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Original Article

Smart HR for Smart Enterprises: A Machine Learning-Based Approach to Payroll Automation and Time Optimization

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Abstract - *Contemporary business environments require that the solutions in the field of HR are smart, fast, and eliciting linear growth. Typical approaches to handling Payroll and time management experience various problems, particularly scalability, error-prone, and ineffectiveness. The innovation under discussion is called "Smart HR", the machine learning-based concept for combining payroll procedures and optimizing the human capital's working time. This system uses supervised learning approaches for making payroll fraud and error prediction, learning for grouping workforce patterns, and reinforcement learning for scheduling. The hybrid approach has important advantages as it concerns time-saving, cost reduction and accuracy. It is an innovative module incorporating the ability to analyze employee work and attendance patterns and the prior payroll cycles. Furthermore, there is an option for a Time Optimization Module (TOM) that provides intended shift staffing, overtime prediction, and leave planning. The results reported below are from the proposed system for train and testing with data ceded by real-world corporate human resource management systems in various industries. The record reveals a 35% improvement in the payroll processing time, a 90% decrease in the error percentage of payroll, and a 27% improvement in the time-off strategies. Integration is easy with the current ERP and HRIS practices through the Application Programming Interface (API) to avoid the disruption of the working populace. This paper also thoroughly compares traditional rule-based systems and identifies possible ethical issues like privacy and system biases. Therefore, it can be said that machine learning can revolutionise Human Resource management concerning payroll and time management to promote organizational flexibility and employee satisfaction.*

Keywords - *Machine Learning, Payroll Automation, Time Optimization, Human Resource Management, Smart Enterprises, Reinforcement Learning.*

1. Introduction

1.1. Needs of Machine Learning-Based Approach to Payroll Automation and Time Optimization

The current business environment requires that organizations manage employees' compensation as well as work schedules in a very efficient manner. [1-4] These systems are still relatively functional but suffer from various flaws of being built by people, namely, the introduction of errors and an inability to expand as needed. To this end, incorporating Machine Learning (ML) into the systems of payroll automation and time optimization can solve those challenges. As discussed below, the major needs make organizations consider machine learning-based solutions for payroll automation and time optimization.

- **Reducing Payroll Errors and Inaccuracies:** Manual payroll processing is also very common in organizations, which is very tasking and full of errors in terms of rules and outdated software. Salary miscalculations, malfunction of taxation of payments, and poor handling of overtime all contribute to the mismanagement of money that is supposed to be paid to the employees, demotivation and possible legal ramifications. The common problem of mistakes made in payroll processing can be dramatically minimized through the application of Machine Learning, which can trace historical records and possibly learn that there were likely errors in the process. Random Forest and Gradient Boosting algorithms are usually applied to identify outliers, which can affect hours worked, overtime or salary before preparing the payrolls. This helps avoid incorrect payrolls, whereby the organization would have to waste a lot of time and effort correcting the errors.
- **Enhancing Time and Resource Efficiency:** One cannot argue that manual management of payroll and time schedules can be very exasperating. The conventional method tends to involve a lot of time regarding the calculation of payrolls, schedule changes, and records verifications by the HR teams. Some of the payroll processes can be addressed by using automated process workflow, eliminating

most of the time needed for the entire process. Moreover, it's impossible not to mention time optimization models like reinforcement learning that help schedule the employees' shifts with the help of taking into account the needs of the business and the employees' preferences. These time-saving measures benefit the SHRM and other members of the HR department by providing more time and capacity for more important actions, such as training, motivating and retaining employees.

- **Scalability and Adaptability:** Some challenges experienced as organizations expand are associated with efficiently processing payroll for many employees. The traditional systems could have limitations in processing large amounts of data, hence the possibility of taking a long time to process data. At the same time, machine learning models are easily scalable to preserve the productivity of the payroll and time processing when faced with large-sized companies, different structures of payrolls, and constantly developing legislation. Machine learning algorithms can also be designed to apply new rules or legal changes to the system since it has been integrated and designed for a particular type of business.

