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The Role of Natural Science in HRM at Industry 4.0 Era

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Abstract: Natural sciences—particularly psychology and biology—can be applied to better understand human behavior, cognitive processes, stress responses, and other factors influencing workplace dynamics and employee well-being. Natural science relies on empirical evidence gathered through observation, experimentation, and data analysis. It aims to formulate theories and laws that explain the natural world and predict future outcomes. The emergence of Industry 4.0 has transformed the landscape of Human Resource Management (HRM) by introducing advanced technologies, including artificial intelligence (AI), machine learning, and big data analytics. These innovations have enhanced HRM processes such as recruitment, training, performance evaluation, and employee engagement. Natural sciences play a critical role in understanding the dynamics of these technological advancements, offering insights into human behavior, cognitive processes, and organizational ecosystems. This article explores how principles of natural science, including biology, psychology, and neuroscience, integrate with modern HRM practices in the 4.0 era. Through a qualitative approach, we examine case studies to illustrate the application of natural science in HR strategies, highlighting the advantages and challenges of adopting a scientifically-informed HRM framework.

Keywords: HRM; Industry 4.0; Natural; Science.

Introduction

Natural sciences and human resources (HR) intersect in ways that bring deeper insights into human behavior, cognitive processes, and physiological responses, enriching HR practices and strategies. While natural sciences are typically associated with understanding the physical world and living organisms, their principles can also be applied to improve various aspects of HR management (Atkins et al., 2023).

The Fourth Industrial Revolution, also known as Industry 4.0, has significantly influenced how organizations manage their human resources. Characterized by the integration of digital technologies, automation, and data-driven decision-making, this era demands new approaches to HRM that can effectively address the evolving needs of organizations and their employees (Husen et al., 2024). Traditional HR practices, which were heavily reliant on manual processes and subjective judgment, are increasingly being supplemented or replaced by technological solutions.

While technology is at the forefront of these changes, the role of natural sciences in HRM has become increasingly relevant (Omar, 2020). Disciplines such as biology, psychology, and neuroscience offer valuable insights into human behavior and organizational dynamics. For example, understanding the biological mechanisms of stress and motivation can enhance employee well-being programs, while psychological theories of learning inform the design of more effective training programs. The purpose of this study is to explore how the integration of natural science principles

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into HRM can create a more holistic and effective approach to managing people in the 4.0 era (Balouei Jamkhaneh et al., 2022).

Data science and artificial intelligence (DSAI) techniques advanced representation learning, advanced analytics and learning, knowledge discovery, computational intelligence platform, event and behavior analysis, social media/network analysis (Trivedi et al., 2024). Other fundamental areas such as statistical modeling and mathematical modeling also play a critical role in enabling FinTech (Cao et al., 2021).

The integration of natural sciences into HRM offers a more comprehensive understanding of employees' needs, behaviors, and well-being (Darmawan et al., 2023). By leveraging insights from biology, psychology, neuroscience, and environmental science, HR professionals can develop more effective strategies for recruitment, training, employee well-being, and overall organizational culture. As the workplace continues to evolve with the demands of Industry 4.0, incorporating natural science principles into HR practices can help create healthier, more productive, and more engaged workforces. This interdisciplinary approach is becoming increasingly crucial for organizations aiming to remain competitive in a rapidly changing world.

Method

The research method using actual and factual situation analysis, as well as considerations based on literature. In this case, it will be possible to find the latest problems on the research topic raised this time, with the literature review method it will get something knowledge that can add insight for researchers. The method used in this research descriptive qualitative research is literature review and actual and factual situation analysis (Sugiono, 2021).

In this second stage by finding a problem, the problem raised in this research is how to implement a smart consumer loyalty system with the chatbot based on web method and internet media. The initial stage in Natural Language Processing is to do Text Preprocessing first. Text Preprocessing is the first step in the model building process (Sihombing, 2022).

