layer. The hidden layer in the RBF network is used for determining the operation of neurons to perform vital computations to learn complex patterns from the previous one and applies a weight matrix to calculate activation value.

The process initiates non-linearity allowing the network to capture complex relations and convert the data efficiently. It can also be used to represent typical network traffic and device interaction patterns for information security in Internet of Things systems. The network may identify non-uniformness that can point to security risks like illegal access or data violation by learning these patterns.

Laudonia et al.[13] explained a data based framework that combines financial metrics, governance and predictive modelling to support organisational decision making and risk management. At the top of the Fig.1, input data sources include HR metrics such as layoffs, AI identified skill gaps and performance reviews analyzed by NLP. These inputs are fed into the data collection and processing stage where key performance indicators (KPIs) are monitored which can clean the data using CRISP-DM and standardized APIs.

The process then moves to the governance and compliance layer which ensures the rules and regulations are being followed. The next process is the data processing stage, NLP is used to extract insights from performance reviews and job description. Then the data is used in predictive modelling stage where machine learning models like XGBoost and random forest predict trends and finally the system generates outputs.

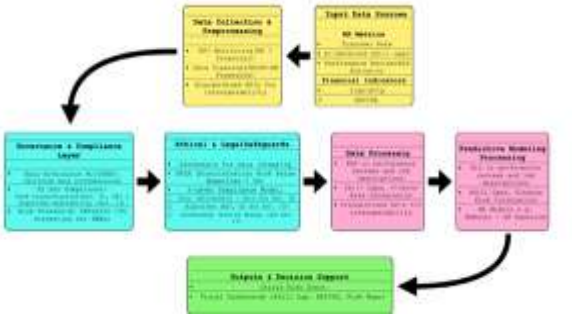

Fig.1. Proposed data based framework to support organizational risk management and decision making [13]

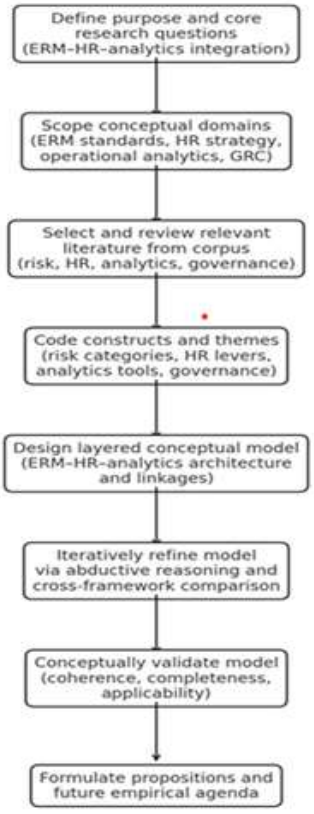

Fig.2. Flowchart of the proposed combined model to connect ERM, HR and data analytics[14]

Falemi et al.[14] proposed a combined model that connects risk management (ERM), HR strategies and data analytics to help organisation risk better. Traditional risk management focuses mostly on money and operations but ignores people-related risk like employee performance, skills or behaviour. It also tries to fix the gap by bringing ERM (risk management), HR strategies (people management) and analytics (data and predictive tools) together as shown in Fig.2.

Ussher-Eke et al.[15] divided HR resources into three parts: polarity based sentiment, emotion based sentiment and aspect based sentiment. Polarity based sentiment is defined as the feedback given to the employees which can either be positive, negative or neutral. It also helps HR to quickly understand sentiment trends which are useful for getting surveys and general employee satisfaction. Next is emotion based sentiment which basically focuses on the emotions like joy, sadness or anger and provides deeper insights into the emotions and personality of a person. It is really important for detecting burnout from work, stress, or motivation among employees and supports more considerate and characteristic HR involvement. Furthermore, aspect based sentiment connects talks about specific topics or aspects like leadership, salary, work culture which allows HR to understand exact areas of concern or satisfaction. Such problems can be solved by multimodal analysis and transparent AI models that will improve HR skills. Sentiment analysis is a step toward emotionally intelligent and people-centric organizational cultures, assisting companies in creating workforces that are more flexible and adaptable.

Alyousef et al.[16] proposed a hybrid machine learning model like Red Forest, XGBoost and logistic regression which predict employee layoff. Similar to this model, explainable AI makes it easier to understand by opening the black box which refers to factors backing the prediction like experience and job, salary, position in the company. It makes the system transparent and understandable, helping the HR to achieve the result and make better decisions. Using these models companies can predict easily and take measures before the employee leaves. Valivarthi et al.[17] explained the algorithm used for

predicting the actions of staff members and analyze potential threats to internal security before bad things happen. Predictive control can activate alarm to conduct right action which can prevent data leaks and can help an organisation. In equation (1), $u(t)$ is Control action (e.g., flagging suspicious behavior), K as Gain matrix, $x(t)$ as state of the system at time t (e.g., employee activity). The equation (1) represents a predictive control mechanism where $x(t)$ is the current state of the system (e.g., employee behavior data) and $u(t)$ is the corrective action (e.g., alerting HR of suspicious behavior). The gain matrix K adjusts the strength of the response.

$$u(t) = -Kx(t) \quad (1)$$

Potel et al.[18] presented a 5-level maturity model of workforce analytics and AI capabilities in HR. At level 1 (Automation) does not require intelligence and works on a pre-defined set of codes. At Level 2 (Assisted analytics) require human intervention companies use reports to understand work force data such as employee performance or layoffs. At level 3 (Predictive intelligence), machines predict the result based on machine learning tools such as hiring needs, layoffs etc. At level 4 (Decision Augmentation), AI gives recommendations and suggestions to make better decisions. Finally at level 5 (Autonomous workforce system), it works separately from the most advanced stage AI. These need minimal human intervention.