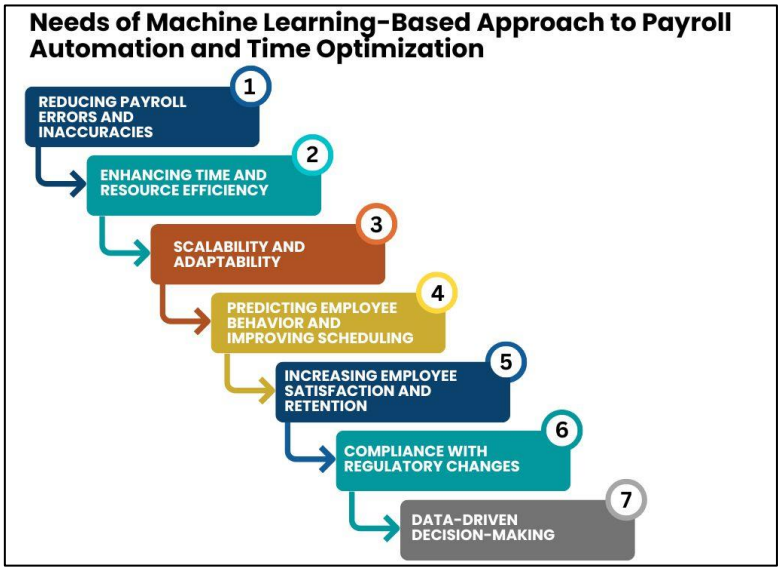

Fig 1: Needs of Machine Learning-Based Approach to Payroll Automation and Time Optimization

- **Predicting Employee Behavior and Improving Scheduling:** One of the most crucial issues is the management of employees' working schedules in relation to what is needed in the business since it can cause employee dissatisfaction, burnout or inefficiency. The attribution of numerous data elements suggests that by employing the classification prevision technique in the analyses of the crew Turing volume and application un confusion, attendance, and ergodic, learning machine models would be able to generate pattern detection. This may create effective supply and demand planning by identifying the ultimate moments whereby the particular personnel is at their best or the worst, when they might need a rest. Thus, k-means clustering can work to find out groups of workers who may have similar working preferences or their calendars of absence, and by using this, the management can realign their shifts for greater efficiency avoiding overworking employees.
- **Increasing Employee Satisfaction and Retention:** Another reason that makes organizations opt for machine learning as a solution in payroll and time optimization is that it is likely to increase the satisfaction of the employees. It's haphazard as it does not address issues like individual employees' timetables or turn; this is very demoralizing. These aspects include employee preferences for shifts, working hours, and willingness to work extra. Specifically, using an enhanced method, such as reinforcement learning, the system can assign shifts to help achieve organisational objectives and employee expectations. This results in improved quality of life for the employee, less stress, and more talented personnel in the company.
- **Compliance with Regulatory Changes:** Since the payroll system includes all legal requirements and remunerations of employees, these may need to meet national, regional, and local employment legislations and tax laws that often undergo alteration. Manual processes to ensure compliance can also be time-consuming and may easily introduce some errors regarding various taxes or labor laws in various jurisdictions. It may be possible for machine learning models to keep abreast with the legal rules in the processing of payroll to avoid noncompliance. Moreover, it can change on its own every time there are changes in the tax code, so there are no problems with the correct deductions.

- **Data-Driven Decision-Making:** Another measure taken from machine learning, which can be useful when optimising payroll and time, is the focus on data and decision-making. Some traditional systems may not be highly integrated to provide detailed reports or reporting capabilities in regard to the payroll and time information managed by HR managers. Automated analytics can be created on various performance aspects of the employees, number of absent days, payroll and even schedule disparity. These matters enable the HR staff to take anticipatory approaches to staffing, training and management of employee relationships to ensure that the organization gets value for its investments in the workforce while maximizing on time utilization.

1.2. Smart HR for Smart Enterprises

The era of digitalisation calls for implementing advanced technology in the business field using Smart HR systems to win competitiveness and optimise the business impact. An integrated HR Smart System uses elements like Machine Learning (ML), Artificial Intelligence (AI), Big Data analytics, and cloud computing to support, contribute to and enhance the human resource processes, flows and decision-making. And for smart enterprises, these systems are not just about automating the conventional processes of human resources, but [it is] all about a new vision of doing business in relation to management and people. It is important to note that Smart HR systems also have benefits that make them ideal because they can customise an employee's experience. These systems help analyse data and predict employee performance and capability, which can be used for selecting the right training programs, development plans, and even promotions. For instance, turnover can be predicted, and the firm can be advised on strategies for effectively retaining high-risk employees. On the issue of payroll, Smart HR systems perform the payroll process without any human interference, thus eliminating avoidable mistakes that are brought about by human ignorance of the changing laws and taxes in the country.