In this last section, the author conducts research based on data that has been collected through previous research studies, and researchers conduct research so that the reset can produce data and the data can be a proposal for a new system, which will be used in the future by conducting research. Then the problem raised can be solved and a solution can be found. The study used unobtrusive research techniques to analyze objectively the impact of AI (Mhlanga, 2020).

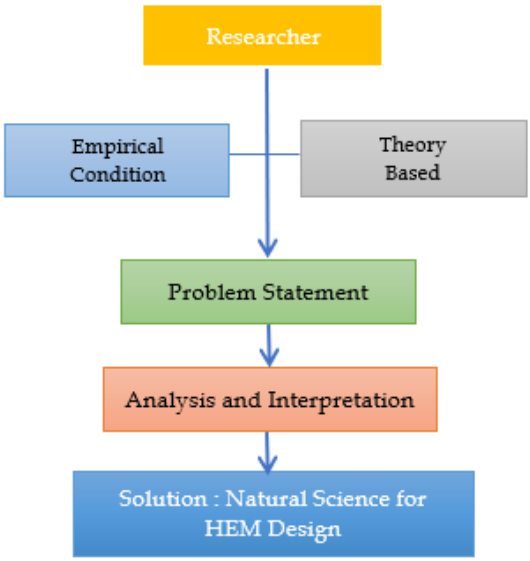

Figure 1. Research Logic Flow

This research uses qualitative methods by reading previous research, by exploring journals that conduct similar research and reading many books that discuss research like this, qualitative methods by also conducting discussions with various parties who understand this research. And then the author will be design the models as follow flow of thinking below.

Result and Discussion

Enhanced Recruitment Processes in HR and the Role of Natural Science

The recruitment process in Human Resource Management (HRM) has evolved significantly with the advent of advanced technology and scientific understanding. Natural sciences, particularly psychology, cognitive science, and biology, have played a critical role in enhancing recruitment practices by offering deeper insights into human behavior, personality traits, and cognitive abilities (Barrett, 2020).

Psychological principles and assessments have become central in modern recruitment. Tools like psychometric tests and personality assessments (e.g., Myers-Briggs Type Indicator, Big Five Personality Traits) are used to evaluate a candidate's suitability for a specific role. These assessments measure traits such as openness, conscientiousness, extraversion, agree-ableness, and emotional stability. By understanding the psychological profile of candidates, HR professionals can ensure that new hires align with the organization's culture and values, and have the cognitive and emotional traits necessary for success in the role. For example, a sales position might require a high level of extraversion and emotional resilience, while a research role might favor individuals who score high in traits like

openness and conscientiousness. A technology company used psychometric assessments to identify software engineers who are not only technically proficient but also have high levels of adaptability and teamwork, ensuring a better cultural fit and improved long-term retention.

Deep learning is a specific field of machine learning that teaches computers to learn and think like humans (Aggarwal et al., 2022; Kaluarachchi et al., 2021). Deep learning involves neural networks consisting of data processing nodes that resemble the operation of the human brain. With deep learning, computers recognize, classify, and correlate complex patterns in input data. When introducing deep learning into the asset management, there are major issues to be aware of (Kato, 2020).

Cognitive Science in Predictive Analytics for Recruitment

Role of Cognitive Science is give an insights from cognitive science are applied in recruitment processes to understand how candidates process information, solve problems, and make decisions. Cognitive ability tests, like problem-solving assessments, numerical reasoning, and critical thinking tests, help gauge a candidate's ability to learn and adapt to new information (Talman et al., 2021).

Cognitive ability is one of the best predictors of job performance across various roles (Wang et al., 2021). These tests help HR managers identify candidates with strong analytical skills and high learning potential, crucial for roles that require constant adaptation and critical thinking. A finance firm integrated cognitive ability assessments into its recruitment process, allowing them to select analysts who excel in complex problem-solving and data analysis, leading to better performance in roles that require quick and accurate decision-making.

This research aims to build a Chatbot to maximize the automation of FAQs at PT SRI by using the NLP method and applied to chat messenger on the website. So that the chatbot that has been built can contribute to improve services that are able to answer questions automatically (Bock & Garnsey, 2008). There are strong implications for all businesses, particularly large businesses in competitive industries, where failure to deploy AI in the face of competition from firms who have deployed AI to improve their decision- making could be dangerous (Stone et al., 2020).