Konda et al.[19] gave AI-powered platforms that provide individual recommendations, such as personal training programs, career development plans, or role adjustments based on the needs of the person. This personalization encourages continuous learning, improves employee engagement, and increases overall job satisfaction. Kumar et al.[20] explained how machine learning and data informed decision making helps transform human resources from intuition based decisions to preventive predictive approaches by using techniques like Random forest. This machine gives accurate results which helps HR to make good decisions replacement for human judgment However ML is not a decision maker, rather it helps provide insights.

Nozari et al.[21] proposed a digital twin-driven Support System (DT-DSS) which improves human resources management by predictive analytics and optimization. It creates a virtual model of the workforce. It uses simple machine learning to give results and help managers make better decisions about living, layoff, and training etc. While tools like Pareto frontiers allow managers to evaluate trade-offs and make right decisions, it is also sustainable as it reduces unnecessary hiring, layoff or resource consumption which contributes to green organization. This system is designed to make decisions like humans to avoid loop-decision making. But this study is limited to synthetic data, social factors and behavioural dynamics. It offers a framework that helps organizations to shift from reactive HR practices to a data based and strategic work force environment.

Bhupathi et al.[22] developed the Iterative Dichotomiser 3 (ID3) that is a tree algorithm which works by splitting the data into smaller subsets. It selects the best possible prediction to divide. This selection is based on information Gain (G) which measures how efficiently an attribute separates a data into distinct classes. It provides useful information for predicting the target. The algorithm repeats again to select the highest information gain until there are no more cases. In decision tree internal nodes represent cases, factors, branches represent possible values and leaf represent final class labels. It focuses on reducing the entropy at each step. The working of the system can be seen through an example tree obtained as shown in the Fig.3

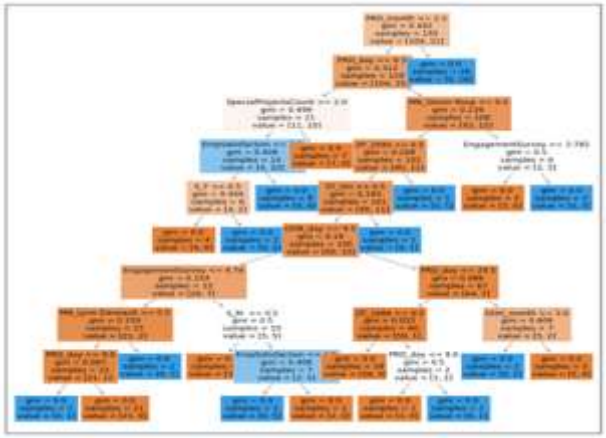

Fig.3. Working of the proposed Iterative Dichotomiser framework [22]

Kehinde et al.[23] gave an example of transportation companies like UPS use systems such as ORION to determine delivery routes. This system analyzes traffic, fast-road comfort drive. Due to faster routes the fuel consumption has reduced significantly. Another example is of health care, hospitals apply similar database techniques to adjust their monitor of a patient This helps staff schedules and allocate medical equipment based on patient demand. With the help of this the hospital can reduce waiting time and improve medical patient satisfaction. It can also be used in manufacturing. Companies use IoT (internet of things) which tracks machine performance and utilization. This helps in prevention of failures and reduces downtime. This leads to productivity and better use.

Benabou et al.[24] explained the challenges of HR with AI implementations. Using AI implementations in HR can be very costly for some organizations and can also cause technical issues like combining data from different systems. Meanwhile employees fear that AI will displace their jobs and thus are not supportive of AI tools to be used. To solve this, companies must balance automation with human involvement. With advancing technologies some HR professionals also need to be trained for efficient work, fair use of AI and ethical issues. Difficulties in using it can easily and effectively be seen during the pandemic COVID-19 when everything was based on AI and hybrid systems.

With new technological tools like Chatbot, Gemini and more, data privacy and correctness of the data have become a major concern. These systems need constant monitoring and updates to stay useful. Tuli et al.[25] talked about the advantages of using AI for HR. Digital tools help companies use data instead of guessing about the behaviour and future needs of the employees. This helps organizations reduce risk, make better decisions & improve data performance. Using this data, employees can search jobs that match their skills and interests, helping them train for career goals which gives better performance which leads to employee satisfaction. Digital AI can help the organization adapt quickly to change. This improves productivity and work-life balance. Continuous monitoring improves HR practices which leads to better decision making.

III. CONCLUSION

Machine learning makes HR smarter. These modern technologies can predict employee behaviour accurately. Many hybrid models (like Random Forest and XGBoost) give better results. It helps managers plan better, reduces risks and losses, and improves employee engagement to support long-term company growth. Before using these techniques, companies face many challenges like data privacy issues, AI bias, high cost, and the need for trained HR professionals. Hence, it helps in the growth of the company by reducing various risks. It supports long-term workforce planning.

There will be no replacement of HR, but it supports them in performing better. It gives an opportunity and enables the organization to build a smarter, more resilient, and future-ready workforce. Overall, machine learning helps in making an organization successful and achieving sustainable development goals. Continuous monitoring and regular updates, along with proper training of various staff members, are necessary to ensure the fair and effective use of AI technologies. Therefore, AI-driven HR analytics presents an effective approach that supports future challenges and sustainable organizational growth.

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