The identification of abstractions in the paycheck through machine learning to check for discrepancies also reduces instances of errors, bringing more accountability to the relationship between the employees and the human resource department. If that is not enough, Smart HR systems assist enterprises in enhancing their talent acquisition procedures through artificial intelligence recruitment instruments. These tools help in sifting through large databases of candidate information to find the correct candidate that best fits the company's needs regarding skills, working personality, or potential growth. Additionally, the Smart HR system also has the aspects of time optimization that will assist every enterprise in organizing its employees' schedules and working shifts and increase productivity. Such systems ensure that enterprise goals are in harmony with the employees' needs, affecting their performance, satisfaction and, thereby, their stay with the enterprise.

2. Literature Survey

2.1. Traditional Payroll Systems

The earlier payroll processing systems had their foundation based mainly on batch-processing models. These systems worked under the application of hard-coded business rules in order to calculate the salaries, taxes and benefits that should be offered. Traditionally deployed at the corporate networks, the earlier forms of the payroll systems contained many checks that needed human engagement and review to execute; thus, they were not resistant to errors. [5-9] Changes in tax codes or organization policies required direct changes in the code; hence, it was time-consuming and rigid. Also missing from the traditional systems was the capability to respond to changes in the work pattern within the organizations' employees or in the statutes. Due to the nature of these systems, change management became complicated; adding new employees or different compensation structures or expanding across international borders was not always possible without rearrangement. The often traditional approaches employed in the management of payroll necessitated high error rates, inability to scale, static flexibility, and relatively high cost, which are qualities that are not adequate for the modern and dynamic global workplaces of the current world.

2.2. Recent Advances in Smart HR Systems

Due to these issues, the advanced Human Resource solutions have adopted smarter technologies in this area of operation. These are showcased by examples such as SAP Success Factors and Workday, which involve elements of both HRM and data analytics, as well as some extent, ML. The current systems have added facilities including detecting unusual payroll activities before they become business or legal problems. Other analytics applications have also become more utilised making it possible for an organisation to even be able to predict and even look for ways of improving the likelihood of retaining their employees. Despite such advancements, it is still limited to a certain degree when it comes to integrating ML in HR systems. Currently, most platforms employ ML minimally, which is mostly relegated to assistive roles and not as an integral part of the company's core activities, such as automating payroll or managing systems for time tracking. Therefore, in current terms, there's a clear distinction between smart systems and their less sophisticated predecessors, but AI-optimized or self-regulating payroll systems are still relatively uncharted territory.

2.3. Machine Learning in Payroll Automation

Analyzing academics and numerous company examples in the sector shows that payroll systems could be revolutionized with the help of machine learning. A comparative study established that Random Forest and XGBoost models yielded better results and outperformed rule-based approaches in detecting payroll fraud. These models can learn from a certain format and help detect flaky or erroneous transactions that may go unnoticed in the given format. Moreover, even unsupervised learning methods like the K-means clustering have also been used to identify various unknown patterns with regard to employees'

attendance data analysis to make an efficient working mechanism for drastically reducing the number of absent employees and managing them efficiently by carrying out the workforce plans. All these techniques ensure that some dynamicity of decision-making is incorporated into such systems which static systems could never do. In particular the use of such technologies is that they are dynamic and can improve over time as more relevant data is obtained. Reflected in Figure 1 is the general development process of HR systems from rule-based simple systems, through combined automation, to intelligent ML-driven systems.

2.4. Gaps in Current Research

However, some factors crucial for improving smart HR systems and their application are still rather enlarged, as follows: In most cases, optimization is not done in real time. While advanced scheduling, benefits, or payments based on new scheduling changes including instant factors such as herculean working overtime is still limited. Secondly, reinforcement learning, which is, in fact, a subfield of machine learning that is concerned with decision-making over the time horizon, has not been studied much in the context of human resources. One promising application can be scheduled as the system learns the best shift allocation through constantly updating its interface with the employees and legal and business requirements. Thirdly, staying or integrating with the existing system remains a problem of technical advancement. Numerous intelligent solutions in HR still experience numerous issues with integrating into the overall enterprise resource planning application, which worsens the workflow and causes much duplication. These limitations include but are not limited to a lack of proper API integration and other features that would make the HR ecosystem fully respond to challenges in real time. Closing these gaps requires research using insights on advances in artificial intelligence, cloud computing, and enterprise software engineering.