Neuroscience research on how the brain learns and adapts has influenced recruitment by providing insights into a candidate's learning capacity and adaptability. Understanding neural processes related to learning helps HR managers predict how quickly a candidate can acquire new skills and adapt to changes in the workplace. This is particularly important in fast-paced industries like technology, where job roles evolve quickly, and employees need to continually update their skills. Assessing candidates' learning agility can help HR select those who will be able to adapt and grow within the company. A tech startup uses gamified assessments based on neuroscience research to evaluate how candidates respond to novel situations and how quickly they can adapt their strategies. This enables them to hire individuals who can thrive in an environment characterized by rapid technological change.

Using Natural Science in Recruitment

Imagine a large company that produces many products every Complexity of Assessments: Implementing scientifically-based assessments can be complex, requiring HR professionals to be trained in interpreting results accurately. Using biological or psychological assessments in recruitment raises concerns about fairness, privacy, and potential bias. It's important to ensure transparency and obtain candidate consent when using such methods. Some scientifically-based tools, such as AI-powered cognitive tests or neuroscience-based assessments, can be expensive, potentially limiting their use to larger organizations.

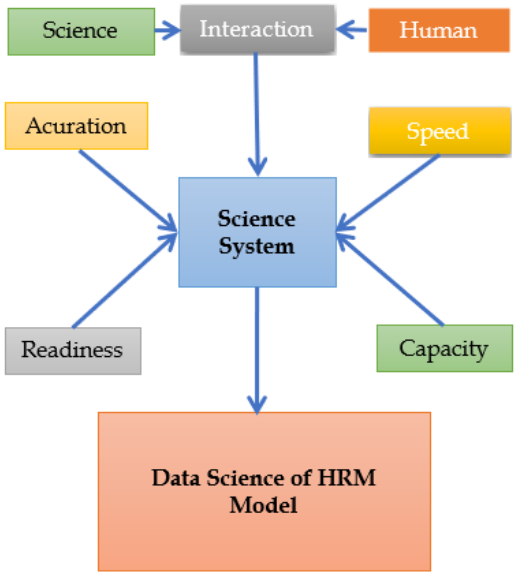

Figure 2. Natural Science for HRM Design
Source: Author

Cognitive science is the interdisciplinary study of the mind and its processes, including how people think, learn, remember, and solve problems (Friedenberg et al., 2021). It draws from psychology, neuroscience, artificial intelligence, linguistics, and other fields to understand how cognitive functions shape human behavior. In the context of Human Resource Management (HRM), cognitive science plays a crucial role in predictive

analytics, particularly in recruitment, where understanding a candidate's cognitive abilities can significantly improve the process of identifying the best fit for a role.

Predictive analytics involves using data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes based on historical data. When combined with insights from cognitive science, predictive analytics in recruitment helps HR professionals make data-driven decisions, ensuring a better match between job candidates and roles (Pessach et al., 2020). Cognitive Ability Tests as Predictors of Job Performance. Cognitive Science Role: Cognitive science provides insights into how individuals process information, solve problems, and learn new concepts. In recruitment, these insights are translated into cognitive ability tests that measure candidates' skills in areas like numerical reasoning, verbal reasoning, logical reasoning, and problem-solving.

Application in Predictive Analytics: Data from cognitive ability tests can be used to predict job performance. Research has shown that cognitive ability is one of the best predictors of job performance across various industries. Predictive models can analyze test results alongside historical performance data from current employees in similar roles to identify candidates who are likely to excel. A software company may use numerical reasoning and logical reasoning tests as part of their recruitment process. By feeding the test scores into predictive analytics models that correlate test scores with high performance in previous hires, the company can predict which candidates are likely to excel in problem-solving tasks required for the job. Measuring Learning Agility for Future Potential. Cognitive Science Role: Cognitive science helps HR understand learning agility, which is the ability of an individual to learn quickly from new experiences and apply that learning to new situations (Hadiono, 2023). It involves skills like critical thinking, adaptability, and the capacity to quickly acquire new skills.