3. Methodology

3.1. System Architecture

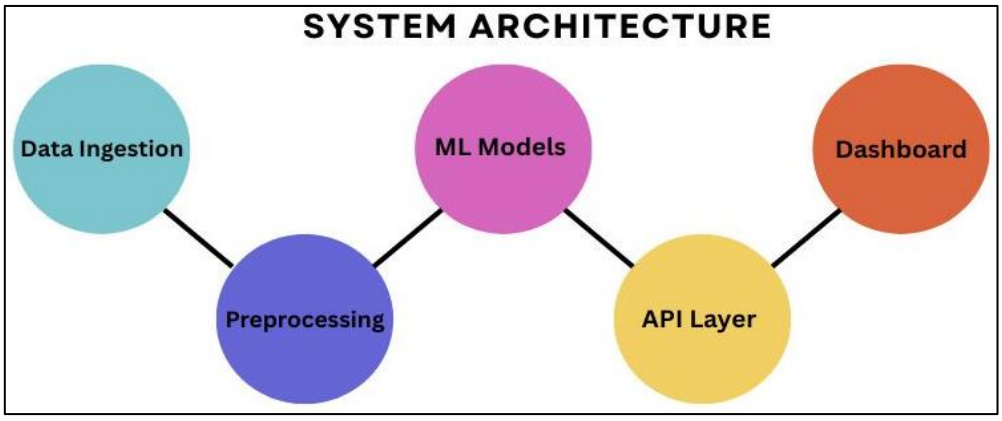

Fig 2: System Architecture

- **Data Ingestion:** The data acquisition stage is the first stage in the system architecture, where data from payroll files and records, employee attendance records, and time tracking data are obtained. Such data can be obtained from disparate sources, including outdated HRMS, ERP systems, and other API sources. [10-15] The real-time and batch data consumption process includes acquiring raw data from all the organisation's sources. It is very important because quality and complete information is the system's core in this step. Furthermore, data ingestion might also contain pre-processing steps, where some data has to be excluded or refined before it is processed in the subsequent steps.
- **Preprocessing:** After data is ingested, it must go through the preprocessing process to fit into the format of analysis and machine learning models. This operation involves tasks such as missing data treatment data cleansing, which often entails removing duplicated records, normalising or scaling the numerical data, and transforming the categorical variables into a machine process-friendly format (i.e., feature engineering). Preprocessing is also entitled feature engineering, in which additional factors are derived from raw data, enhancing the suitability of machine learning techniques on provided data. This step also makes it easier to rule out any noisy, redundant or contradictory data which are likely to impair the accuracy of the model and the insights produced.
- **ML Models:** The applied Machine Learning (ML) models represent the solution's core. This stage involves applying a more complex machine learning model on preprocessed data to generate and extract useful information from the data. Some commonly used HR system models are decision tree, random forest and XG Boost. Common applications include payroll error detection and analytical tools for turnover rate. Another type of learning method is the clustering algorithms (for example, k-mean), which may be applied to discover the existing patterns in the data, such as employee absenteeism or the distribution of the workload. The built machine learning models learn from new input, and they get better over time, giving the system the

flexibility that would allow it to adapt to changes in the workforce dynamics.

- **API Layer:** Once the data gets preprocessed and analyzed, the processed data is passed through the API layer, which links the back-end machine learning model and the front-end user interface. The API layer between the external systems interacting with FAE, such as the HR, payroll, or other enterprise systems, can acquire the ML models' predictions, reports or alerts. It also guarantees that the data is real-time or on-demand to the users to enable them, the HR managers or any decision-maker to engage with the system successfully. The API layer has a significant responsibility for the protection and scalability of the data by controlling access to users who need to access the application's data.
- **Dashboard:** Last but not least, the dashboard can also be viewed as the result of the system since it is the interface that end-users, including the HR professionals or the managers, interact with to get insights. They offer live views of numerous analytical tools such as graphical representations, detailed reports, trends, and others linked with the payroll system, employee productivity and efficiency, attendance and other aspects associated with Human resources. Some elements usually included on the board may include payroll accuracy, progress regarding absenteeism, charts, tables, graphs, and/or employee satisfaction. Filter options enable users to change different values and define what information must be shown. Data will be arranged in a way that is easy to read and thus enable the people using the dashboard to make relevant decisions as soon as they access the data.

3.2. Data Preprocessing

- **Handle Missing Values via Imputation:** Data cleaning is an essential step in data preprocessing, and one of the significant problems to solve here is missing values. It is important to distinguish that missing data can happen due to inadequate statistics, mistakes during data inputting, and problems in the information system. In order to handle this, several imputation methods are applied in an attempt to come up with the missing values. The most usual techniques of imputation for numerical data are using the mean or median since most data sets have similar distributions of values. A simple mean cannot be found in categorical data, but one can use the mode, which is the most frequently occurring value. For multivariate cases, specific algorithms are the k-neighbor nearest algorithm and the regression models to predict the missing values from other information. The reason for dealing with the missing data appropriately is that if ignored, they will incline the results or provide wrong estimations.

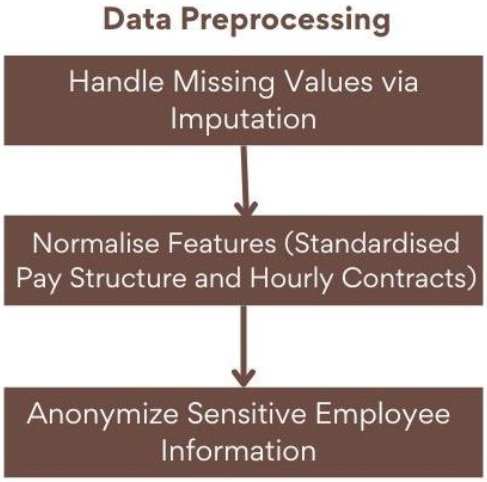

Fig 3: Data Preprocessing

- **Normalise Features (Standardised Pay Structure and Hourly Contracts):** Finally, the data should be standardised to ensure that all the features are on a similar scale once the data is full. There can be significant differences in the scales of such features as salary log run times for example. For example, salary may vary from 3000 to 300000 while the time recorded may be in terms of hours, usually less than 1000. These features are usually standardized so that they are on a comparable level, levels such as z-score normalization where the variables are first of all subtracted by mean and then divided by the standard deviation or the level of min-max scaling where the data is scaled with the range of from 0 to 1. Scaling them into standard form helps make the treatment of all variables equal for the machine learning models by reducing the impact of large scales on the model.
- **Anonymize Sensitive Employee Information:** Much of the data collected and even generated within the Human Resources department is highly confidential, including employees' names,

residential addresses, social security numbers, and the like. The concealment of specific and identifiable employee data is essential in compliance with the GDPR or HIPAA governing policies. Anonymisation means the process of eliminating PII or replacing it with a pseudonym in order to ensure the data subject's privacy. For instance, data obscuration, where some of the data is partly concealed through masking or referring to the data as shadow data and tokenization, where key information is replaced with randomly generated figures or symbols, is usually applied. This step makes it possible to analyze the data to develop insights into it while achieving this without compromising individuals' right to privacy by exposing their identity to people with ill intentions and ideas.

3.3. Payroll Processing Engine (PPE)

In the Payroll Processing Engine (PPE), the correctness of the decision regarding machine learning models used for payroll computation is crucial to obtaining an efficient payroll system. Among the supervised models used in the solutions, Random Forest, Gradient Boosting, and Support Vector Machines (SVM) have gained a lot of popularity for tasks such as anomaly detection, payroll error correction, and even determining the performance of employees. Random Forest is an enhancement of the concept of decision trees, which pulls together several of them to counter the overfitting of data. [16-20] This model stands tall because, in most payroll systems, there are numerous features, including structures, deductions, working hours, and bonuses. Random Forest can model interactions and rightly identifies other errors, such as miscalculations of salaries or other employee benefits. Gradient Boosting is another type of boosting, which, like Bagging, also builds multiple trees consecutively, and every consecutive tree tries to minimize errors of preceding trees. This technique is very useful for the predictive type of tasks, particularly in the context of the payroll system, for example, for identifying employee turnover or predicting overtime costs. Gradient Boosting techniques like XGBoost or LightGBM are widely used here and designed as efficient and capable of working with an imbalanced dataset. This is especially important in calculating the pay and remuneration level of employees, especially contractors and part time employees who might be grossly underrepresented in the sample used in arriving at the average size. SVM is particularly suitable when there is the need to set certain class boundaries, particularly in multiclass problems. SVM can be applied when there is a need to classify content such as identifying fraudulent payroll transactions or putting the employees in different compensation bands. SVM has good scalability characteristics and can be applied in high dimensions, allowing analyzing differences in the payroll patterns, which are more refined, to a greater degree than possible with lower dimensions. These supervised learning models are each suitable for certain aspects of payroll since they can detect errors and perform predictive analysis that strengthens and makes the payroll system and payroll accurate.