Application in Predictive Analytics: Learning agility is critical for roles that require ongoing adaptation, such as those in technology, where tools and methodologies change rapidly. Predictive analytics models can use assessments of learning agility, combining them with data about past job changes and career trajectories, to predict how well a candidate might adapt to new challenges and learn new skills (De Meuse & Harvey, 2022).

A consulting firm uses a series of cognitive tests designed to measure adaptability, combined with machine learning algorithms that analyze past performance data of current employees. The predictive model identifies candidates who have a high likelihood of thriving in an environment that demands constant problem-solving and adapting to client needs.

Data-Driven Behavioral Analysis and Problem-Solving Skills. Cognitive Science Role: Understanding cognitive processes such as decision-making, pattern recognition, and problem-solving helps recruiters assess how candidates might behave in job-related scenarios. Cognitive science insights are used to design situational judgment tests and simulation exercises that reveal how candidates think through complex situations.

Application in Predictive Analytics: Predictive analytics uses data from these behavioral and cognitive assessments to identify candidates who demonstrate the ability to solve problems in ways that align with the role's requirements. By combining cognitive test scores with data on how candidates performed in specific job scenarios, predictive models can forecast their performance in real job settings. A financial services firm uses simulation exercises that replicate typical job challenges, such as analyzing market trends or making investment decisions. The data from these simulations are used in predictive models to evaluate how candidates approach problem-solving, which is then matched against the success profiles of high-performing analysts in the firm.

Natural Language Processing (NLP) is the processing of language, such as spoken and language processing, such as spoken and written by humans in everyday conversations through computer. The computational process for processing language processing, must be represented into a series of symbols that fulfil certain rules. In the process, NLP will make computer can understand any commands or standard language that is commonly written or performed by humans. The output of the standard answers entered by the user beforehand already based on the summarized meaning of the input.

Behavioral science combines insights from psychology and other natural sciences to understand and predict human behavior (Hofman et al., 2021). HR departments use behavioral data to identify patterns in candidate behaviors during the recruitment process, using AI and predictive analytics to determine the likelihood of a candidate's success in a role. The application of chatbot can be applied in the form of Natural Language Processing which is one of the field of Artificial Intelligence) to study communication that is by humans with computers through natural language (Primasari, 2023).

System and software design is the stage of describing and designing the system and interface display, both the letters used and the background as the appearance of the virtual customer services chatbot application (Mulyatun et al., 2021). This approach allows

for a more personalized recruitment process, where decisions are based on empirical data rather than subjective judgments. By analyzing candidates' responses to various behavioral scenarios, HR can predict future job performance and cultural fit more accurately.

The use of artificial intelligence on this chatbot system lies in the pre-processing process, specifically using natural language processing. NLP is a branch of AI concerned with enabling computers to understand words in much the same way as human. The preprocessing process includes tokenization and lemmatization. This method is applied to the process of preparing a bag of words for chatbot training based on the pattern and response file (Christian & Erline, 2022).

A multinational corporation uses AI-based platforms that analyze video interviews for non-verbal cues such as facial expressions and tone of voice, combined with behavioral science theories (Chakraborty et al., 2023; Mari, 2024). This helps them gauge candidates' confidence, empathy, and communication skills, leading to better hiring decisions. Thereafter, this method is applied for processing the user's response in advance of doing the pattern matching to find the answer (Christian & Erline, 2022).

Conclusion

There are several things that have been done and can be concluded as follows: In this research has been achieved analysis, design, implementation, testing and publication. Analysis and design in this research using an object-oriented approach. Diagrams for design and modelling using UML. Customer Service can be facilitated in respond to questions from visitors or customers who ask without having to answer them manually. Natural Language Processing approach in the customer services application, conversations and discussion that occurs as if it were done between humans and humans.

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Conflicts of Interest
In this research, there is no interest and or hidden interests among the researchers

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