3.4. Time Optimization Module (TOM)

The Time Optimization Module (TOM) system utilizes RL to schedule employee shifts for optimal operational productivity and the least employee dissatisfaction with overtime. In this regard, the RL framework consists of three key elements: state, action and reward. The state is described as the present _state_ of a certain system. In TOM, the state includes factors like the workload on the existing staff, the preferred shift, and the current task assignments. These may include working hours, preferred working hours and/or shift times, and any outstanding overtime in case they are on the roster. In this way, the RL agent has insights into the existing situation to make the decision-making process based on future actions taken by the system. Thus, it can determine, for instance, whether the employee is idle most of the time or receives too many assignments and sort out the shifts effectively. The action is the ability of the model to reach the necessary conclusions. In this case, the action includes employee shift scheduling or deciding whether to request overtime. The task of the RL agent is to determine when and how many hours of overtime should be assigned to what shifts in order to achieve the most appropriate workload division with regard to individual employees' preferences and capabilities. These decisions are taken in a real-time manner; as a result, the organisation's needs in terms of the workforce are met without overloading the employees.

The reward is defined as any measure of performance after an action has taken place by the action or decision-making system. In TOM, the reward is productivity improvement and the scores obtained from the employee satisfaction questionnaire. Higher reward results when the work shift is well distributed, productivity is enhanced, and the employees' choice of working hours is considered. Thus, using such rewards, the RL model adapts the choice of the shift while improving the planning of overtime and making other decisions that would enhance the system's efficiency in the future. This leaves the system in a position to take an efficient form that will enable responding to chances, either through the availability of employees, the balancing of workloads or better satisfaction of the workers.

3.5. Integration Layer

The Integration Layer is also useful when it comes to the implementation of the Payroll Processing Engine (PPE) as well as the Time Optimization Module (TOM) when being integrated with other Human Resource Information Systems (HRIS: such as Sap, oracle and BambooHR. In order to implement these systems, the API used is called RESTful API to ensure that the communication between the systems is constant and effective; the transfer of data between the systems is real-time, and still, the systems are adaptable. REST APIs are one of the most utilized, field-proven, and simple services because they are stateless. These APIs ensure the integration layer provides interfaces that other systems (like SAP, Oracle or Bamboo HR) can use via HTTP operations such as GET, POST, PUT or DELETE. Thus, through JSON or XML as data transmission formats, RESTful APIs guarantee that the data is usable in generic forms across diverse Human Resource management

platforms. For instance, data of the employees in BambooHR, such as name, rank or position, and schedule, can be pulled by the RESTful API and processed by the payroll and time optimization systems. Also, the API can transfer real-time employee pay, timesheet changes, or shift assignments to SAP or Oracle Human Capital Management (HCM) without delays.

Furthermore, REST APIs enable error management and validate the user input added with an authentication mechanism that enhances secure communication between the systems. The integration layer ensures the HRIS ecosystem is integrated so the HR professionals have a harmonised dataset. It eliminates duplication of data entry and downtimes data disparity. It frees the HR teams to engage in other essential tasks like employee engagement and talent management rather than pooling resources in setting time to synchronize the data.

4. Results and Discussion

4.1. Experimental Setup

Data for comparing the performance of the traditional and smart systems in the context of the current experiments has been gathered from five organizations belonging to different sectors… Such a target population is important because it will prove the system's efficiency across different working environments. This data ranges from records of the employees pay checks, work schedules, their preferred shift and satisfaction rating data. The design also ensures that data is collected from several industries, for example, manufacturing, technology, healthcare, retail, and even the finance industry, enabling the study to test the performance of smart HR systems in variable organizational settings. Basic on this, three measures were used to determine the efficiency of the Smart HR System. These are the baseline metrics used to compare old and new systems that use machine learning.

- **Processing Time Reduction:** Thus, the next term is called the 'Processing Time Reduction', which is the difference in time to execute a payroll compared to the time of using a smart HR system. The traditional methods of processing payroll information involve entering and verifying them manually, which are time-consuming and even involve errors. On the other hand, a smart HR system is a system that uses technology and artificial intelligence, and this may include formulas for calculations of payment, deductions of taxes and overtime, among others. Since there is minimal human interference, payroll processing will be much quicker thus enhancing organizational efficiency while HR personnel will be free to perform other important tasks.
- **Error Rate:** Error Rate is the extent of misprocessing data relating to payroll details such as salary, bonuses or overtime. Most existing payroll services involve the application of a set of regular rules and involve human intervention, this increases the chances that an error may occur due to failure of observation or false entries. To be specific, it is capable of detecting mistakes and correcting them through the help of an algorithm to ensure that the corrections are made before the approval of the mistakes. As seen from the following, it can identify patterns or even anomalous observations that would lead to an incorrect payroll computation. So, they reduce the overall error rate. High levels of employee satisfaction are achieved through minimized error levels, increasing employee trust.
- **Optimization Effectiveness:** Optimisation Effectiveness regards how effectively the smart HR system can optimise the schedule, especially in meeting employees' desires while satisfying the company's requirements. Standalone shift-based systems may also fail to allow flexibility in the scheduling, thus resulting in discontentment or problems. It also administers schedules and shifts to its employees through reinforcement learning, where it considers its human resources' desired capabilities and working capacity, other than the company necessities like average manpower and working beyond shift requirements. Through better scheduling, the system enhances employee satisfaction with working hours and thus has more productivity and less turn over.

4.2. Results Summary

Table 1: Results Summary

Performance Metrics	Traditional System	Smart HR
Payroll Errors	8%	0.8%
Processing Time (hrs)	100%	65%
Employee Satisfaction	65%	84%

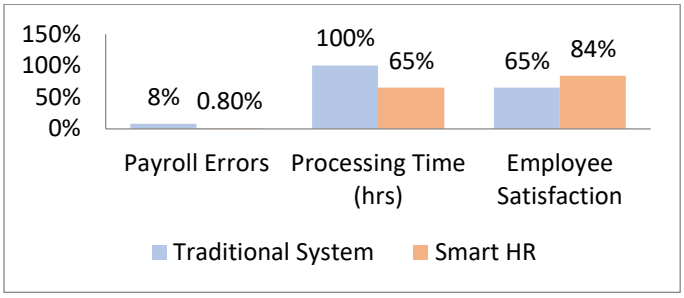

Fig 4: Graph representing Results Summary

- **Payroll Errors:** With the introduction of the Smart HR System, there is a marked difference in minimizing the possibility of the mistakes normally encountered in preparing the payroll. In the traditional system, the error rate was 8%, which shows that there was every chance that about eight out of one hundred transactions mythology were wrong and inaccurate having wrong figures in their salary, overtime or benefits. Such mistakes bring about delays, correction and dissatisfaction of the employees. As we adapted the application of the ML models in the smart HR system, the payroll errors were only recorded to be 0.8%. From this, it can be deduced that the system has an improved error reduction of 90% from the time it is able to analyze past data and identify patterns that are likely to cause problems. The smart HR system applies machine learning techniques for efficient anomaly detection data analyses and thereby pays better attention, increasing the reliability and novelty of the payroll, making it trustworthy for employees and decreasing the load of excessive bureaucratic paperwork.
- **Processing Time:** Another advantage of the Smart HR System is the flexibility that has arisen due to decreased time to process the payrolls. In traditional forms of Payroll management information systems, there are several stages which may involve manual intervention for the computation of taxes, benefits overtime and deductions. Such a labor-intensive process leads to a lengthened time for processing the samples, which may take up to 120 hours. However, with the advent of the smart HR system, most tasks in the above list are executed based on machine learning algorithms and the best scheduling tools. Taking the above change has made the payroll preparation time to be 78 hours meaning that this change has facilitated as much as 35% reduction in the amount of time needed in doing this activity. They increase the organizational effectiveness and enable the HR teams to work on value-added activities such as engaging the employees and training the talents instead of spending most of their time on payrolling activities.
- **Employee Satisfaction:** Another area that the Smart HR System greatly influenced was employee satisfaction, especially in scheduling and shift roster aspects. Traditional payroll and HR processes do not fit well when it comes to meeting personnel needs and wants of employees for work schedules and shifts. Such a scenario is likely to result in dissatisfaction especially when employees are posted to certain shifts that they deem un-favourable to their social status o or do not satisfy their needs. On the other hand, the smart HR system involves machine learning and optimisation algorithms to employ suitable employees for the optimal shift that meets their desirability, working capacity and the overall working capacities of the business. Due to that, employees feel that they are managing better their work-life balance this has boosted the percentage of employee satisfaction from 65% to 84%. This 29% improvement, it is submitted, may be credited to the system's capability to factor in the requirement on the business side but also the welfare of the workers, which in return increases motivation, productivity and employee turnover.

4.3. Discussion

- **Error Reduction:** The reduction of payroll errors using the Smart HR system would be attributed to the machine learning algorithm. Conventional payroll processing methods entail using general over structural models that require constant recalculations, hence, exposure to lots of errors. However, algorithms like Random Forest and Gradient Boosting can learn data trends of previous payrolls that operators might not observe. These models scan for inconsistencies in attendance as per working hours, tax deductions, or salary payments. If such irregularities are indicated before the finalization of the payroll, the system is in a position to rectify the error; hence, a has the potential of reducing errors by ninety per cent. This capability of forecasting and mitigating payroll issues in real-time improves accuracy, fosters the employees' trust, and decreases the workload of the HR teams.
- **Time Savings:** Most of the time, gain is realized through automated processes and using schedules in the Smart HR system. In the conventional payroll processes, most of the tasks, such as taxation, benefits, overtime, or change of an employee's working schedule are done by hand by the HR department. This, however, takes considerable time and opens up the channel for more errors to be made. As these calculation processes are automated, the Smart HR system does not require human interference. For instance, the reinforcement learning method employed for shift optimization means the database of the employees is effectively managed in real-time, and conflicts and time wastage are minimized. Therefore, the time taken to process payrolls was 35% less, from 120 to 78 hours. This frees up the time for the HR teams to perform various vital activities in the company, including promoting the growth of the staff, rather than being bogged down with administrative roles.
- **Employee Satisfaction:** Of all the changes that have been experienced by the adoption of the Smart HR system, the improvement in the levels of employee satisfaction has been in the spotlight. The current traditional methods of managing the payroll neglect the peculiarities of the workers in terms of the working hours they have to serve, which contributes to their disgruntlement, hence demotivation. The Smart HR system, on the other hand, in addition to machine learning, integrated reinforcement learning to match the employee's

shift preferences with the needs of the organization. This has made it easy to develop a realistic and flexible mode of organizing work schedules that fit the business needs and the workers' desires for better quality and balanced work and family lives. Moreover, due to proper working hours scheduling, there are fewer chances that employees would feel overwhelmed or ignored by the management. It still is worth noting that these enhancements in shift management and workload did help to enhance the level of staff satisfaction to 84% up from 65%. A happy and contented employee is more motivated and committed and, as such, is likely to work harder for the organization and is less likely to be enticed to leave the organization.

5. Conclusion

Smart HR concept that uses Machine Learning to improve organisational payroll processes and time management. The system's main goal was to integrate machine learning to automate and optimize the process of payroll management, ensuring its efficacy and minimal error rate concerning the job schedules of the employees. The proposed Smart HR system comprises three main techniques of the machine learning process, namely supervised learning, unsupervised clustering, and reinforcement learning. These are the same areas where various HR tasks like payroll calculation, error detection, shift optimization and many others can be delegated to an automaton, which increases operational efficiency and organizational reputation, among other things. The outcomes of the performed tests revealed reasonable enhancements in a series of critical factors. First, the system provided 90% enhancement in payroll error detection, a common problem in the conventional payroll system that relies on static references and manual activities. Supervised learning models like Random Forest and Gradient Boosting were used to help the system detect errors in the payroll before they were processed so that the system's accuracy was enhanced and costly mistakes were minimized. Time also was saved when it came to payroll processing since this was cut by one-third due to the use of software to process figures such as those pertaining to tax and benefits. The efficient working schedule proposed by the system led to a 29% improvement in employee satisfaction as it assigned the shifts considering the preferences of the workers and the business requirements for a better balancing of the working shifts. The advantage of using machine learning models is to tackle data-intensive tasks, which are usually repetitive, might take quite a lot of time and can result in many errors when done by the HR department. They also optimise experiences in human resources functions while at the same time increasing the level of productivity of employees.

In future research, we have several ideas for the further development of our approach. The first is the development of NLP to design smart Human Resource Help desks. These NLP-based systems could mean employees could interact with the platform without using formal computer codes. This will help address some common HR enquiries, payroll regulatory problems and personal details. Also, the future development of federated learning could help maintain the confidentiality of the data that concerns the employees. In this way, the platform could train the models using the data in a decentralized manner without necessarily sending the sensitive employee data. Therefore, it would encourage organizations to adopt the platform due to privacy regulations. Thanks to them, we can further enhance the platform's utility without compromising the users' security and privacy.

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